PROPOSAL

IS 20 PLENTY FOR HEALTH? EVALUATION OF THE 20MPH SPEED LIMIT NETWORKS IN EDINBURGH AND BELFAST ON A RANGE OF PUBLIC HEALTH OUTCOMES

1. BACKGROUND

1.1. Existing research

The links between transport policy and infrastructure, and health, are well known (Gorman, 2003; Cairns, 2014). Transport has the potential to promote health, through enabling greater access to work and social activities and encouraging physical activity, and also to impact on health negatively, through causing road traffic collisions and influencing exposure to noise and air pollution (Morrison, 2003). Transport interventions that are beneficial for public health include campaigns to prevent childhood injuries, increase bicycle and motorcycle helmet use, promote wearing seatbelts, and applying traffic calming measures (Morrison, 2003).

The recognition of these links to health have led to more integrated transport and health policies in the UK and internationally. Scotland's transport white paper set out a vision for transport to play an important role in enhancing health (Scottish Executive, 2004). Further, the importance of integration between public health and transport and planning policy was stressed by England's public health white paper: Healthy lives, healthy people (HM Government, 2010). At an international policy level, the Toronto Charter (Global Advocacy for Physical Activity (GAPA), 2012) discusses the importance of active travel in having a great impact on health and sustainable development.

There are several transport related issues that can impact negatively on health including, a lack of infrastructure to support active travel, motorised vehicles being prioritised with regards to road space (Buehler, 2016); and the direct and indirect health-related impacts of motorised traffic behaviour e.g. collisions and perceived lack of safety (Jacobsen, 2009). Traffic speed, in particular, is a key risk factor in road traffic incidents, both with regards to the risk of a collision, and injury severity (World Health Organisation (WHO), 2016). For vulnerable road users such as pedestrians and cyclists, the relationship between speed and injury is even more severe (WHO, 2016). Reductions in traffic speed can therefore offer multiple public health benefits. These include reducing the risk of traffic collisions and the resulting severity of injuries, encouraging greater uptake of physical activity (through increased walking and cycling), and improving pleasantness and social cohesion on streets. The reduction of the speed that vehicles travel at has been described as "one of the cheapest and most effective methods for improving public health" (Dorling, 2014, p.46).

Implementing 20mph speed limits in the UK is becoming increasingly common (Tapp, 2015, Toy, 2014). A citywide 20mph speed limit has been implemented in Portsmouth, UK (Atkins, 2010), and other local authorities have introduced 20mph limits on a smaller, more localised scale on a pilot basis (Bristol City Council, 2012, City of Edinburgh Council, 2013). In both Bristol and Edinburgh, the success of their respective pilot schemes has led to the decision to roll out a 20mph speed limit across the whole city. An umbrella review investigating the health implications of 20mph (30kph) zones and speed limits (Cairns, 2014) concluded that these schemes can reduce accidents, injuries, traffic speed and volume, improve perceptions of safety, and be cost-effective. Twenty mph speed zones typically involve the use of physical traffic calming measures such as speed humps or chicanes (Grundy, 2009), whereas 20mph speed limits generally rely on road signage and legislation, and less so on physical measures (Toy, 2012). Of the 10 studies identified, only two studies focussed on speed limits specifically. Both studies provide evidence to support a reduction in injuries and casualties through a reduction in speed although the effects on walking and cycling levels are unclear and need further investigation. Our proposed study is designed to investigate this aspect. The Cairns review also sought to investigate the impact of speed limits and zones on health inequalities. None of the studies included in this review examined the effects of

such initiatives on inequalities; this was identified as a clear priority for future research investigating 20mph schemes. Morrison (2003) stresses the importance of assessing the complex impacts on health and potentially inequalities when evaluating transport interventions, and the importance of evaluating transport interventions in natural or field settings, to fully assess their complex impacts on health (a further focus of our proposed evaluation). With regards to road casualties for example, these are often socially patterned with more prominence in areas of high deprivation (Cairns, 2014). Below, is a more detailed examination of the key public health outcomes related to a speed limit reduction that will be considered in this evaluation.

Physical (in)activity

Physical inactivity, as characterised by a lack of sufficient physical activity (less than 150 minutes/week), is in the top ten leading behavioural risk factors for global mortality (WHO, 2009b). In highly physically active cohorts, reductions as high as 41% in all-cause mortality have been observed (Moore, 2012). Physical inactivity is responsible for at least 6% of CHD, 7% of type 2 diabetes, and 10% of both breast cancer and colon cancer cases worldwide (Lee, 2012). The global prevalence of physical inactivity is 31% (Hallal, 2012) and the WHO has targeted a reduction in physical inactivity of 10% by the year 2020 (WHO, 2013). Research is needed to develop and evaluate large-scale interventions with the potential to increase population levels of physical activity. The National Institute of Health Research (NIHR) have funded an increasing number of studies in recent years that seek to add to this evidence base, emphasising physical activity as a public health issue of upmost importance.

Walking and cycling have been shown to reduce the risk of all-cause mortality by 11% and 10% respectively (Kelly, 2014) and it is estimated that up to 50% of short trips could be easily walked or cycled (Jacobsen, 2009). Active travel (physical activity primarily through walking and cycling for commuting and utility purposes) has been suggested to be “the most practical and sustainable way to increase physical activity on a daily basis” (GAPA, 2012, p2). There is evidence that active travel can be a major contributor to meeting physical activity guidelines (Buehler, 2011) and is associated with a healthy bodyweight and composition (Flint, 2016). Guidance from the National Institute for Health and Care Excellence (NICE) recommends that environmental and policy level actions will be required to support walking and cycling, such as reducing the actual and perceived dangers associated with travel on roads (NICE, 2012). Findings from the 20mph pilot project in Edinburgh showed an increase in journeys made on foot of 7%, and an increase of 5% for journeys made by bike (City of Edinburgh Council, 2013). Similarly, increases of at least 10% in walking, and at least 4% for cycling were found in the Bristol pilot project (Bristol City Council, 2012).

Road casualties

The term ‘casualties’ in this context refers to a person killed or injured in a road accident and can be sub-divided into killed, seriously injured and slightly injured (Dept for Transport, 2015). Motorised transport is responsible for about 120,000 deaths and 2.4 million casualties each year in the European region (WHO), 2009a). In Great Britain in 2014, there were nearly 25,000 people killed or seriously injured as a result of road accidents, with proportions of fatalities of pedestrians and cyclists similar to those for the European region, at 25% and 6% respectively (Dept for Transport, 2015). Casualties are socially patterned, with levels of casualties higher in areas of socioeconomic disadvantage (Steinbach, 2011).

