A mixed methods investigation of factors influencing decision-making for new active living infrastructure in different contexts

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CEDAR
Centre for Diet and Activity Research

Declaration

This thesis is the result of my own work and includes nothing which is the outcome of work done in collaboration except as declared in the Preface and specified in the text. It is not substantially the same as any that I have submitted, or, is being concurrently submitted for a degree or diploma or other qualification at the University of Cambridge or any other University or similar institution except as declared in the Preface and specified in the text. I further state that no substantial part of my thesis has already been submitted, or, is being concurrently submitted for any such degree, diploma or other qualification at the University of Cambridge or any other University or similar institution except as declared in the Preface and specified in the text. It does not exceed the prescribed word limit for the relevant Degree Committee.

Abstract: A mixed methods investigation of factors influencing decision-making for new active living infrastructure in different contexts

Anna Le Gouais

Physical inactivity increases the risk of many non-communicable diseases. The built environment is an important determinant of physical activity and the ways in which places are designed and built may lock in, or out, opportunities for greater physical activity and improved health outcomes. Policies and guidelines support the creation of active living infrastructure (walking and cycling infrastructure and open spaces); however, local social, environmental and political context may influence what is built in practice.

The aim of this mixed methods thesis is to investigate what influences the creation of new active living infrastructure across different contexts. It also explores the value of different methods to demonstrate impacts of new walking and cycling infrastructure.

The first two studies are qualitative investigations exploring decision-making for active living infrastructure across three areas of England and in Jamaica. These involve semi-structured interviews with public health practitioners, urban and transport planners, environmental and civil society stakeholders and councillors. I then synthesise the findings from these studies to gain additional insights from across different country contexts.

Building on the qualitative study findings, I investigate quantitatively the association of context with use, users and benefit-cost ratios of new walking and cycling infrastructure, using repeat cross-sectional data from 84 new walking and cycling schemes in the United Kingdom (Sustrans' Connect2 programme). I also explore the association between use and physical activity using pragmatic monitoring data from Connect2 alongside more scientifically rigorous longitudinal cohort data from three of those schemes (the iConnect study).

My final qualitative study follows on to investigate issues about perceptions of contextual relevance of case study examples. This involves semi-structured interviews with a sub-sample of participants from the first England qualitative study, using Connect2 walking and cycling route examples and results from my quantitative analysis as discussion prompts.

I identified three themes in this thesis: how to bridge the gap between policy and practice for creating active living infrastructure; issues of inequality; and synthesising evaluations across contexts. I find that the benefits of active living infrastructure can be under-valued and suggest that formal and informal roles can facilitate sharing of believable stories, including case studies, to influence decision-makers. Whilst new walking and cycling infrastructure is associated with large relative increases in pedestrians and cyclists, and increases in physical activity, lack of monitoring and evaluation, reliance on market forces, and views on individual agency may be detrimental to tackling inequality. Greater collaboration between public health practitioners and non-health sectors could emphasise multi-sectoral outcomes of active living infrastructure, including wider economic impacts.

Contents


examples
development
research
local
areas
living
making
health
study
cycling
evidence
use
schemes
planning
levels
urban
all
routes
users
activity
physical
issues
associated
new
public
data
walking
value
infrastructure
government

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List of abbreviations

ALI	Active living infrastructure
BCR	Benefit-cost ratio
CEDAR	Centre for Diet and Activity Research
CI	Confidence interval
DALY	Disability-adjusted life years
e.g.	Exempli gratia or 'for example'
GPS	Global positioning system
HEAT	Health Economic Assessment Tool
HIA	Health impact assessment
i.e.	Id est of 'that is'
IMD	Index of Multiple Deprivation
ITHIM	Integrated Transport and Health Impact Modelling tool
IQR	Interquartile range
km	Kilometres
LMIC	Low- and middle-income country
LSOA	Lower Layer Super Output Area
MET	Metabolic equivalent of task
min	Minute(s)
MRC	Medical Research Council
n	Number (used to indicate number of participants)
N	Number (used to indicate number of schemes)
NGO	Non-governmental organisation
NHS	National Health Service

OR	Odds ratio
P	p-value
PA	Physical activity
PCT	Propensity to Cycle Tool
QALY	Quality-adjusted life year
TCPA	Town and Country Planning Association
UK	United Kingdom
US	United States
WebTag	UK Department for Transport's web-based transport appraisal guidance

List of tables

List of figures

1. Introduction

1.1 Physical activity and health

Physical inactivity increases the risk of non-communicable diseases including heart disease [1–3], certain cancers, particularly breast and colon cancer [4–7], stroke [1], diabetes [1,8,9], mental health conditions [10,11] and overall mortality [1,9,11–15]. There is also weaker evidence to demonstrate impact on bone health [11]. Higher levels and more vigorous-intensity physical activity are associated with greater health gains, but even low doses can reduce risk of disease and premature mortality [14].

The issue of inactivity is a global one, with 58% of adults classified as inactive or insufficiently active for good health worldwide, attributing to 3.2 million, or 5.5% of all deaths each year [12]. Conversely, it has been shown that globally physical activity averts at least 3.9 million premature deaths each year [16].

The World Health Organization recommends that adults undertake at least 150 minutes of moderate-intensity physical activity per week, for example walking or cycling, or alternatively 75 minutes of vigorous-intensity activity, or a combination of the two [17]. Although the guidelines for physical activity in the United Kingdom (UK) align with the World Health Organization recommendations [18], Public Health England report that 34% of men and 42% of women are not active enough for good health [19], and physical activity is predicted to fall as technological change impacts lifestyles [20]. In the UK, physical inactivity is estimated to cost the National Health Service (NHS) between £450 million [21] and £1.06 billion per year [22], whilst lost productivity is estimated to be £5.5 billion per year due to sickness absence and £1 billion per year due to premature death of the working age population [11].

Physical activity is often classified into one of four domains: occupational, domestic, transportation and leisure-time. Incorporating physical activity within everyday life (‘active living’) brings scope to increase physical activity across all four of these domains. In this thesis I focus on the creation of environments that provide opportunities for everyday physical activity, such as walking and cycling infrastructure and open spaces, which I refer to as ‘active living infrastructure’ (ALI). These may influence transportation and leisure-time physical activity, particularly through walking and cycling. I focus on these because they are accessible to most people and more easily incorporated into everyday lifestyles compared with other forms of exercise, such as traditional sports.

1.1.1 Strategies to increase physical activity

Increasing levels of physical activity is a complex challenge and is the focus of government efforts globally to improve population health [23]. Traditional public health approaches to increasing levels of physical activity focus on behaviour change interventions, often for people who are at highest risk of disease. Whilst these have been found to have short-term benefits for those taking part, there is uncertainty about the long-term sustainability of individual behavioural change interventions and mixed cost-effectiveness [24,25]. Furthermore, a targeted approach for highest risk groups may be unable to influence large numbers of people which is problematic because very large numbers of people are not active enough for good health and population levels of physical inactivity are increasing [19,26]. A population-wide approach which seeks to improve health outcomes across the whole population is an alternative strategy. Rose described this type of approach as 'shifting the curve' [27].

Involvement in sport has been encouraged as a way to increase physical activity for larger numbers of people, but this is likely to only attract particular types of people who are interested in sports. As found in research into adolescents and physical activity, many young people, particularly girls, drop out of sport [26] and it is very challenging to encourage people to take up sport again in later life, particularly when people are limited by time, finance and motivation. Finding ways to reduce the decline in physical activity as people age, as well as facilitating increases in activity, could have large health benefits.

Framing physical inactivity as primarily behavioural, ignores issues about access to opportunities to be physically active which may relate to the quality of the environment, availability of time or resources. It also relies on individual motivation and will-power to sustain an exercise routine. An alternative approach is to support the creation of environments which enable everyday physical activity, such as walking and cycling for utility purposes, as well as providing safe and attractive places for leisure-time physical activity, therefore reducing time and resource barriers. This type of environmental change is likely to be particularly relevant in towns and cities where the majority of people live. Around 83% of the UK population and 54% of people globally live in urban areas and these figures are rising [29,30], therefore ALI in these contexts could impact on large populations [27,28]. There also appears to be potential for many more journeys to be made on foot or by bike which could increase levels of physical activity, for example it is thought that around 50% of car trips in Europe are less than 5km and 30% are less than 3km [33]. Many of these could involve walking or cycling, rather than private car use.

1.1.2 Health inequalities

The social determinants of health are the social and economic conditions that may influence a person's health. These are widely discussed with reference to Dahlgren and Whitehead's model [34], shown in Figure 1.1, which highlights the individual, societal and wider environmental conditions that can influence the health of people in a population.