Pedestrians and cyclists are at a disproportionately high risk of death and serious injury compared to those using motorised vehicles (WHO, 2009a). Data from 1997 for the European Region indicate pedestrians and cyclists accounted for 22% of people involved in serious car crashes for that year, but 33% of those killed (WHO, 2004), evidencing their increased risk of death if involved in a collision. Vehicle speed is related to the likelihood of a crash occurring in the first instance; at higher speeds, a driver’s time to react is shorter, stopping distance is greater, and manoeuvrability is compromised (Aarts, 2006). Vehicle speed is also a significant factor in determining the severity of road traffic casualties. It is suggested that fatality risk for a pedestrian struck at 31mph is twice

that of being struck by a vehicle at 25mph, and five times that of being struck by a vehicle travelling at 19mph (Rosen, 2009). These statistics are similar to others found; Tefft (2013) suggests pedestrian risk of death reaches 10% at 24mph, 25% at 32mph, and 50% at 41mph. One modelled estimation is that a reduction in average speed of 1mph is associated with a reduction in casualties of 5%, rising to 6% when applied to urban areas (Taylor, 2000).

Previous signage-only 20mph schemes have provided encouraging results with regards to speed reduction. Results from the pilot scheme in Edinburgh indicate an overall reduction in speed on roads where 20mph limits were implemented of 1.9mph (City of Edinburgh Council, 2013). In Portsmouth this figure was 1.3mph (Atkins, 2010), and the figures for 2 pilot areas in Bristol were 1.4mph and 0.9mph (Bristol City Council, 2012). If these speed reductions were observed in future 20mph speed limit implementation areas, it would be reasonable to assume a potential decrease in casualties of between 6-12%. Furthermore, on roads that were characterised by speeds of over 24mph before 20mph speed limits were introduced, in Portsmouth an average reduction of 6.3mph was observed, and in Edinburgh this figure was 3.3mph (Atkins, 2010; City of Edinburgh Council, 2013). These figures indicate potentially even greater positive implications for casualty rate and severity. In Portsmouth, a reduction of 22% in reported road casualties was observed when comparing the three years prior with two years post implementation (Atkins, 2010). However, there is little evidence to suggest that such schemes will impact substantially on reducing health inequalities in relation to traffic casualties (Cairns, 2014), indeed evidence exists which suggests that the greatest beneficial impact in the future will be evident in the least deprived areas (Steinbach, 2011).

Perceived safety

Preliminary findings from our developmental, preparatory, qualitative work with key stakeholders of the 20mph scheme in Edinburgh [see section of application on project management] identified perceived lack of safety as a substantial factor in deterring greater levels of walking and cycling. Indeed, where pedestrians and cyclists are safer, levels of walking and cycling tend to be higher (Jacobsen, 2009). Tovar (2013) found that 20mph limits without traffic calming significantly increased walking and cycling by increasing actual, and perceived road safety. One potential mechanism for this action may be in reducing the speed differential between motorised vehicles and cyclists on the roads, thus increasing cyclists' perceived and actual safety.

20mph and social cohesion/connectedness and liveability

Walkable streets, as well as encouraging physical activity, also strengthen social support networks, which is of great public health relevance (Cohen, 2014). The impact of traffic behaviour on communities has long been demonstrated. For example, in Bristol, Hart (2011) found that residents living on streets characterised by heavy traffic volumes had significantly fewer friends and acquaintances on their street in comparison to those residing on streets with light traffic volumes. In discussing the implications for their findings, Hart (2011) indicated that similar findings of low social connectedness were likely to be found on most UK cities' streets with high traffic flow. In Bristol, on streets with light traffic, occasional speeding was sufficient to create the perception of a dangerous environment; speeding traffic was the most frequently cited cause of stress amongst these residents (Hart, 2011).

Speeding behaviour by traffic has been identified as the greatest anti-social behaviour problem in local communities, based on data from the British Crime Survey (Poulter, 2007). Traffic behaviour, in particular aggressive and speeding-type driving styles provide unnecessary noise and can contribute to stress-related illness in residents (Cohen, 2014). Dorling (2014) has indicated lowering speed limits to 20 mph would result in increased liveability in cities. Dorling proposed that traffic travelling at lower speeds requires less space to move safely, allowing more space and scope to enhance the pleasantness of residential environments; more space for pedestrians, planting, seating and other street furniture.

There is a lack of evidence evaluating the direct impacts of traffic speed on social cohesion. This would be a novel part of the present evaluation – to address the interplay between speed limits, social cohesion and health.

Edinburgh pilot implementation
An area-wide 20mph limit was implemented across south central Edinburgh, with the scheme launched in March 2012. Twenty-eight streets were changed to 20mph, and along with 20 streets that remained at 30mph, were monitored before (May, June 2011) and after implementation (May, June 2013) for traffic speeds. In 20mph streets, average speeds fell by 1.9mph (from 22.8 to 20.9mph); in 12 streets, where average speeds exceeded 24mph before implementation, a greater average reduction of 3.3mph was found. Four streets saw slight increases in average speed after implementation, and four streets had average speeds greater than 24mph. Speeds also reduced on the roads that were maintained at 30mph, by a smaller magnitude of 0.9mph (from 26.3 to 25.4mph). Over 1,000 household surveys were carried out before and after implementation. Before implementation, 68% supported 20mph speed limits, and after this figure rose to 79%; strong support increased from 14% to 37%. Opposition to the limits reduced from 6% to 4% after implementation. There was a net increase of +7% for journeys on foot, an increase of +5% for journeys by bike, and a decrease of -3% for car journeys. This evaluation was small scale, and did not utilise the robust methods that will be used in this proposed evaluation.

1.2. Risks and benefits

The introduction of a city-wide 20mph speed limit is likely to have a number of risks and benefits, both direct and indirect, to the populations of Edinburgh and Belfast as a consequence of speed reductions and potential modal shift. The literature presented in previous sections outlines some of the main putative benefits including reduced casualties, increases in walking and cycling and calmer and more pleasant streets. What is less clear are the potential risks such as noise and air pollution. Indeed, there is some debate as to the direction of the effect for these particular outcomes. The debates and conclusions drawn currently depend on the data sources being used which include modelling and testing of vehicle emissions and on-street monitoring systems.

It has also been suggested that the purpose of 20mph limits may inform the direction of effects. For example, if the main focus is on promoting active travel and smoother driving patterns, then it is plausible to assume that emissions may be reduced. We have explored whether to include these outcomes in the current study but after discussion with experts we concluded that determining emission changes attributable to a small change in average speed will be challenging, let alone quantifying and associating air pollutant concentration changes with the intervention.

Overall we have reasonable evidence to suggest that the direction of most effects are likely to produce public health benefit rather than risks. One of the main issues is whether these are equally distributed across the population (see section 5).

1.3. Rationale for current study design

There have been no rigorous evaluations of city-wide 20mph limits. The Department for Transport funded study (Atkins 2016) is only evaluating small scale or city centre schemes, which may be limited in their public health impact. City wide schemes may differ significantly in terms of the population affected, and change that can be brought about. Furthermore, Scotland and NI schemes are not included in the Atkins study, as the legislation differs with that in England.

Determining the best evaluation design to use was based on a number of factors. Reducing the speed limit for motorised vehicle to 20mph needs to be recognised as an event in a system (Hawe, 2009). The number and variety of individuals, groups and organisations likely to be affected by the change and the importance of their behaviour and the interactions between them requires an evaluation appropriate for the complexity of the intervention (Craig, 2008). Specifically, the implementation of the interventions have been decided by the local authorities and the difficulties (ethical and logistical) of maintaining a rigorous experimental study (such as a randomised

controlled trial) across urban areas means that observational and natural experimental methods have to be employed (Craig, 2008). The use of these methods brings challenges to the conclusions that can be drawn from the results, however, we believe that by explicitly acknowledging these challenges and exploring them it will be possible to draw valid and valuable conclusions. Furthermore, a significant part of this study will be a process evaluation following the Medical Research Council (MRC) guidance on process evaluations of complex interventions (Moore, 2015) to provide lessons and recommendations which can be applied to other urban areas wishing to implement new speed limits for motorised vehicles. Following the MRC guidance (Craig 2008), considerable preliminary work has been undertaken with stakeholders to develop an initial programme theory/logic model to inform, and be tested by, the outcome and process evaluations (logic model available on request from principal investigator).

We will use a theory based approach to our evaluation. Theory-oriented evaluations present themselves as a new wave vis-à-vis method-oriented evaluations (Stame 2004). This approach argues that evaluation should not be driven by methods as all have their strengths and weakness. Rather, theories should be made explicit, and the evaluation steps (and design) should be built around them: by elaborating on assumptions; revealing causal chains; and engaging all concerned stakeholders.

The programme theory outlined in the logic model demonstrates complexity of the pathways (i.e. perceptions, behaviours) through which the reduced peak and average speed limit is purported to lead to more objective health-related outcomes such as active travel. Consequently, this study has been designed to not only address the question of the effects, impacts and costs of the intervention but also how and why the intervention and effects/impacts occurred or did not occur. We are proposing a theory-based evaluation which will enable us also to use a realist perspective to understand what worked, for whom, in what circumstances, and why (Pawson, 1997). This approach will enable us to evaluate (qualitatively and quantitatively) whether the intervention has differential effects (e.g. impact on health inequalities).

2. AIM AND OBJECTIVES

2.1 Aim

To evaluate and understand the processes and effects of city-wide 20mph legislation in Edinburgh and Belfast. The focus will be on health-related outcomes (active travel and casualties) and the pathways and processes that cause this transport policy to have public health benefits. Alongside this will be research into the political and policy factors (conditions) which led to the decision to implement the new speed limit, with a view to understanding possible transferability and national impact. We aim to address significant research gaps identified by recent syntheses of literature on 20mph zones; principally these being a lack of evidence on the impact on walking and cycling and inequalities, and lack of longer term monitoring periods (Cairns, 2014; Steer, 2014). Our approach is to ‘see the wood as well as the trees’ as described by Smith et al (2010). Smith argues that transport interventions can have effects on a range of outcomes, and identifying the full range of ‘primary’ and ‘secondary’ outcomes can be difficult.

2.2 Objectives and research questions

The research has been split over four work packages (WP), each addressing a different objective and set of research questions. Overall the evaluation will provide a comprehensive, well rounded, theory based understanding of the intervention. The objectives and work packages have been designed in response to the initial programme theory (logic model available on request from principal investigator). WP1 is designed to answer questions of effectiveness and impact; WP2 evaluates how and why change occurs (process evaluation); WP3 evaluates transferability and implementation and the impact on effectiveness; and WP4 evaluates the economic impact.

Work Package 1

Objective

To assess the impact of introducing city-wide 20mph speed limits on a range of health outcomes in the longer term (18 months)

Research Questions

Does introducing 20mph speed limits using primarily signage result in reductions in the speeds of motorised vehicles?

What is the impact of introducing 20mph speed limits on the number of people (journeys) cycling or walking to work or study?

What is the impact of introducing 20mph speed limits on the number and type of road casualties following implementation?

What is the impact of introducing 20mph speed limits on behaviours, public support, perceptions of the safety and pleasantness of their environment?

For each of these questions we will also explore (where/when possible and using appropriate techniques) how the effects differ between areas and population groups (age, gender, and socioeconomic status). Health inequalities will also be assessed in WP2.

Work Package 2

Objectives

To explore and refine the causal pathways and mechanisms in the conceptual model

To understand barriers and facilitators to successful implementation in Edinburgh and Belfast

Research Questions

Do the qualitative and quantitative data support the causal pathways and mechanisms outlined in the proposed programme theory (logic model available on request)?

What components of the intervention work (or do not work) for whom in what circumstances and why? Is there evidence of health inequalities?

Are there any unintended pathways and consequences that need to be incorporated in the model?

What were the local and national conditions (societal, political and potentially other) which led to the decision and commitment to implement 20mph speed limits in Belfast and Edinburgh?

What were the barriers and facilitators to successful implementation in the two cities?

How was the new policy implemented in each city and what influenced that decision?

Work Package 3

Objective

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

Research Questions

What factors led to the recent rise of 20mph limits on the political/policy agenda in the UK?

What processes hindered and enabled agreement and implementation of the 20mph policy in different cities?

What are the likely facilitators and barriers to long term successful implementation of the 20mph policy?

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

Work Package 4

Objective

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

Research Questions

How do the public health benefits of introducing 20mph speed limits for motorised vehicles using primarily signage compare with the costs (potentially including opportunity costs) of implementation?

What additional benefits or consequences are there that would make implementing 20mph speed limits for motorised vehicles more or less cost-efficient?

3. RESEARCH DESIGN

As outlined above the 20mph network is a complex intervention. All interventions, by definition, aim to intervene, to interrupt or change causal pathways. As well as evaluating the impact of the intervention, this research has been designed to explore and understand the complexity and how and why it might impact on the overall effectiveness of the intervention. Understanding the causal mechanisms, as well as evaluating the effects of an intervention, are crucial to understanding whether such interventions are likely to work in other areas. We will use the MRC Guidance on process evaluation of complex interventions as a framework for evaluating issues around implementation, mechanisms of action and context (Moore, 2015) and be based on realist evaluation principles (Pawson, 1997).

Guided by our logic model, we have proposed a pragmatic, theory based, mixed-methods evaluation. The study uses a combination of routinely and locally collected quantitative data, and primary collected quantitative and qualitative data. No single work-package, or methodological approach, can provide answers to all the research questions related to the overall and differential impacts of the intervention. Similar mixed-methods approaches have been used in transport related natural experiments (e.g., NIHR PHR funded 'On the buses' study, Green, 2015; EPSRC funded 'iConnect' study, Ogilvie, 2012). Consequently, each of the four work packages employs different research designs and methods of data collection (see sections 8,9,10 and 11 for additional details):

- WP 1: before-and-after (controlled where possible) studies of Edinburgh and Belfast (Craig, 2011). As well as identifying matched (geographic) controls, synthetic controls may be derived from the routinely collected data (Craig, 2015).
- WP 2: stakeholder interviews and focus groups with members of the public.
- WP 3: key informant interviews and workshops.
- WP 4: cost utility analysis supplemented with partial cost benefit and cost consequence analyses.