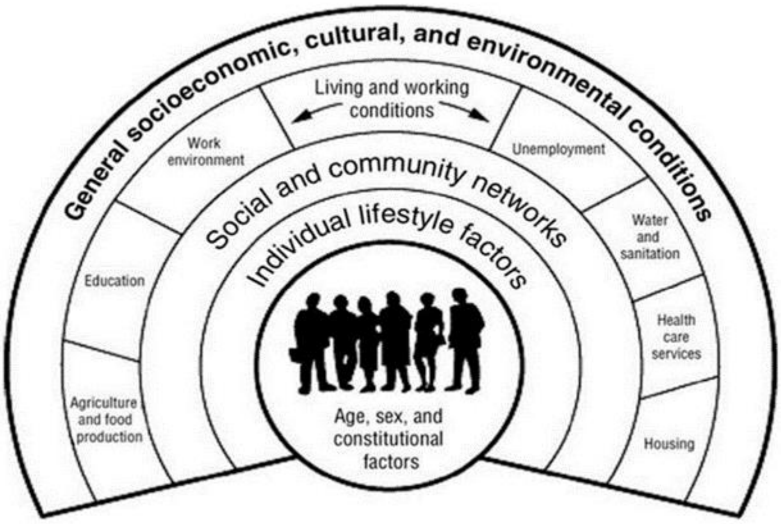

Figure 1.1: Social determinants of health [34]

Structural and environmental issues, which go beyond individual lifestyle factors, are likely to particularly affect certain groups in society and influence health outcomes. For example, people living in more deprived areas are likely to have higher levels of morbidity and mortality than those living in more affluent areas [35]. The Marmot Review highlighted problems of health inequality in the UK, demonstrating that people in the most deprived areas live an average of seven years less than people in the most affluent areas and up to 17 years longer living with poor health [36]. There are multiple factors that influence this disparity in health outcomes for deprived communities, including limited opportunity for recreational physical activity due to cost of activities, lack of time, lack of nearby facilities, or concerns about safety [37]. In England the most deprived local authorities, as measured by the Index of Multiple Deprivation (IMD) [38], have the highest levels of physical inactivity (defined as achieving less than 30 minutes of physical activity per week) – 34% of adults were classified as inactive in the most deprived areas in 2016/17 compared to 23% nationally [37], as shown in Figure 1.2. This is despite generally higher levels of active travel (particularly walking) by people in more deprived areas [39,40].

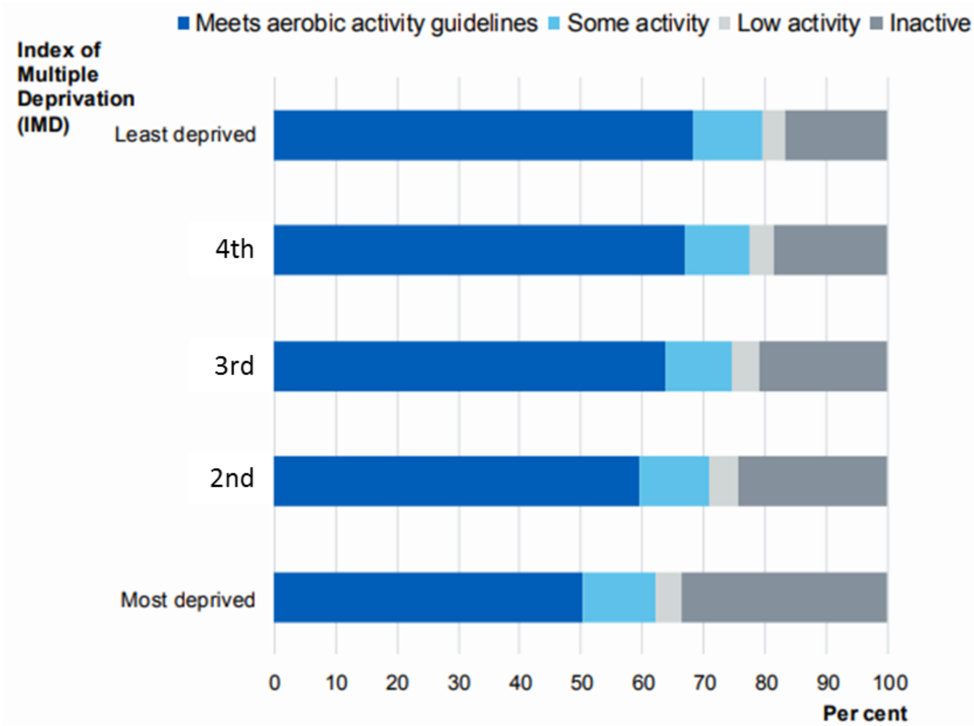

Figure 1.2: Age-standardised summary activity levels in England in 2016, by IMD quintile (age 16 and over) [41]

People living in more deprived areas are not the only group to have lower levels of physical activity. Older people are less likely to undertake sufficient physical activity for good health, compared with younger people. For example 47% of people aged 75-84 are believed to be inactive in England [42]. Concerns about safety may influence older people's decisions to walk or cycle - they are disproportionately more likely to be killed whilst walking or cycling. Whilst older people make up 20% of the population in Europe they account for 47% of pedestrian deaths and 44% of cycling deaths [43]. People with disabilities or long-term ill health are also more than twice as likely to be inactive compared with those without a disability [19].

Across the world women are more likely than men to undertake insufficient physical activity for good health, as shown in Figure 1.3, and low levels of physical activity by women are particularly apparent in high-income Western countries, Latin America and the Caribbean, and South Asia [26]. There may be many reasons for this including cultural, social and financial.

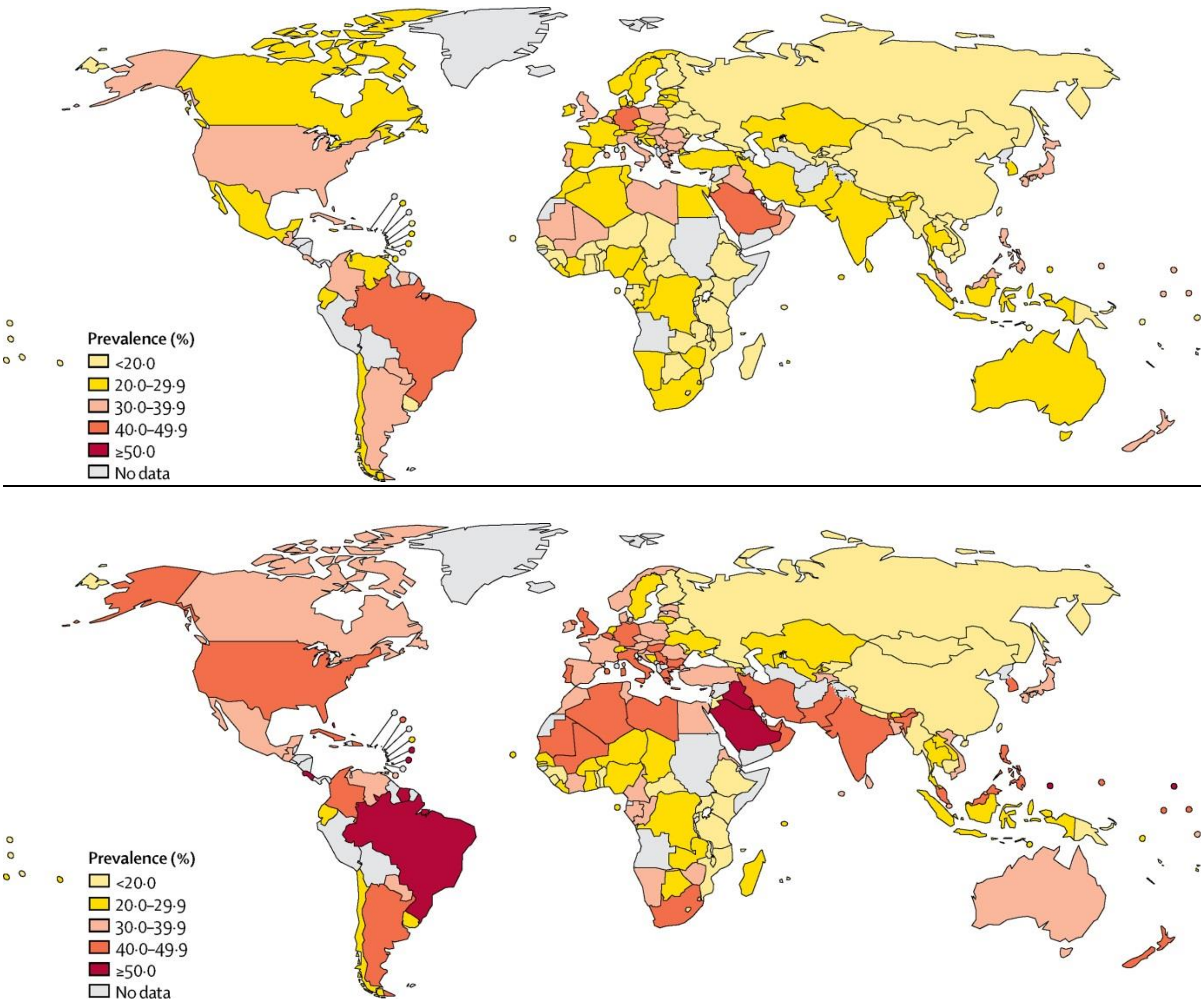

Figure 1.3:Country prevalence of insufficient physical activity in men (top) and women (bottom) in 2016 [26]

Reducing some of the environmental barriers to being physically active for these different groups, as well as reducing the decline in levels of physical activity as people age, through inclusion of ALI in urban design, may help to increase levels of physical activity and impact on health inequalities.