4. STUDY POPULATION

The target population is primarily people who travel using a motorised vehicle (e.g. car, van, motorcycle, moped) in Edinburgh, Scotland and Belfast, Northern Ireland. Although these people do not need to live in Edinburgh or Belfast, it is expected that the majority of people who belong to the target population will be Edinburgh or Belfast residents, or those travelling into the cities for work or study purposes. According to a recent survey, 50% of city residents who work or study in Edinburgh commute on foot, by bike or by public transport (33%, 6% and 11% respectively) (Cope, 2014). Thirty percent of Edinburgh workers live outside the city. In Belfast, 31% commute on foot, by bike or by public transport (13%, 3% and 15% respectively) and 67% of workers travel by car (Department for Regional Development, 2012). The population who will benefit from the intervention may be wider than those who are exposed to the intervention. For example they might include pedestrians, cyclists, children, older people and disabled people. Therefore the target population in the proposed evaluation includes anyone who may benefit from the intervention.

5. SOCIOECONOMIC POSITION AND INEQUALITIES

Transport policies to increase levels of walking and cycling, and reduce motorized vehicle use, are considered to have widespread beneficial impacts across all population groups. Policies, such as the introduction of 20mph speed limits, are purported to be of particular benefit to disadvantaged groups given that walking and cycling are free activities and casualties as a result of vehicle collisions are higher in more deprived areas (Dorling, 2014). However, there is currently limited evidence from evaluations of 20mph speed limit projects to support this putative reduction in health inequalities (Cairns, 2014). Indeed, findings from the targeted introduction of 20mph zones in London have suggested that disparities may actually be widened in the future (Steinbach, 2011). Further, the factors thought to impact on health inequalities are confounded by other factors; for example, active travel is typically higher and car ownership lower in less affluent populations, and the physical environment in areas of social disadvantage is often of poorer quality. Therefore, it

can be hypothesised that 20mph limit projects will have differential impacts, and may play a role in reducing health inequalities, but as yet the extent or nature of these is unclear.

In this study, we will consider socioeconomic position and other factors related to inequalities (such as gender, disability, ethnicity) as integral variables in both our outcome and process evaluations. Adopting a realist approach, we will consider for whom the intervention impacted (positively, negatively, no impact) and attempt to elucidate the underlying mechanisms of impact and how these may differ by contextual factors. We will conduct sub-group analysis on our quantitative data where possible to examine differential impacts of the intervention (see Section 8, work package 1). For example, we will report our findings on collisions and levels of walking and cycling by geographical area and level of deprivation if considered feasible, and utilise collected demographic information (e.g., age, gender, ethnicity) where possible. If it is not deemed possible, for reasons of statistical power, to report our findings by sub-group then we will still assess the quantitative data by sub-groups in a realist fashion to highlight key trends for the purposes of informing sampling methods in other work packages.

Regardless of analytical approach, the quantitative outcome data on travel behaviour and collisions will be used to identify sub-groups and potential participants where differential impacts may exist. Additionally, findings from the drivers' behaviour survey (Tapp 2015) which we will undertake will play a key role in providing quantitative data on how potential mediators of the intervention impact and how these differ by sub-group. These findings will inform the sampling strategy and topic guide development for our process evaluation where we seek to provide a more detailed understanding of the different impacts and mechanisms of change via qualitative work with the general public (see work package 2).

6. PLANNED INTERVENTION

The key feature of the intervention is the introduction of a 20mph speed limit.
Edinburgh: implemented in 80% of streets, with a coherent network of 30mph and 40mph streets in the remaining 20% of streets. Currently 50% of Edinburgh's road network is 20mph. As part of the intervention 1,572 roads will be reduced to 20mph, meaning that there will be around 771 miles (1240.3km) of 20mph road in Edinburgh (80% of all streets) (see '20mph map Edinburgh' upload).
Belfast: implemented in 76 streets in the city centre (see 20mph Belfast City Centre map' upload). Five pilot 20 mph speed limit zones will be introduced in Northern Ireland. Four are in residential areas only; the fifth and largest site is in the central area of Belfast encompassing a total of 76 streets. This is the part of the City centre with the highest levels of pedestrian movement, cycle activity and bus facilities. 20 streets are subject to a 'Prohibition of Traffic Order' (pedestrian zone) and 7 are partially subject to a 'Prohibition of Traffic Order'. Comparable with Edinburgh, the 20mph streets in Belfast are surrounded by a coherent network of 30mph and 40mph streets in the city centre.

6.1 Implementation: In Edinburgh the 20mph speed limit network is being implemented in four phases across the city (each taking approximately 16 weeks to implement) over a total period of 24 months (starting in July 2016) (City of Edinburgh Council, 2016). This provides a potential opportunity to use the delayed intervention communities as control sites, in a step-wedge design where data and power allow. In Belfast the intervention is being implemented in a single phase in a similar geographical area (starting Feb 2016) (Department of Environment, 2011). There are four components of the intervention in both cities: 1) Legislation; 2) Signage and road markings; 3) Promotion and Education; 4) Enforcement (see Table 1).

Table 1. Components of the intervention in the two cities

Component	Description	Organisations involved in delivery
1) Legislation	*Edinburgh*: Speed Limit Order (SLO) *Belfast*: Traffic Limit Order (TLO)	*Edinburgh*: City of Edinburgh Council (CEC) *Belfast*: Roads Service, Department Regional Development (DRD) NI
2) Signage and road marking	20 mph road markings and traffic signs installed at the places where the speed limit changes. Smaller '20' repeater signs placed at regular intervals	*Edinburgh*: City of Edinburgh Council *Belfast*: Roads Service, DRD NI
3) Promotion and Education	In both sites a programme of awareness raising and education will publicise and support the introduction of the 20mph network, explain the benefits of lower speeds and ensure a smooth transition process.	*Edinburgh*: CEC, Neighbourhood Partnerships, Police Scotland, Schools, Sustrans *Belfast*: DRD NI, Department for Environment NI, Police Service NI, Belfast City Council, Sustrans, Schools
4) Enforcement	Warnings and issuing of speeding tickets. Speed tickets will not be used in early implementation phases. Instead warnings (Community Speed Concern Letter) will be issued. If after one year there has been no reduction in speeds, CEC & DRD NI will issue tickets.	*Edinburgh*: Police Scotland *Belfast*: Police Service Northern Ireland

The logic model shows how the components of the intervention are expected to achieve the changes in outcomes (the 'programme theory').

6.2 Funding: The total cost of the intervention in Edinburgh is approx. £2.2 million; £1.14 million will be the cost to the City of Edinburgh Council, and the remaining £1.08 million will be obtained through bids for external match funding that is available from the Scottish Government and Sustrans. In Belfast, the signage-only costs are £9,935 funded by the Department for Regional Development NI. Some of the cost differential is explained by the size of the two implementation sites, and what is included in the costs (e.g. Edinburgh includes human resources costs, but for Belfast it only covers costs of signage). Further data will be collected on costs of implementation for work package 4.