1.2 Active living infrastructure

1.2.1 Urban planning and health

Urban planning historically began as a means to improve population health in cities. Joseph Bazalgette developed London's sewerage system following The Great Stink of 1858, bringing an end to cholera outbreaks in the city. Forty years later Ebenezer Howard initiated the Garden City Movement [44] inspired by planned communities designed to provide healthy living conditions for factory workers. These early examples of urban design for public health stemmed from concerns about infectious disease. However, today non-communicable diseases are greater challenges in many countries, including in high-income countries such as the UK. Urban planning still has an important role to play in ensuring places support healthy behaviours, such as physical activity, as well as supporting other health outcomes for communities, as outlined in Figure 1.4 from the Town and Country Planning's guide to creating health promoting environments [45].

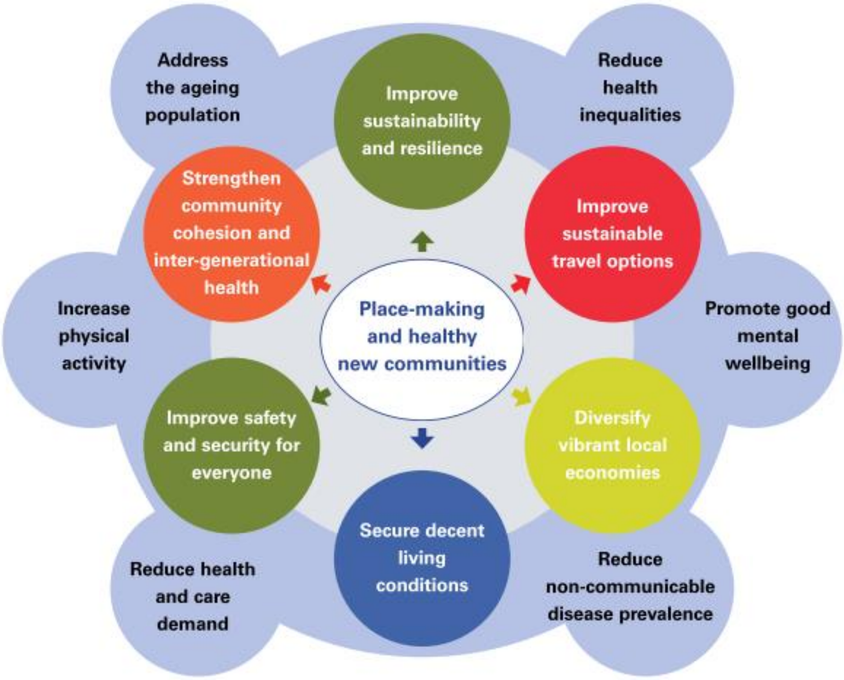

Figure 1.4: Putative benefits of quality place-making[1] for healthy communities [45]

[1] Place-making is a process for creating sustainable, well-designed buildings and spaces, with strong communities, character and sense of place, that are safe, legible and accessible, and that meet peoples' needs and improve quality of life [389].

1.2.2 Types of active living infrastructure

This thesis focuses on decision-making for particular elements of urban design referred to as 'active living infrastructure' (ALI): walking and cycling infrastructure and open spaces that may provide opportunity for people to be physically active. This includes pavements and cycle lanes adjacent to roads (Figure 1.5), shared-use paths (Figure 1.6), off-road pedestrian and cyclist routes (Figure 1.7), pedestrian and cyclist bridges and tunnels (Figure 1.8), and greenspaces such as parks (Figure 1.9), which may or may not include formal paths, sports pitches, play areas or exercise equipment (Figure 1.10). These are features that can require large amounts of land. Less resource-intensive measures, such as on-road painted cycle lanes, advanced stop lines (Figure 1.11), pedestrian crossings, and filtered permeability that restricts car access using bollards or other obstacles (Figure 1.12) can also be included within the scope of ALI. I do not focus on ancillary features such as cycle parking, workplace showers and changing facilities, benches, toilets or financial incentives for active travel, although these may be influential to support use of ALI [46–48].

Figure 1.5: Pavement and cycle lane example

Figure 1.6: Shared-use path example

Figure 1.7: Off-road footpath and cycle route example

Figure 1.8: Pedestrian and cycle tunnel example

Figure 1.9: Open greenspace example

Figure 1.10: Park with outdoor gym and children's play area example

Figure 1.11: Painted cycle lane and advanced stop line example

Figure 1.12: Filtered permeability to restrict motor vehicles example

1.2.3 Measuring the impact of active living infrastructure

Changing the built environment to create more and better quality ALI may lead to increases in physical activity and population health. Understanding these impacts may influence decisions to build ALI, however, there are challenges to assessing causality and strength of association, particularly using observational studies. Because non-communicable diseases can take years, or even decades, to emerge, few studies have attempted to directly investigate associations between the built environment and health, although there are some exceptions involving prospective cohort studies, such as UK Biobank. Examples are Mason et al.'s study which found an inverse association between physical activity facilities around the home and adiposity [49], and Sarkar et al.'s study which found evidence of a protective association between neighbourhood walkability and blood pressure outcomes[50]. Associations between environmental characteristics and physical activity are also evaluated in observational studies, such as within Smith et al.'s investigation of environmental features and physical activity, which also used data from UK Biobank [51]. Investigating associations between the environment and physical activity, rather than disease outcomes, may involve fewer confounding issues and may also be more practical to measure within the timeframe of a research study. Dose-response relationships between physical activity and risk of disease [3,52,53] can be used to understand health effects associated with different environments. However, prospective cohort studies running over several decades are increasingly able to investigate associations with disease outcomes. Although prospective cohort studies generally include large numbers of participants, demographic representation has been raised as a potential source of bias. For example, UK Biobank had a 5.5% response rate, with evidence of a 'healthy volunteer' selection bias and over-sampling of people from urban and more affluent areas [54].

There has been a long history of cross-sectional observational studies looking at associations between the environment and physical activity [55,56], including using sub-sets of data from cohort studies. They appear to show that the presence of walking and cycling infrastructure is associated with greater levels of walking and cycling, and also that there is an association between green space and physical activity [57–59] (although studies suggest that quality of parks may be more important that quantity [60–63]), but the cross-sectional nature of studies restricts causal inference. Evaluating the impact of the built environment on levels of physical activity can struggle to tackle problems of self-selection bias since it is difficult to determine the extent to which people choose to live in a particular location because of the type of environment, such as the availability of ALI, rather than the impact of the infrastructure directly influencing levels of physical activity.

A small number of longitudinal cohort studies have attempted to measure behaviour change of people moving to different environments, such as in the RESIDE study in Australia [64,65]. However, this type of study design can have difficulties in measuring reliable baselines because of the challenge of recruiting people before they move to a new location, as found in the RENEW study in the UK [66]. There are also difficulties associated with unmeasured confounding due to residential self-selection[67] and adjusting for life events, such as changing jobs or the birth of a first child which could influence relocation and travel decisions[65].

An alternative to analysing observational studies is to evaluate ALI interventions. The impact of changes to the built environment on physical activity is a complex problem and there are logistical, ethical and political difficulties in using randomised control trials to evaluate effects associated with changes to ALI, therefore this study design is unlikely to be appropriate [68]. An alternative is to use natural experiments [69] – taking advantage of opportunities of changes to the built environment to evaluate impact. Quasi-experimental methods can therefore be used which do not use random assignment of participants.

The transport sector tends to favour cross-sectional approaches to evaluating changes associated with ALI, measuring changes in use, such as numbers of cyclists on new cycle routes, rather than overall physical activity. Whilst such evaluations may see change over time of use of new infrastructure, this approach may be unable to account for displacement from other places, particularly where nearby alternatives are not also measured and used as controls. Measurement of use also does not account for impact on overall physical activity as it does not evaluate within-person changes to physical activity over time. It may also not be possible to measure whether any increase is as a result of existing users (who may already be active) more regularly using the infrastructure, or if it has attracted new users to become more physically active - there has been criticism of a lack of prospective studies on the effectiveness of cycling infrastructure involving comparison groups [70]. This lack of detailed information about who uses new infrastructure may hide impacts on inequalities. For example, cross-sectional analyses have demonstrated that construction of new cycling infrastructure will result in its use, particularly by commuters [71], but such infrastructure may not increase use by older people [72]. However, if monitoring is solely based on automated count data it may be unable to capture this information about users. Despite the limitations of these types of observational studies, these monitoring methods are much less expensive than cohort studies and are frequently used in transport evaluations [73].

Where there are multiple time points pre and post creation of new ALI then interrupted time-series designs can be used, such as in Heesch et al.’s evaluation of changes in numbers of cyclists associated with new cycling infrastructure in Australia [74]. This is an example of improving the reliability of a routine monitoring method by reducing bias through controlling for seasonal changes, or other confounders (particularly where a control site is used).

Investigating changes to overall physical activity associated with new ALI can be achieved using longitudinal studies with people living near to newly constructed infrastructure, as done with the iConnect study for example [75]. This approach overcomes some of the limitations of cross-sectional studies, particularly as it is possible to measure within-person change over time (i.e. at baseline before construction of the ALI and at follow-up sometime after construction). However, the complexity of evaluating such interventions may clash with a traditional evidence hierarchy of evaluations that can place a higher value on randomised control trials over natural experimental designs [76]. This may go some way to explain a reluctance to fund the latter [77,78], resulting in a low number of such evaluations [79].