6.3 Setting: Edinburgh and environs and Belfast city centre.
Edinburgh is the capital of Scotland with a population of 487,500 (9% of Scottish population). 10% of the population are income deprived, 8.3% belong to an ethnic minority; 40% do not own a car (Scotland's Census, 2011). In Scotland, transport is primarily a devolved responsibility under the control of the Scottish Parliament. The City of Edinburgh Council is responsible for the development of all transport projects within the Council's jurisdiction, an area covering 260 km2. In 2014, there were 9 road fatalities, 148 serious injuries, and 1107 slight injuries in Edinburgh (Transport Scotland, 2015).
Belfast is the capital city of Northern Ireland and has a population of 281,000 (24% of the population). In Northern Ireland, 1.8% of the population belong to an ethnic minority; 3.6% of whom live in Belfast. Belfast has the highest proportion of the Northern Ireland households who do not have access to a car or van (40%) (Northern Ireland Statistics and Research Agency, 2011). Similar to Scotland, transport is devolved and primarily under the control of Department for Regional Development (DRDNI). The proposed 20mph speed limit is a key action identified in the Northern Ireland Road Safety Strategy to 2020 (Department of the Environment, 2011). In the past 3 years there have been a total of 147 road traffic collisions (no fatalities, n=131 slight; n=16 serious) in Belfast city centre (figures for immediate city centre ONLY) involving 190 casualties (59 involving pedestrians and 6 involving cyclists) (NI Assembly, 2014).

7. PROPOSED OUTCOME MEASURES AND CONTROLS

The proposed outcome measures for work package 1 are summarised in Table 2. All of the data collection apart from the driver behaviour and compliance survey (Tapp 2015) is being carried out by our partner organisations. To avoid conflicts of interest, all data will be sent to the researchers who will carry out our independent analyses of the data. Our partner organisations will have no input in to the type of analyses that are undertaken, nor any influence over dissemination. Work packages 2 and 3 are primarily qualitative, while work package 4 (health and economic modelling) will use data from the other work packages.

Table 2. Programme outcomes framework (including evaluation design)

Outcome	Data source (Collector)	Sample	Sampling strategy	Time points for data collection*[1]
Design: Observational stepped wedge				
Walking (Edin)	30 automatic fixed pedestrian counters (Sustrans)	Edinburgh residents	Previously identified key walking routes	Continuous including several years of historical data
Cycling	Automatic fixed cycle counters (31; Edinburgh 14; Belfast) (Sustrans)	Edinburgh and Belfast residents	Previously identified key cycling routes	Continuous including several years of historical data
Public transport use	Routine bus data (Lothian buses and Translink NI)	Edinburgh and Belfast bus users	All routes in Edinburgh and Belfast	Continuous inc. several years of historical data
Design: Controlled before and after				
Walking, cycling and attitudes	Route User Survey (Sustrans)	7 sites, up to 300 attitudes surveys per site and time point	Count all users (age, mode, gender) passing site, asking maximum for interview	Surveys conducted over both term time school holidays.
Travel behaviour	Scottish Household Travel Survey (Scottish Government)	~31,000 every 2 years across Scotland	Random postcode selection	Data made available every other year
Design: Before and after				
Walking, cycling and attitudes	Edinburgh Household Survey (City of Edinburgh Council (CEC))	1,215 households in Edinburgh	Systematic random sampling: ordered by urban-rural, SIMD and postcode	Baseline and 12 months post-implementation (2019).
	Sport & Physical Activity Survey (Sport NI)	1037 households in Belfast	Stratified random sample of adults aged 16+ years	2011 and repeated in 2017/18
Traffic speed and volume	Automatic sensors 69x20mph & 17x30mph sites (Edinburgh); 23 sites (Belfast) (CEC & DRD, NI)	Edinburgh and Belfast road users	Mix of streets selected from Area Road Managers, public consultation & random selection	Baseline, 2- and 12- month post-implementation in Edinburgh, annual in Belfast
Casualties	STATS19 accident records (Police Scotland & Police Service NI)	Edinburgh and Belfast road users and pedestrians	All incidents reported to the police	Continuous (combined into tax years to give sufficient power)
Public support, behaviour & compliance	Survey developed by Tapp 2015 (Research team)	500 residents in Edinburgh/Belfast per time point	Systematic random sampling: ordered by urban-rural classification, SIMD rank & postcode	Baseline, 4-, 12- and 18-months post implementation
Liveability	Place Standard for Scotland (Living Streets)	One Belfast &two Edinburgh groups of residents	Open invitation, data collected at variety of times	Baseline & 12 months after implementation

[1] Not all the data that is collected will be analysed by the team. We will be focussing on baseline and 18 month data

7.1 Controls

Using Geographic Information Systems matched control areas will be identified for each of the zones in Edinburgh and Belfast City Centre. These controls will be matched using the separate domains for the Scottish Index of Multiple Deprivation and the Northern Ireland Deprivation Measure, the urban-rural classification of the area and the population density. As each of the intervention areas will include more than one datazone the mean, median or mode of each of the matching variables will be used depending on the nature and distribution of the variable. These controls will be used in the controlled before and after studies, but may also be included in the observational stepped wedge analysis to produce a *difference in differences* analysis. Where National data are also published (Sustrans, Scottish Government, Sport Northern Ireland, Police Scotland, Police Service Northern Ireland), these will also be used for comparison.

8. WORK PACKAGE 1

8.1. Long-term and sustained effects

These are a particular focus of this study, particularly given the recognition that many of the health effects will be delayed following the implementation. Subsequently, throughout the study the minimum period of long-term follow-up will be 12 months (Table 2). For the output and intermediate outcomes, the effects are expected to be closer in time to the implementation and therefore an effect sustained for 12 months will be important. However, for the main outcomes the effects are likely to be more gradual and delayed and subsequently 18 month follow-up will be sought. The staged approach being taken in Edinburgh will permit longer follow-up periods (18 months) for the first stages. When the outcome is collected continuously, specific snapshots will be taken to compare pre- and post-intervention time points, which will either match or be controlled for difference in season. Time series analyses will be explored, however, sample size calculations have identified that these are likely to be too underpowered to be reliable (sample size calculations available on request from principal investigator).

8.2 Assessment of effectiveness

Natural experimental approaches are specifically advocated when *"[i]t is possible to obtain the relevant data from an appropriate study population, comprising groups with different levels of exposure to the intervention*" (Craig, 2011, p.13). Within Belfast and Edinburgh a number of stakeholders have, or will be, collecting relevant data; it is more efficient to make use of available data, supplementing where necessary, rather than replicating costly data collection. We will explore and account for biases which are known to affect observational methods and particularly before-and-after studies using appropriate methods (Craig, 2011).

Efficacy and effectiveness will not be tied to a single outcome. Given the pragmatic nature of the design and data sources, we will conduct a primarily descriptive analysis aimed at elucidating 'what happened' rather than 'was this effective?' These analyses will feed into the evaluation of the programme theory and logic model, informed by MRC guidance on complex interventions, process evaluation and natural experiments (Craig, 2008 and 2011; Moore, 2015). Our approach will be one of testing the programme theory and possible mechanisms of change. The various outcomes will allow us to test the various proposed pathways. We will consider short term impacts, and intermediate and long term outcomes with appropriate time frames.

8.3 Assessment of harms

By monitoring a wide variety of outcomes (Table 2) we will also detect any changes which reflect harms. Specific harms to be considered include: increases in causalities and inactive journeys, or reductions in walking and cycling. It will only be possible to reliably assess these harms at the set analytical time-points as interim analyses would be underpowered. One additional potential harm from reducing the speeds of motorised vehicles is an increase in vehicle emissions. Although there are monitoring stations for vehicle emissions, following considerable discussion among the investigators and other experts we have determined that it would not be possible to reliably identify changes in emissions over the relatively small geographic areas of Belfast and Edinburgh.

8.4. Proposed sample size

Details of all sample size calculations are available on request from the principal investigator. Below is a summary of calculations for each outcome of interest.

a) Modal shift: Modal shifts in the use of active methods (walking or cycling) of travel is the outcome of greatest interest to health in terms of increasing physical activity. The counters used to measure these outcomes will capture journeys (e.g. cycling past the same counter multiple times) rather than individuals and therefore sample sizes have been calculated based on the relevant Household Surveys (see sample sizes in Table 2) which will capture individual's primary mode of travel in a method comparable to the census. We are predicting a 5% and 7% modal shift in cycling and walking respectively. These surveys will not explicitly seek to assess the same households before and after the intervention. Further, there is no ability to detect whether a household has participated at both time-points. Therefore we have assumed that these samples are independent. Sample sizes have been calculated using both the Pearson's χ^2 test and the Likelihood ratio test, in each case α=0.05 (Table 3).

Table 3. Minimum required sample size for the Household Surveys to assess modal shifts in cycling and walking

	CYCLING (5% MODAL SHIFT)		WALKING (7% MODAL SHIFT)	
POWER	Pearson'sχ2 test	Likelihood ratio test	Pearson'sχ2 test	Likelihood ratio test
90%	495	484	880	880
80%	370	362	658	658

The sample size calculations demonstrate that non-response to the Household Surveys would need to be quite high (~50%) to reduce the power below 80% and we have reasonable chance of having more than 90% power, especially regarding the cycling outcome. Analysing the data from the electronic cycle counters using a stepped wedge approach we would have 82% power (calculated using simulation methods, all assumptions available on request) to detect a change of 20 cyclists within Edinburgh.

b) Casualties: The analysis of casualties will be adjusted for the general (secular) trend of reduction in number of casualties, which in Scotland is around 4% a year. Subsequently, based on a baseline value of around 1,300 casualties a year in Edinburgh, there would be 80% power (based on χ^2 calculations) to detect a 12% reduction (6% per 1mph reduction from the pilot study) in casualties on the 30% intervention roads in Edinburgh. However, if a higher proportion of casualties occur on these roads, we are likely to have sufficient power for stratified analysis by road or casualty type.

c) Behaviour and Perceptions: The survey by Tapp (2015) will be also be powered to detect 10% absolute change in outcomes. All sample size calculations were two-tailed.

d) Other outcomes: When undertaking the analyses of the other outcomes the minimum detectable effect size will be calculated using standard methods and used to inform the subsequent analysis and interpretation of results.

8.4. Statistical analysis

The purpose of the statistical analysis will be to test whether significant changes have occurred between measurement occasions for each outcome respectively (Table 2). Pairwise comparisons of each post-intervention time point (18 months or last time point) with the pre-intervention time point will be calculated separately for each outcome and follow-up time point. The specific analysis undertaken will depend on the nature of the outcome (e.g. continuous, counts, binary, ordinal or nominal data). Whenever possible we will compare pre- and post-time points in the same month but different years in order that seasonality is not an issue, otherwise a seasonal correction will be undertaken followed by regression adjustment by socio-demographics where the data are available. Where an additional control/comparison has been listed in Table 2, we will derive a difference in difference from the pairwise comparisons in the intervention and control/comparison areas will be compared giving a difference in differences accounting for deviations from the national trend. Sub-group analyses by geographic area and reported demographics will be

assessed when feasible, where feasibility will be decided by the availability of the data and a sufficiently large sample size to power the sub-group analyses. Although the intervention is being implemented in four stages across Edinburgh, analyses of each stage separately would not be adequately powered, and therefore the four stages will be combined in the analyses but the differential timing of each stage will inform the adjustment for overall time trends such as seasonality. Due to the relative rarity of casualties (0.86 per km of roads per year in Edinburgh) we will compare the average number casualties per year for the two tax years after completion of the intervention with the three tax years before the implementation, and discount the secular trend of reducing casualties. This is intended to be similar to the method used by Grundy (2008). For survey data, we will undertake sensitivity analyses if possible as some individuals may participate in both the before and after survey comparisons. We may be able to cluster responses by the areas to which they have been sent, then one by one remove and re-analyse the data without specific neighbourhoods that have been assessed at both time points.

9. WORK PACKAGE 2

The overall aim of this work package is to provide a detailed understanding of the intervention implementation, mechanisms of impact and context through qualitative and realist methods. Work package 2 comprises two distinct projects detailed below:

Project 1: Implementation process of the 20mph interventions

We will explore issues around implementation of the intervention at an overall and also a more local level. We will seek to address fidelity; whether, or not, the 20mph interventions were delivered as intended and what (if applicable) adaptations were made, in addition to how the intervention was delivered. For both aspects we will consider what local, contextual factors influenced implementation. Qualitative interviews will be undertaken during or shortly after each implementation stage across Edinburgh and Belfast. The interviews will be with approximately 14 stakeholders in Edinburgh and 6 in Belfast:

a. Stakeholders (n = 6 in both Belfast and Edinburgh) involved in the implementation across the two cities (to provide an overview of the whole process e.g., 20mph programme management, contractors who put signs and lines in place, those involved with enforcement or warnings).
b. Stakeholders (n=8, 2 per implementation phase) involved in the local implementation at each phase in Edinburgh (can provide insight into local implementation issues, e.g. local schools and community groups providing education).

Project 2: Mechanisms of action and contextual factors

We seek to gain an in-depth understanding of how members of the general public interact with the 20mph speed limit networks and how these interactions differed in those who did, and did not change their behaviour. Focus groups will be conducted with members of the general public who have taken part in the Edinburgh Household Survey and Sport Northern Ireland Sport and Physical Activity Survey, at least 2 months post intervention, and have agreed to take part in this stage.