Of the relatively small number of longitudinal studies about changes to ALI, most have occurred in a small number of high-income countries and many of those involving cycling infrastructure are in places with high baseline levels of cycling [67,80]. The transferability of findings to other contexts may therefore be unclear.

Many natural experimental studies involve self-reported measures of physical activity, for example through the use of postal or online questionnaires, which are prone to self-report bias [81,82]. However, self-report can facilitate larger numbers of participants to be recruited at lower cost than if objectively measured methods are used, such as activity monitors. Self-reported physical activity has been used for nearly fifty years [83], providing most of the foundation for the guidelines about how much physical activity we need [18].

Despite the limitations with observational studies and individual primary studies, we can understand more about the impacts of ALI through synthesising results from multiple studies, such as using systematic reviews. These suggest that improvements to walking and cycling infrastructure can lead to increased levels of physical activity and places with better walking and cycling infrastructure generally have higher levels of walking and cycling [84], but the impacts vary across studies [32,85,86].

Overall, there tends to be a trade-off in terms of cost, breadth and precision when evaluating the population impacts of new ALI. The low number of prospective cohort studies and natural experimental studies evaluating associations between ALI and physical activity suggest that there could be benefit from increasing understanding of the value of routine data collection methods to provide insights into use and users of ALI and associated physical activity in different contexts.

1.2.4 Active living infrastructure use and context

Local physical, social, economic and political context is likely to influence the impact of new ALI [87] and the built environment may be a necessary but not sufficient condition to influencing physical activity [88]. Higher density, walkable, connected, accessible, mixed-use neighbourhoods with good environmental quality, aesthetics and safety are consistently favourably associated with physical activity [89–95]. In contrast, low density neighbourhoods with car dependence or safety concerns (e.g. poor lighting, fear of crime and lack of pedestrian crossings) are associated with lower levels of physical activity [32,96]. It is likely that creating new ALI in these different types of settings will result in different impacts [97]. Urban areas across the world are expanding with low density urban sprawl in both high-income countries (e.g. North American cities dominated by private cars), and low- and middle-income countries (e.g. informal or unplanned settlements, often with informal public transport systems) that may have unfavourable implications for physical activity [98]. Understanding the likely impact of new ALI in different contexts could help to support the creation of healthier communities.

Changing the built environment to increase the quantity and quality of ALI can provide opportunities to engage in physical activity, but there appear to be multiple pathways that can lead to behaviour change, including changes to social norms and enhanced visibility of others using the ALI that can influence the social environment and increase population levels of physical activity [99,100]. Perceptions of safety, aesthetics, connectivity and accessibility also appear to influence levels of use of ALI, particularly for certain groups of users [97]. Although some longitudinal studies have found greater use of new walking and cycling routes for recreational use, rather than transport [100], other reviews exploring the association between physical activity and the built environment have found a stronger association for transport physical activity rather than leisure-time physical activity [89,92]. This may be related to the primary design purpose of the route and point to the need to understand local context.

The Canadian Institutes of Health Research and UK National Institute for Health Research has produced guidance for taking account of context for complex population health intervention research [87]. It points out that context is inadequately considered in many population health interventions, often treating it simply as a potential confounder during analysis, or with poor reporting of context in primary studies, making synthesis difficult. However, understanding physical, social, economic, cultural, historical and political contextual issues in the development of interventions could help to create more effective intervention designs for particular contexts. Understanding relationships between context and outcomes can also help to understand causal mechanisms - why impacts may vary in different places and how interventions may influence health inequalities, particularly whether target populations engage with an intervention [87]. When considering context for ALI the physical setting is the most obvious aspect (i.e. where and how ALI is built), however, concepts of context can also describe characteristics of individuals, relationships, institutions, and systems that may enable or constrain whether and how ALI is built [101]. Understanding these implementation issues could help to improve likelihood of creation of appropriate ALI in different contexts.

It is difficult for generic guidance material about population health interventions to provide specific requirements for contextual issues to be considered for every evaluation since the variety of types on intervention are very broad, beyond those associated with the built environment and physical activity. However, greater understanding of the contextual features that are relevant to ALI-type interventions could be useful to inform future research, and in turn influence decision-making for new ALI.

1.3 Deciding to invest in active living infrastructure

1.3.1 Policies supporting active living infrastructure

The potential health benefits of ALI have been recognised in international policy guidance, such as the World Health Organization's action plan for implementation of the European strategy for the prevention and control of noncommunicable diseases [33], as well as national guidance documents, for example from Public Health England [86]. However, towns and cities around the world are still car dominated, lacking adequate walking and cycling infrastructure to make active travel attractive and convenient, and with a lack of quality open spaces to encourage people to be physically active. There are some exceptions, such as the Netherlands where more than a quarter of all trips are made by bicycle [102], following extensive cycling infrastructure investment since the mid-1970s. Seville is another example where investment in cycling infrastructure, beginning in 2006, led to induced demand for cycling, resulting in more than 5% cycle mode share despite no previous culture of cycling [103]. However, in many places, policy statements supporting ALI are not translated into the creation of ALI on the ground and this gap between policy and practice needs to be better understood.

1.3.2 Active living infrastructure is a cross-sectoral issue

ALI is a cross-sectoral issue with outcomes which go beyond physical activity – it is also likely to impact on congestion, air quality, climate change, road safety, heat islands, social cohesion and biodiversity, and therefore can be described as a systemic issue. ALI has relevance to non-health sectors including urban planning, housing, transport, and environment. The design and construction of ALI is done by the transport and urban planning sectors, including private sector developers, and often decisions about urban form are driven by political and economic priorities, such as provision of housing [104].

Identified barriers to investing in ALI include low public demand, maintenance costs, public opposition to cycling and prioritisation of private cars, lack of resources, political leadership, pressure to build houses, and siloes restricting collaboration between departments [104–106]. Despite the potential health implications of the built environment, and the 'health in all policies' agenda [107], public health departments may lack ability to influence designs for the built environment. Therefore clearer understanding of the system failures that lead to environments that are unsuitable or unappealing for physical activity, including active travel, appears necessary.

1.3.3 Use of 'evidence' across disciplines

There are different epistemic cultures between sectors involved in ALI. The public health sector has origins in clinical medicine which is likely to follow an evidence-based approach, where traditional hierarchies of research may highly value meta-analyses, systematic reviews and randomised controlled trials as the strongest types of evidence to consider when determining policy. As discussed above, the need to rely on natural experimental studies may be met with uncertainty and scepticism within public health departments because of the difficulties of demonstrating clear causality between interventions and health outcomes [77]. This could therefore deter the public health sector from using evidence from such studies to demonstrate potential impacts to non-health sectors. However, urban planning and transport planning professionals are less familiar with using health evidence and unlikely to be concerned with hierarchies of evidence to judge the quality of studies. They are more likely to base decisions on design codes, precedent and local data [108]. Built environment decisions are also likely to be highly influenced by public opinion and political priorities [105,109].

These different uses of 'evidence' may limit collaboration between health and non-health sectors as different disciplines 'speak different languages' [106,109,110]. Difficulties accessing and understanding relevant research are also barriers between researchers and practitioners [111–113] and even within the public health sector 'evidence' will mean different things to practitioners compared to researchers [114]. The traditional individual behaviour change approach of public health practice makes silo-working possible, but if public health is to influence the wider determinants of health, such as supporting the creation of ALI, then collaboration between health and non-health sectors is required. The policy process is complex and understanding is limited at this intersection of urban planning and health [115,116]. Policy analyses and frameworks increasingly aim to capture and understand this complexity, yet the understanding of knowledge exchange and the use of evidence requires further investigation for this field [76,117].

It is widely recognised that knowledge exchange is non-linear and complex [110]. The importance of relationships, resources and skills for knowledge translation is increasingly recognised, as well as power to share knowledge [113]. Weiss' enlightenment paradigm [118] considers evidence as a means for agenda setting and influencing longer-term change indirectly, which may be relevant for the cross-sectoral issue of ALI and the social determinants of health [34]. For other public health issues, policy change has been slow, despite epidemiological evidence showing adverse health impacts, for example restrictions on smoking, or minimum unit pricing for alcohol. Interest groups who may be negatively impacted by proposed changes may lobby government decision-makers to limit or delay action. Despite attempts to make research more impactful through knowledge exchange, it appears that greater understanding of relevant practical processes is also necessary to influence the creation of healthier places [110].

1.3.4 Reluctance to invest in active living infrastructure

Investment in walking and cycling infrastructure may require road space to be taken away from cars which could upset car-drivers and may require a change in funding allocation within the transport sector, which has historically focused on roads. This points to the power of public opinion on political decision-making which may go some way to explain the gap between aspirations to increase levels of cycling and the lack of investment in cycling infrastructure. For example, the UK government has had a target to double cycling by 2025 from 2013 levels [119] and the All Party Parliamentary Cycling Group has aspired to increase journeys made by bike from 2% in 2011 to 25% by 2050 [120]. However, only £1.2 billion was proposed for both cycling and walking between 2016-2021 (before additional funds were announced in February 2020 for cycling and bus services[121]) compared to £15 billion allocated to major roads and motorways in England between 2015-2020 [122]. With generally low numbers of people cycling but high levels of motorists there is vocal opposition for increasing investment in cycling infrastructure. This is despite evidence that increasing construction of new segregated cycling infrastructure is associated with higher levels of cycling, particularly for less represented groups, such as women [103,123,124].