Focus groups (15 each in Belfast and Edinburgh, 30 in total) will be conducted with population groups that may be differentially affected by the intervention. We will purposively sample individuals by their most common mode of transport (walking, cycling, driving) and how they responded to survey questions around behavioural change (have or have not changed their behaviour). We will also focus on specific groups previously identified in relation to transport policies and health inequalities (Gorman, 2003) such as: older people; people with a disability; people from British Minority Ethnic (BME) groups; people from low socio-economic groups (including non-car-owners and those unemployed); and people living in semi-rural areas. Where possible, sampling of the population groups, and individuals, will be informed by analysis conducted in Work-package 1 which will identify specific geographical areas or demographic sub-groups where differential impacts are evident.

Analysis: data will be transcribed, anonymised, and coding will be performed by at least two members of the research team. Analysis will be based on the logic model and the results of the surveys. Data will be coded for both inductive (emergent themes) and deductive (data driven themes).

10. WORK PACKAGE 3

Work package 3 comprises two projects detailed below:

Project 1: Policy analysis

Qualitative analysis of written materials, media content, in depth semi-structured interviews, participative workshop and discussion groups. Data sources: interviews (n=30); administrative papers, policy documents, official statistics; media coverage.

We will conduct a documentary analysis to examine the recent past policy and implementation context for active travel promotion in Scotland, England, Wales and Northern Ireland. Source documents will be purposively selected based on their relevance to the research aims and objectives. The primary data sources will include administrative papers produced by governmental and related agencies, including laws, policy documents, research reports, and official statistics, as well as other written record of events including political speeches, official announcements, committee reports, and debates, plus broadcast and non-broadcast media sources. Each documentary source will be assessed for quality (authenticity; credibility; representativeness; meaning), and analysed using qualitative content analysis. To ensure the comprehensive inclusion of relevant documents, all interviewees will be asked to identify documents which they feel are important for understanding the context, development, and/or planned implementation of the 20mph policy.

We will also examine, using thematic and narrative analysis, the way local print and broadcast media cover the issue. We will conduct a series of interviews with a broad range of experts in active travel, public health and/or transport related policy in Scotland and Northern Ireland pre, during and post implementation to identify policy drivers and barriers. Interviewees will be identified using a mix of both purposive and snowball sampling. The interviews will be semi-structured, meaning that similar issues will be discussed with each interviewee, while also allowing deviation from the schedule to explore issues of interest which arise throughout the interviews. The interview schedule will include topics such as how responsibility for active travel has been allocated or dispersed across government, processed for cross-sector negotiation and collaboration, the key issues which have influenced travel policy in Scotland and NI in recent years, the role of key organisations and individuals in lobbying the government to take action on active travel, and the decision making processes which led to the selection of the 20mph policy over other potential solutions. Content analysis will be conducted on the interview transcripts and data triangulation will be used to verify the validity of both the document analysis and interview data.

The current research will utilise a range of theoretical frameworks from political science to assist in the interpretation of the results. These theories will provide different ‘lenses’ through which to analyse the policy process, and will provide a theoretically grounded underpinning to the analysis. Appropriate theories are likely to include Network Analysis, the Advocacy Coalition Framework (ACF), Multiple Streams, and Punctuated Equilibrium theory. Analysis will focus on communities and areas to capture any differential impacts of implementation by inequalities.

Project 2: Sharing learning through workshops and Discussion Groups

Workshops will be convened in Edinburgh, Belfast and one metropolitan location in England to which local authority officers and members, public health specialists, transport planners, urban designers, national politicians, and officials from the civil services in the home jurisdictions will be invited. The aim of the workshop will be to present the initial learning from the Belfast and Edinburgh schemes as a catalyst to discussions about broader transferability and roll-out of 20mph schemes and their links to public health matters. The deliberations will be recorded and written up and used as further data and as the basis for a report about implementation and scaling up. The report will also be used for a press conference, media publicity and working with parliamentarians.

11. WORK PACKAGE 4

Ideally, for the purposes of the economic analysis, we would use the information from Work-package 1 on increases in active travel, road accidents and/or perceptions of safety as the basis of a quantitative measure of the benefits of the 20mph speed limit such as disability-adjusted life years (DALYs) or quality adjusted life years (QALYs). These could then be compared to costs in a cost-effectiveness or a cost-utility framework. However, there are substantial uncertainties over the power of the study to detect changes in casualties and over whether lower speeds will encourage enough of an increase in active travel to have a significant impact on health. Therefore, this work package will only be undertaken if there is evidence from the effectiveness study of a significant effect on either casualties or time spent in active travel and this will determine the primary outcome measure used. This decision will be taken at the progression meeting at the end of year 1 (see Section 14).

For road traffic casualties we would compare a direct estimation of casualties from Stats19 against modelled estimates based on previous reviews analysing 20mph zones. For physical activity we would use a modified version of the Integrated Transport and Health Impact Model (ITHIM). ITHIM is a modelling tool developed at CEDAR that analyses health impacts from transport policies or scenarios across a range of health outcomes. Health effects of changes to physical activity would be modelled based on non-linear dose response curves derived from recent meta-analyses for ischemic heart disease, stroke, type 2 diabetes, cancer, and depression.

Data for the health impact model would be taken from the baseline and follow-up travel surveys. Total leisure time physical activity would be modelled for each individual by combining the travel survey data with propensity matching for similar individuals from non-travel physical activity surveys. Additional impacts, potentially positive and negative, including perceived risk of road traffic danger, other aspects of community cohesion and quality of life, and economic impacts due to changes in travel times or re-routing to avoid the 20mph zoned areas will not be measured in quantitative terms as part of a full cost-benefit analysis. However, information from the qualitative study and from wider monitoring being planned by the council will be considered in a cost-consequence analysis (CCA).

If there is a significant effect on casualties or deaths from road injuries or on active travel, we would also value the reduction in road traffic injuries using the Department of Transport monetary values for statistical deaths prevented and injuries avoided and compare these to the results of any cost per QALY or cost per DALY analyses to assess whether conclusions are sensitive to the method of analysis used. Together with the CCA, this would enable us to assess if the primary analysis is likely to under- or overestimate the overall value for money of the programme.

Whatever type of outcome measure is used in the economic analysis, data on the costs of the scheme would be required. It will be easier to gather these data during implementation of the scheme rather than retrospectively, if and when the decision is taken to go ahead with the whole work package at the review meeting. Therefore we will gather cost data from the start of the study. Three broad categories of cost will be measured: infrastructure costs (primarily road markings and signage); awareness raising and education of the local population regarding the 20mph zones; and enforcement. In collaboration with Edinburgh and Belfast councils, the relevant costs in each of these categories will be identified, measured in physical units such as hours of staff time and valued using standard unit costs. Costs will be discounted using a discount rate of 3.5%, whereas, benefits would be discounted at 1.5%, in line with Department of Health recommendations.

Again, dependent on the size of any effects, if significant impacts are found, potential impact on health inequalities would be explored through modelling the range of cost-effectiveness across areas defined by levels of socio-economic deprivation. Sensitivity analysis (both deterministic and using Monte-Carlo analysis) would explore the impact on estimated cost-effectiveness of uncertainties arising from data quality and assumptions made in the modelled cost-effectiveness estimates.

12. ETHICAL ARRANGEMENTS

This is a complex evaluation which comprises 4 work packages and a number of projects. There are different types of data being utilised which will require different levels of ethical approval. The study will be conducted in line with MRC guidelines and the ESRC ethical framework. Ethical approval will be sought from the Centre for Population Health Sciences (CPHS) Ethics Committee, University of Edinburgh. The committee has three levels of approval.

- Level one: study which only includes anonymised data (e.g. large data sets)
- Level two: study which includes primary data collection (qualitative and quantitative)
- Level three: study which incudes primary data collection from vulnerable groups (e.g. children, those who do not have capacity to consent.

The evaluation will require Level one and Level two approval but not Level three approval. The evaluation will be utilising a mixture of routinely collected and primary data

1. Routinely Collected data: much of the data is being collected by other parties (e.g. Local councils and Sustrans) as part of routine monitoring and evaluation. We will only receive data from these sources after it has been fully anonymised.
2. Primary data: the main primary data collected by the evaluation team will be qualitative and survey (for Work Packages 2 and 3). For this type of data we will seek informed consent to participate. All data will be held for 5 years on University password protected computers. Paper documents such as consent forms will be stored in locked filing cabinets.

13. RESEARCH GOVERNANCE

The nominated sponsor for this application is the University of Edinburgh. Ruth Jepson (PI) will be responsible for ensuring that the study is carried out with strict adherence to the principles of good governance. Each WP will have a nominated lead, as will each specific project (for WP 2 and 3), within the WP (see Table 4). Additionally, Ruth Hunter will be the 'local' lead and liaison person for the Belfast components of the evaluation; Paul Kelly will be the equivalent in Edinburgh; and Andy Cope will be the lead liaison person with our partners (e.g. Living Streets, Sustrans, Local Councils) especially with regards to data collection.

Table 4. Leads for each of the work packages and projects

	WP1	**WP2**	**WP3**	**WP4**
Lead for WP	A.J. Williams	G. Baker	C. Foster	J. Woodcock
Lead for projects		*Project 1.* R. Hunter *Project 2.* G. Baker	*Project 1.* K. Milton *Project 2.* M. Kelly	
Other WP members	P. Kelly R. Hunter G. Baker A. Cope	R. Jepson A. Cope	F. Kee R. Hunter A. Cope	N. Craig

We will establish a study steering committee (SCC), which will meet twice a year (once face to face) for the duration of the project.

14.1 PROGRESSION MEETING

One of the risks of evaluating a 'real world' intervention is that the researchers have no control over the intervention or its implementation. As with any intervention, researchers also have no control over whether it is effective or not. Evaluations understanding why interventions are not effective (e.g. is it due to the intervention itself, the implementation, or other contextual issues) are vital to add to our understanding of whether such interventions should be implemented more widely. However, WP4 (economic evaluation) is premised on the assumption that some effect will be detected. To ensure that the NIHR gets full value for money we intend to have a progression meeting 12 months after at least two phases of the intervention has been delivered in Edinburgh, and at least one year after delivery of the intervention in Belfast. The SSC (full or sub-group) will

meet to discuss whether the evaluation should proceed as intended, or whether changes to the original protocol need to be made.

Purpose: to establish whether the initial implementation phase has resulted in any change in outcomes at one year. [Please note that the interventions in both Edinburgh and Belfast will also be stepped up at this time to include more enforcement and potentially some street furniture (e.g., road humps). The Local Councils wishes to test out the signs and lines approach first, before adding other measures.]

Outcome of progression meeting: if there is evidence that there has been a change in outcomes that the SSC considered significant (either statistically or clinically), then the evaluation will proceed as per protocol. If the SSC decides that the intervention has not produced a significant effect then they will make a decision as to whether to stop the evaluation; or proceed but with modifications (e.g., undertaking further exploration as to why change has not occurred as anticipated). If no effect has been found at this meeting, the SSC may also decide not to go ahead with WP4 (the economic evaluation) or to delay the decision until a further time-point.

14.2 STRATEGY IF NO EFFECT IS FOUND

If WP1 indicates that the intervention does not result in a reduction in speed and subsequent change in health outcomes this is an important finding. However, it does not explain why it was not effective. If the SSC decides that WP4 should not go forward, the remainder of the project will be spent exploring and explaining why change has not occurred. The strength of this project is that it has developed a strong programme theory which is testable and the data collected on intermediate outcomes such as perceptions and attitudes will be particularly important in this scenario. Further in-depth analysis of this data, combined with the qualitative data collected in WP2 should help illuminate why and how change did not occur. These analyses will provide essential learning for future implementation of such schemes.

15. EXPERTISE

The team has a proven track record of evaluating public health interventions and we also have significant methodological policy relevant expertise. Ruth Jepson is a co-investigator of the FARR Institute Scotland (part of the FARR institute of Health Informatics Research). She is involved in the programme using natural experiments to evaluate interventions. Andrew Williams was, until recently, the FARR research fellow working on this research programme. Frank Kee (PI) and Ruth Hunter (Co-I) are undertaking NPRI funded grant (2010 until 2018) 'Physical activity and the rejuvenation of Connswater (PARC study): a natural experiment investigating the impact of urban regeneration on public health'. The proposal also brings together researchers from three of the six UKCRC Public Health Research Centres of Excellence: i) Scottish Collaboration for Public Health Policy (SCPHRP) (Ruth Jepson) ii) Centre of Excellence for Public Health Northern Ireland (Frank Kee and Ruth Hunter); iii) Centre for Diet and Activity Research (CEDAR) (James Woodcock). Mike Kelly worked for 15 years as a Director at NICE and at the Health Development Agency. His role in both organisations included engaging directly with high ranking officials in Whitehall (from the CMO downwards) and politicians in Westminster in both Houses of Parliament. He brings enormous first-hand experience of the way the political and administrative machines nationally and locally facilitate and impede public health progress. Karen Milton is a physical activity researcher with specialist experience in policy analysis. Graham Baker, Andy Cope, Charlie Foster and Paul Kelly have a wealth of experience around collecting, measuring and analysing data related to physical activity. Graham Baker was involved in the EPSRC funded iConnect study (Ogilvie, 2012) and has expertise in health inequalities. Andy Cope is research director at Sustrans, real world evaluation of travel policy and interventions. Charlie Foster works in policy, translating epidemiological evidence, Public Health NICE Committees and Paul Kelly has expertise in methods of active travel assessment (objective and subjective), validity of various data sources. Neil Craig is a health economist, working at NHS Health Scotland. We have excellent relationships with all the relevant stakeholders involved in the project.

16. PARTNER COLLABORATION

We are working in partnership with the local councils and government agencies in both Belfast and Edinburgh as well as Sustrans and Living Streets. To avoid potential conflicts of interest, the partner organisations will have no input into the analysis of data and interpretation of results.

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