Investment in ALI is often a political decision, but low income groups who may benefit the most may be least likely to demand it where they have low political voice [125], as well as having other short-term economic concerns - investment in pedestrian and cycling infrastructure for utility purposes may have large benefits for people who are unable to afford a car, making active travel more accessible and safer. However, car ownership is aspirational for many people living in deprived areas which could affect their willingness to demand better infrastructure for a mode they may not be using out of choice. More affluent groups can also benefit from changing mode away from cars to active travel, and this can contribute to more supportive social environments for walking and cycling and encourage people from all social groups to increase levels of walking and cycling over time [99].

Decision-making for open spaces is also likely to be a political and economic decision since these environments require on-going maintenance budgets and there may be opportunity costs for withholding permission to develop the land for housebuilding or other commercial gain.

Better understanding of decision-making issues for ALI, including issues of influence and power, could help the public health sector to target research and knowledge exchange efforts to support the creation of healthy communities.

1.3.5 Economic impacts of active living infrastructure

Economic evaluations of ALI can help to demonstrate impacts, considering economic costs associated with physical inactivity such as healthcare costs, sickness absences and premature mortality, as well as non-health economic impacts such as those associated with land-use and transport issues [126]. Cost effectiveness analysis relates the costs of interventions to non-monetary outcomes, whereas cost benefit analysis compares the costs to the monetarised benefits. Cost effectiveness analysis can be used within the health sector, involving disability-adjusted life years (DALY) averted or quality-adjusted life years (QALY) gained in assessing the economic value of interventions [127]. Metabolic equivalent (MET)-hours gained can also be used to compare cost effectiveness of ways to increase levels of physical activity, although this is unlikely to distinguish between the types of people who become more active, which may obscure inequality issues.

Population-level physical activity interventions may be calculated as better value for money than individual behaviour change interventions since they can reach much larger numbers of people. This relates to the concept of an effectiveness hierarchy whereby it is more effective, equitable and cost-saving to tackle the 'upstream' determinants of health rather than 'downstream' activities which target individuals [128]. Wu et al. found that the least cost-effective types of interventions were high-intensity 'individually adapted behaviour change' and 'social support' programmes (median cost-effectiveness ratios $0.84 and $1.16 per MET-hour gained/person respectively), although they had large effect sizes [25]. Community campaigns included in Wu et al.'s review varied widely with cost-effectiveness ratios between $0.009 and $1.90 per MET-hour gained/person. Few environmental interventions were included in this review, only involving playground improvements, with large differences between studies (cost-effectiveness ratios between $0.17 and $4.47 per MET-hour gained/person).

Cost of interventions per QALY can be compared with The National Institute for Health and Care Excellence thresholds of £20,000-£30,000 per QALY to assess cost-effectiveness [129]. This approach was taken by Love-Koh and Taylor to develop a cost-effectiveness model for ALI interventions, based on the risks of developing five diseases associated with physical activity (breast and colon cancer, diabetes, stroke and coronary heart disease) [129]. They calculated that cost-effectiveness of ALI interventions varied depending on context, but that the benefits outweighed the costs for interventions by up to £100 per person in the UK. This suggests that such 'up-stream' interventions should be supported.

A systematic review of cost-effectiveness of ALI, using cost per MET-hours gained per person per day, was conducted by Laine et al. which claimed that changing the built environment, such as through improving walking and cycling infrastructure, could be a cost effective way to increase physical activity in large populations [130], but they pointed out that cost-effectiveness of population-level physical activity studies were limited. A more recent evidence review on urban green space interventions by Hunter et al. [131] identified only two published studies that investigated economic impacts associated with park-based infrastructure, conducted in Los Angeles, California with the same first author (no economic analyses of urban greenways were identified). These used cost per MET-hour per year for park users, describing them as cost-effective ($0.73 per MET-hour gained for pocket parks [132] and $0.10 per MET-hour increase for family fitness zones [133]).

Whilst cost effectiveness analysis allows comparison of ALI interventions with medical treatment options, such as using associations between level of physical activity and risk of chronic disease [53], there are difficulties in using such measures in non-health sectors which are likely to prioritise non-health outcomes. The Health Economic Assessment Tool (HEAT) for cycling and walking [134] was designed to follow a transport assessment approach [135] to appraise walking and cycling interventions by monetising health-related outcomes. It uses the value of statistical life in calculating the economic value of mortality rate improvements from population changes in walking and cycling due to changes in physical activity, road accidents and air pollution, as well as valuing the effects on carbon emissions in the latest version of the tool. It is designed for adults between aged 20-64 for cycling and 20-74 for walking. It can be used at different scales to assess levels of cycling or walking, assessing changes over time, and evaluating projects, including to calculate benefit-cost ratios (BCR), for example it was used by Fishman et al. to estimate the economic benefits associated with walking and cycling for the Dutch population, finding it provided Euro 19 billion benefits compared to Euro 0.5 billion costs per year [136].

BCRs can be useful to demonstrate the economic return on investment of ALI. This can be valuable for local authorities where funding for ALI may be lacking and it may be necessary to use BCRs to apply for national funding for ALI. BCR results can be viewed in light of the UK's Department for Transport BCR categories whereby a BCR of at least 2 is considered 'high' and at least 4 'very high' value for money [137]. The review by Cavill et al. found that the evaluation of the Sustainable Travel Towns programme in the UK, which only considered congestion benefits, produced a BCR of 4.5 (i.e. for each £1 invested there was a return of £4.50), whilst the Local Sustainable Transport Fund, which included 11 large projects, had an estimated BCR of 5.2-6.1, and the initial Cycle Demonstration Towns had BCR of 2.59 [138].

HEAT is a widely available tool able to demonstrate mortality impacts from ALI (there are other tools available that can model morbidity impacts, such as the Integrated Transport and Health Impact

Modelling tool (ITHIM) [139]). The simplicity of HEAT makes it attractive to non-health sectors, requiring few inputs about the amount of walking and cycling in a population, which may make it practical for poorly resourced environments. However, its use in published research evaluating the economic impacts of walking and cycling infrastructure is limited, as highlighted by a recent review by Cavill et al. [138], commissioned by Sport England. With a limited number of studies evaluating the economic impacts of ALI it can be challenging to compare these impacts between contexts, particularly because different research methods incorporate inclusion of different benefits. Whilst economic benefits may not translate into actual financial gains and there may be differences between sectoral budget responsibilities and benefits, greater use of economic evaluation for new ALI, particularly using BCR, may be useful to influence local government decision-makers by demonstrating cost effectiveness in monetary terms.

1.4 Thesis overview

1.4.1 Aims

As discussed, ALI is being promoted in policy and guidance documents to support healthier communities. However, supportive policies may not result in more ALI being built and greater understanding about the gap between policy and practice would be useful to support the creation of active living communities. Evaluations of new ALI often focus on use, rather than overall physical activity, and few high quality studies are available from a limited number of contexts, therefore greater understanding about how different methods may demonstrate impact of new ALI in different contexts could be useful to influence ALI investment decisions. Therefore, this thesis aims to address the following issues:

- What influences the creation of new ALI across different contexts, including how decisions are influenced by scientific evidence and case study examples, alongside other factors?
- What is the value of using different methods to demonstrate the impacts of new walking and cycling infrastructure?

New ALI may be built as part of new developments, often led by private sector developers, or be constructed within or between existing communities, led by local government. This thesis considers creation of new ALI in both new and existing communities.

1.4.2 Thesis structure and mixed methods research design

My thesis takes a pragmatic approach to answering my research questions, combining and utilising a variety of methods and findings to develop greater understanding of factors influencing decision-making for new ALI in different contexts. I use a sequential mixed methods approach, developing qualitative and quantitative analyses by 'following a thread' [140] to inform one another (see Figure 1.13). I also combine methods and results in other ways: synthesising findings from two of my qualitative studies in different contexts to identify additional insights; and investigating how different types of quantitative evaluation can be beneficial to demonstrate outcomes of new ALI involving 'routine' monitoring data (manual counts and user surveys) as well as longitudinal cohort data to explore use and physical activity of new walking and cycling infrastructure.

Chapters 2 and 3 are qualitative studies in three areas of England and in Jamaica respectively which used semi-structured interviews with stakeholders from different sectors to investigate decision-making for new ALI. Whilst the majority of this thesis focuses on England, I chose to include a small study in Jamaica to understand issues of decision-making for ALI and the value of different methods to demonstrate impact in a very different context to England. This enabled me to reflect explicitly about contextually, which is a thread that runs throughout this thesis. Chapter 4 then reports a multiple case study [141] of the England and Jamaica studies to identify additional insights about decision-making for ALI in different contexts. I used the findings from my first qualitative study to help define the research questions for my quantitative study of Chapter 5 - a quantitative study investigating use, benefit-cost ratios (BCR) and users of new walking and cycling infrastructure in different contexts and the association between use and physical activity. It uses repeat cross-sectional data from the Connect2 programme which was a series of new walking and cycling routes led by the charity Sustrans in 2010-2013, alongside longitudinal data from the iConnect cohort study from 2010-2012.

Chapter 6 is my final qualitative study which uses results from my quantitative analysis described in Chapter 5, and individual case studies from Connect2, to investigate perceptions of contextual relevance for examples of new walking and cycling infrastructure. It involves a second round of semi-structured interviews with stakeholders in two areas of England.

Chapter 7 presents an overall discussion of the thesis through an interpretive integration [140]. It summarises findings and discusses over-arching issues and themes from my mixed methods investigation. I also discuss possible areas for future research.

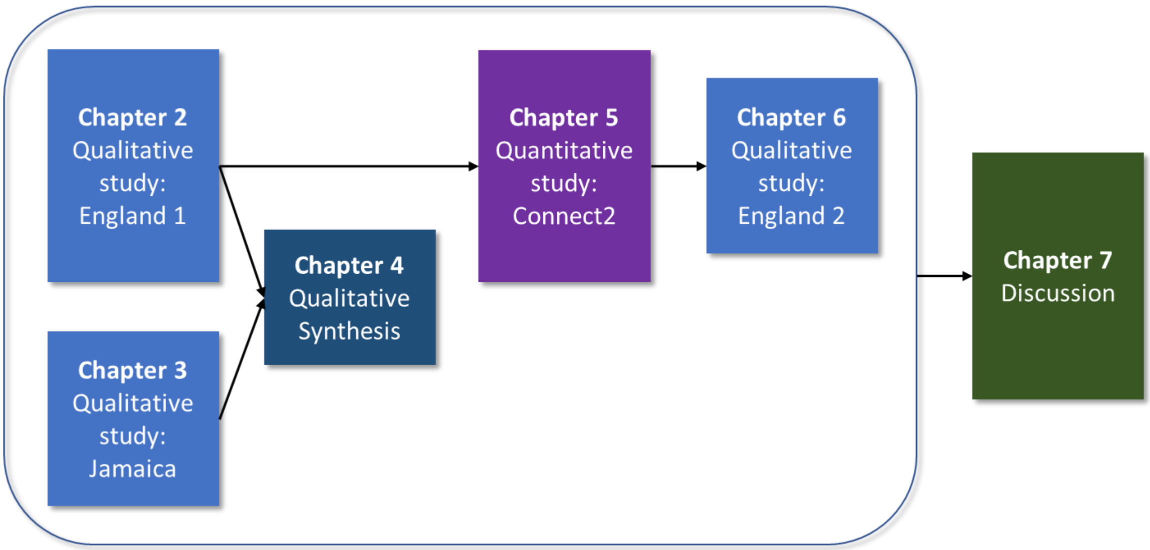

Figure 1.13: Summary of study linkages and thesis chapters

My investigations of new ALI are viewed across different settings and consider different contextual issues. Figure 1.14 outlines the aspects of context that this thesis seeks to investigate, involving physical, social, economic, organisational and political issues both within and between settings.

Dobrow et al. described context as either internal, involving issues within an organisation which can relate to the role of individuals; or external, involving environmental features which are mostly fixed, at least in the short-term [76]. In this thesis I consider the external contextual features within and across my study settings, and in my qualitative studies I also investigate internal contexts.

<table>
<tr><th rowspan="2">Chapter</th><th rowspan="2">Case study settings</th><th colspan="4">Dimension of context</th></tr>
<tr><th>Physical
e.g. Hilliness; Population density</th><th>Social
e.g. Cycling culture</th><th>Economic
e.g. Deprivation; Funding</th><th>Organisational /political</th></tr>
<tr><td>2</td><td>England: 3 local authority areas</td><td colspan="4">Within and across case studies</td></tr>
<tr><td>3</td><td>Jamaica</td><td colspan="4"></td></tr>
<tr><td>4</td><td>England (3 local authority areas) and Jamaica</td><td colspan="4">Across case studies</td></tr>
<tr><td>5</td><td>UK: 84 locations</td><td colspan="3">Across case studies</td><td></td></tr>
<tr><td>6</td><td>England: 2 local authority areas</td><td colspan="4">Within and across case studies</td></tr>
</table>

Figure 1.14: Aspects of context included within this thesis

1.4.3 Qualitative studies overview

As outlined above, I conducted three primary qualitative studies: The first in three areas of England, the second in Jamaica, and the final one as a follow-up study in England. Participants of the first England study (the largest of the three studies) came from three quite different local authority areas, allowing issues of context to be investigated during the study. Jamaica was a very different context, therefore this study allowed me to reflect explicitly about contextually issues. Synthesising findings from those of the study in Jamaica also provided an opportunity to generate additional insights from across different contexts. In my final follow-up qualitative study in England I chose to include participants from two contrasting contexts: one relatively affluent and semi-rural; the other urban with areas of high deprivation.

For each of the primary qualitative studies I followed a similar methodology based predominantly on semi-structured interviews and thematic analysis [142,143]. This allowed me to focus on my research questions, to understand in depth about decision-making for new ALI, whilst also allowing for flexibility to explore emerging issues which were not identified a priori.

1.4.4 Quantitative data sets

My quantitative analysis used data from Sustrans' Connect2 programme, which involved 84 new walking and cycling routes across the UK. This included 4-day manual counts, route user surveys and annual whole scheme usage estimates (pre and post construction) and BCRs. I also used longitudinal cohort data from the iConnect study, which was collected using a postal questionnaire from residents living within five miles of three of the Connect2 routes at baseline and 1-year and 2-year follow-up. I was not involved in any data collection for these studies.

1.4.5 Personal perspective

I have been inspired by the ideas of critical realism, considering reality across three levels: empirical - experienced and observed events; actual - events that occur whether observed or not; and real - mechanisms that cause events [144]. I also draw on realist perspectives, proposed by sociologists Pawson and Tilley [145], and increasingly used across public health to consider mechanisms [101] through which an intervention leads to outcomes, accounting for context. Although my research within this thesis does not investigate mechanisms empirically it is an implicit issue in my discussion of context.

Awareness of the three levels of critical realism and distinguishing between them is useful as it encourages reflection about what is real, what is reported by participants, and how issues are interpreted by the researcher. The latter is particularly important to consider as a qualitative researcher (although also relevant as a quantitative researcher) and I know that it is important to be aware of my own assumptions which may influence interpretation during the qualitative research process. Whilst drawing on ideas from critical realism can help in considering issues of causation, agency, structure and power, I also accept that my own perspective of the world influences how I understand realities.

I have conducted this PhD at the MRC Epidemiology Unit but I have a background in civil engineering with a Master's degree in Engineering, Economics and Management, and have spent time working in a private sector engineering consultancy, including doing investment planning for infrastructure projects. I have also worked in a private sector transport team designing road junctions and pedestrian crossings (during vacation employment), in a local authority on a change management programme (on a work placement as part of my Master's degree), and in the international development sector, which included influencing sectoral improvement for rural water services. These varied experiences in the public and private sectors have helped me to engage with different types of stakeholder during my qualitative studies and provided me with some appreciation of the types of organisations in which they worked. My experience of having lived and worked in multiple low- and middle-income countries, including Benin, India, Senegal, South Africa and Thailand, as well as visiting several others (Cambodia, Ecuador, Ghana, Lesotho, Mauritius, Namibia, Swaziland and Vietnam) influenced my decision to conduct research in a middle-income country setting and is likely to have influenced my overall approach to conducting research and interpreting findings in Jamaica (see Chapters 3 and 4).

I think that my epistemological perspective has changed over the course of my PhD. I began with a relatively positivist perspective, focussing on answering my predetermined research questions and seeking to identify ways to influence the urban and transport planning sectors to create more active environments through more and better quality walking and cycling routes and open spaces. Over time I have developed a more reflexive paradigm that has enabled me to develop insights which may be of wider relevance across multiple public health issues. This has resulted in a theoretically flexible approach to qualitative analysis, similar to what Braun and Clarke describe as 'codebook thematic analysis' [146], which combines pragmatic focus on pre-determined, applied research questions, alongside flexibility to investigate themes that were not defined a priori. This change occurred over the course of my PhD as I gained greater understanding about qualitative research and approaches to conducting mixed methods investigations.

Acknowledging that existing theory can be fallible [147], I build on well-known policy theories in this thesis, such as Kingdon's multiple streams framework [148], to develop explanations of reality from my research. This results in a preliminary conceptual model outlined in Chapter 2 to describe an 'evidence-output implementation gap'. I go on to develop these ideas through my mixed methods investigation to present a more comprehensive conceptual model in Chapter 7 that describes the 'policy-practice implementation gap' for creation of ALI.

2. Decision-making for active living infrastructure in new communities: A qualitative study in England

'Evidence' and influential individuals

2.1 Introduction

This chapter describes my first primary research study conducted for this PhD. I explored decision-making for new walking and cycling infrastructure and open spaces, described as 'active living infrastructure' (ALI), in three areas of England.

2.1.1 Chapter outline

This chapter describes the rationale and method I used to conduct this qualitative study, including participant selection and conducting semi-structured interviews. I present the findings from my thematic analysis of the qualitative data and in the discussion I compare these with other research; present a conceptual model that I developed about decision-making for ALI; and discuss strengths and limitations of the study. The chapter finishes with a summary.

2.1.2 Background

As discussed in Chapter 1, the social determinants of health are shaped by policies and decisions in non-health sectors. National and international policies increasingly acknowledge the impact that the built environment can have on population health through physical activity [149–151], recognising the role that non-health sectors such as urban and transport planning can play in producing activity-promoting environments [67,152]. Newly built communities can serve as ideal test sites for this public health strategy.

Evidence-based policy and decision-making is promoted within the health sector. However, urban designs are often locally developed by decisions-makers outside the health remit and broader concepts of 'evidence' than scientific research are involved [76,153–155]. The role of scientific evidence in influencing policy and practice has been widely researched [108,111,113,156], but there remain limitations in understanding the facilitators and barriers to decision-making for healthy outcomes in traditionally non-health sectors [157]. Communication and co-production of research is promoted to improve the relevance of evidence for uptake for better decision-making [13,14], but few studies have investigated the use of evidence, alongside other influences, at the local level [106,158].

2.1.3 The planning system in England

Local authorities in England may be two-tiered, involving a higher-tier county council and multiple lower-tier district councils, or single-tiered, such as unitary authorities, metropolitan districts or London boroughs [159]. There are over 350 local planning authorities in England[160]. The planning system is complicated involving multiple structures, agencies and institutions, as shown in Figure 2.1. Overarching national policy for urban planning is based on the National Planning Policy Framework which was originally published in 2012 [161], and updated in 2018 and 2019 [162], supported by Planning Practice Guidance. The 2012 version was in place at the time of the study described in this chapter. It called for planning policies to “aim to achieve healthy, inclusive and safe places” and there were statements supporting availability of open spaces (including multi-use spaces) and walking and cycling routes, as well as support for increasing housing densities.

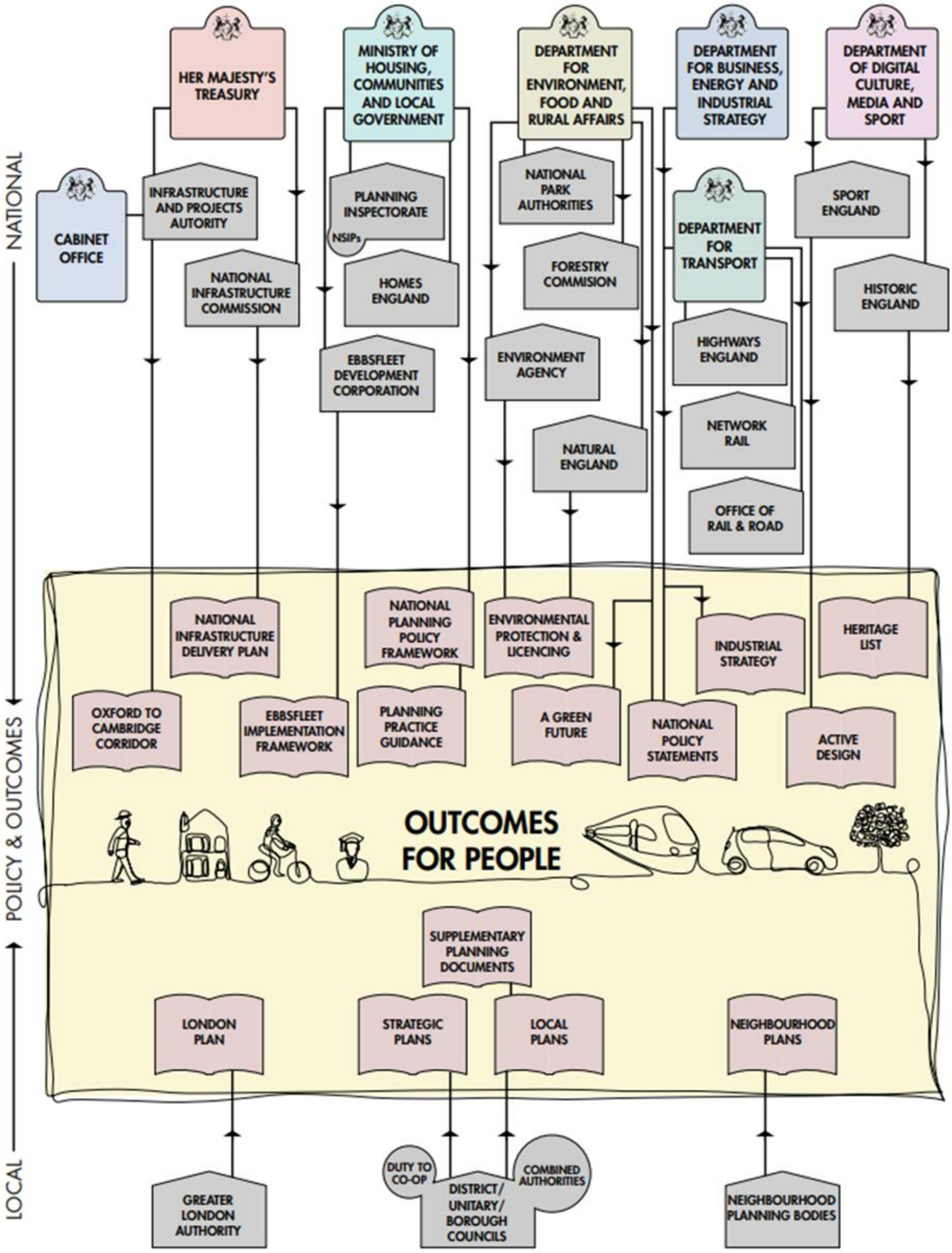

Figure 2.1: Some aspects of the planning system in England [104]

The English planning system is a discretionary system that uses local planning policies (such as the 'Local Plan') as the basis for decision-making but allows for professional judgement of urban planners and political involvement by elected councillors. This is in contrast to zonal planning, which for example occurs in the United States (US), where any development proposal that meets the requirements of the zone will be accepted but otherwise permission will be refused. Local government planners have a coordinating role balancing the demands of multiple internal and external stakeholders and aligning with national and local policies. Despite decision-making being devolved to local authorities the English planning system has a high level of central control with national guidance and a role for the Secretary of State to intervene if a local authority is believed to not be performing adequately, as well as providing an avenue for developers to appeal against local government decisions. Some of the profit from development is able to be captured by local government, such as via Section 106 agreements, which can provide finance for schools, healthcare, transport and open spaces. In some areas health impact assessments [163] are required as a formal mechanism to mitigate negative health impacts of developments, although there may be limitations to using this as a tool to proactively improve health outcomes [164]. Furthermore, health impact assessments are only required by a minority of local authorities for developments over a particular size.

In England there is substantial political pressure to increase housebuilding [165], and new communities with thousands of new homes are being built, designed and financed by developers (mostly from the private sector), guided by local planning policies. Decision-making for ALI in large developments ultimately lies with locally elected councillors who grant planning permission. Local government urban planners (in lower-tier or single-tier local authorities) are also highly influential as they develop policy, negotiate with developers and advise councillors. They may also be granted delegated powers by councillors to determine planning permissions, particularly for minor developments. Public health practitioners also work in local government, supporting the ‘health in all policies’ [107] agenda – they transferred to upper-tier and single-tier local authorities in 2013 [166], alongside the formation of health and well-being boards and Public Health England [167]. Because of the discretionary nature of England’s development planning system, urban planners could be perceived as what the sociologist Lipsky termed ‘street-level bureaucrats’ [106,168] - public sector policy implementers who have some degree of freedom to interpret rules for their own day-to-day activities. This can be relevant for local government urban planners since they work in a discretionary planning environment that requires them to negotiate with developers which could result in outcomes that differ from that which is written in policy. Local government planning service budgets decreased by 42% between 2009-10 and 2017-18 [169] and a recent review of the planning system identified low morale in the planning sector, with high workloads and reactionary responses.

However, it is recognised that for a discretionary planning system to be effective planners require creativity, a complex skillset and adequate resourcing [104].

2.1.4 Study aims

This study sought to understand what influences decision-making for ALI in new communities. It also explores how evidence and data associated with the impacts of new walking and cycling infrastructure are valued by stakeholders. The research was guided by three main questions: (1) How does evidence, information or data influence decisions relating to ALI and what else is influential? (2) What leads to changes in plans of new residential developments or towns which affect walkability, cycling or open spaces? (3) What evidence or data could support more effective planning of ALI?

2.2 Methods

Semi-structured interviews were the primary method for data collection. This was chosen because of the opportunity to investigate issues in more depth, allowing for flexibility in questions depending on the participant and the local context, and providing opportunity to understand why things were done. Ethnographic observation was also conducted to triangulate responses from the interviews and understand more about attitudes and approaches by different types of stakeholder related to decision-making for ALI. Ethical approval was obtained from the University of Cambridge School of Humanities and Social Sciences on 5th August 2017 (University of Cambridge sponsorship reference number: RG71157).

2.2.1 Scoping

Initial scoping discussions were conducted with 13 key stakeholders from the public and private sectors in transport, urban planning and public health (7 local government, 1 central government, 5 non-government). These helped with developing the interview guide (see Appendix 2.A) to enable practitioner-relevant research.

2.2.2 Setting

Three local government areas of England (two unitary local authorities and one with two-tier local authorities: district and county) were purposively sampled, each with a large new housing development being planned and/or built (thousands of new homes plus local commercial centres). Contextual settings differed and included rural, peri-urban and urban areas with developments adjacent to existing urban areas or villages, or involved urban regeneration. The three local government areas were also chosen because they either had a public health practitioner dedicated to urban planning, existing high levels of ALI, or both, and were therefore considered information-rich sample settings [170]. The locations are not identified to ensure anonymity of study participants who come from small stakeholder groupings. A summary of contexts of the local government areas included in this study is shown in Table 2.1. As can be seen, there were differences between areas of Index of Multiple Deprivation (IMD) quintiles and other contextual features: Area 1 was a relatively wealthy semi-rural district with major growth areas; Area 2 was a relatively deprived urban area undergoing regeneration; and Area 3 had a mix of wealthier and more deprived urban neighbourhoods within a New Town[2], with relatively large amounts of open space. Each area was in

[2] New Towns were developed by Development Corporations predominantly during the 1940s and 1960s to increase housing supply after the Second World War.

a low quintile for ‘barriers to housing and services’, reflecting the high housing demand in each area which was a driver for the large new housing developments discussed in this study.

Table 2.1: Summary of contexts for each local government area included in the study

Contextual features		**Area 1**	**Area 2**	**Area 3**
Local government structure		Two-tier	Unitary	Unitary
Urban/rural		Semi-rural	Urban	Urban/peri-urban
Main type of new housing development discussed in the study		New town	Regeneration	Urban expansion
Index of Multiple Deprivation (IMD) domain quintile (1 = most deprived)	Overall	5	2	3
	Income deprivation	5	2	3
	Employment deprivation	5	2	3
	Education, skills & training deprivation	5	1	4
	Health deprivation and disability	5	3	3
	Crime	5	1	2
	Barriers to housing & services	2	2	1
	Living environment deprivation	5	3	5
Quality/quantity of cycling infrastructure		Medium	Low	Medium

2.2.3 Participants

Interview participants were purposively sampled across influential stakeholder groups for ALI. Snowball sampling [171] of recommended knowledgeable stakeholders was conducted through initial contacts from local government and the private sector to arrive at a diverse sample of individuals from urban and transport planning, public health, environment, elected councillors, cycling groups and developers. In total 40 stakeholders were interviewed during 35 interviews between October 2017 and June 2018 (see Table 2.2). Limited ethnographic observations were also conducted during two urban planning meetings in two areas involving private sector developers, local government urban planners, public health practitioners, environment professionals, and others to inform the analysis and aid triangulation.

All interviewees were invited to participate via email and sent copies of the participant information sheet and consent form in advance (see Appendix 2.B). Where ethnographic observation was done, the meeting convener distributed the relevant participant information sheet in advance with the meeting documentation (see Appendix 2.C).

Table 2.2: Summary of interview participants by role in each local government area

Role	Area 1	Area 2	Area 3	Total
Councillors	1	1	1	3
Public health practitioners	1	1	1	3
Greenspaces stakeholders (including for parks, landscaping and footpaths)	2	1	2	5
Cycling stakeholders	2	0	2	4
Local government urban planners	3	3	3	9
Private sector urban planners (including from master-planning developers and volume housebuilders)	4	2	1	7
Local government transport planners	2	1	1	4
Private sector transport planners (contracted by master-planning developers)	1	0	1	2
Other (public sector, including police)	0	0	3	3
Total	**16**	**9**	**15**	**40**

2.2.4 Data collection

Qualitative interviews were semi-structured and allowed flexibility to explore emerging issues. They aimed to understand how different stakeholders used evidence, information and data to influence decision-making for ALI (explained to participants as walking or cycling infrastructure or open spaces which could enable physical activity), and when and how they were involved in the planning and design process. I did not want to restrict definitions of 'evidence' and invited participants to interpret it as they saw fit. I initially piloted the topic guide with the first two participants to check relevance across different sectors (urban planning and public health). All interviewees provided written informed consent.

I conducted 35 interviews either face-to-face (68%, 81% of which were at the participants' offices, the remainder at my office or a public café), or by telephone (33%). Interviews took an average of 51 minutes each (range 21 – 97 minutes). All except one (at the participant's request) were audio-recorded and transcribed verbatim by a private transcription company. I checked all transcriptions and removed any identifiable terms, including people and place names. I made notes for the non-recorded interview which were checked and edited by the participant. I also made field notes during ethnographic observations.

2.2.5 Analysis

I conducted thematic analysis [170] to allow for emergent, unanticipated issues to arise and to identify and analyse patterns in the data using a rigorous process of data familiarisation, coding and theme development [143]. I also included some deductive coding, focussing on the research questions.

I started this process by conducting line by line coding of the transcripts and notes, supported by NVivo 12 [172], with two of the earlier interviews also coded independently by Cornelia Guell. This allowed for reflection on and discussion of the codes. The majority of codes were developed during the first few interviews, guided by the research questions as well as directly from the data. However, additional codes were added for data that did not fit the original set, and some original codes were merged as I coded the later interviews. I also grouped codes into categories that were conceptually related. A list of my codes is included in Appendix 2.D.

My analysis was also supported by framework analysis, which is often used to support applied research [173]. This helped me to analyse the perspectives of different types of stakeholder related to my research questions. I produced matrices about use of health and economic evidence and how 'effectiveness' was understood; and how different types of stakeholders interacted, and their views towards one another. Each matrix had a line for each interviewee, grouped by stakeholder type, and columns for each issue related to the research question.

I also produced a table summarising how different types of stakeholder were influential and what issues affected their support for ALI. This was used in the additional analysis discussed in Chapter 4. I also conducted content analysis to identify gaps in understanding by interviewees, or where it appeared that additional information or evidence may be useful to them. This is discussed further in my follow-up study described in Chapter 6.

I took a positivist perspective to the initial stages of analysis that focussed on the research questions. This involved the creation of domain summaries of my findings, supported by development of an extensive Word document of close to 70,000 words in which I combined findings from the interviews, as well as the ethnographic observations to triangulate findings. I then used these preliminary outputs to conduct reflexive thematic analysis to develop higher-level themes [143]. This was an iterative process involving discussion and revision with Cornelia Guell. Throughout the analysis I kept an ideas log to support the process of development of the higher-level themes.

2.3 Results

Stakeholders used a variety of 'evidence' to influence designs of ALI: to identify a problem; inform solutions; or justify decisions post hoc. Public health practitioners could be influential across non-health sectors. Barriers to ALI involved political, organisational and structural issues.

> *"I think when we talk about evidence, I'm talking of a scale between anecdotal through to your proper published papers" – Public health practitioner B03*

2.3.1 Problem and solution evidence

2.3.1.1 Evidence of a problem – needs assessment beyond health

Stakeholders were influenced indirectly by academic research which informed national dialogue and organisational concern about levels of physical inactivity and health impacts. Participants generally understood that there is strong evidence of health benefits of physical activity, which they described as 'common sense'. Health impact assessments [163] conducted by developers were often not required in local planning policy, or were reportedly weak due to lack of skills and enforcement mechanisms.

Overall stakeholders tended to prioritise more tangible ALI-related issues such as air quality, congestion and car parking.

> *"Air quality and congestion may be something that you could use more in terms of motivating [politicians] to think a bit more differently in terms of modal shift, but I think the [physical] activity argument and the rest of it, I don't think that is as powerful to local councillors as the air quality issues are." – Local government urban planner C04*

Some interviewees used local (qualitative and quantitative) data extending beyond the health sector, for example combining local childhood obesity statistics with spatial data of quality assessment of parks or traffic congestion. Public opinion was also influential. Demonstrating local problems increased political motivation of councillors to act, but restricted funding limited monitoring and the ability to use objectively measured data.

> *"…some [councillors] really need a very clear picture at a local level, before they'll decide that it's something they should be challenging the status quo on." – Local government urban planner B01*

2.3.1.2 Evidence for a solution – knowing what works

Evidence for solutions to identified problems or needs was available within guidance material, based on academic evidence from evaluations and case studies, for example from Public Health England and the Town and Country Planning Association [86,174]. This was particularly accessed by urban planners, developers and public health practitioners who understood the value of ALI for health and wanted workable solutions. However, some developers complained that health evidence struggled to reach non-health sectors and one transport planner described guidance for cycling infrastructure as “sporadic” and “ad hoc” (B08).

> *“I know there’s a lot of research and data being shared around that, that we’re sort of desperate to get our hands on really because of probably things that we can be doing on that, I sort of think sometimes health is in danger of seeing itself as a sector that stays within its sector, rather than being part of transport and lifestyles and greenspace and built form and everything.” – Private urban planner B07*

Public health practitioners were most likely to access research evidence, whereas councillors rarely did this, admitting it was difficult accessing information and, like other participants, often simply used internet search engines such as Google.

> *“I don’t think I am supplied, generally speaking, with as much evidence as I would like… recently there was the BMJ article, wasn’t there, on the health benefits of cycling earlier this year which I’ve been quoting very widely… I would like a bit more ammunition that I could use because cycleways you see are really really controversial, many motorists and of course most councillors are motorists, feel that cyclists get far too much money spent on them... it’s actually sometimes quite a struggle to persuade your colleagues that actually active modes deserve priority over road traffic.” – Councillor B04*

A handful of local government and private urban planning interviewees had directly engaged with academics to create evidence of effectiveness of ALI through evaluating new housing developments, whilst some cycling stakeholders and police participants engaged with academics to increase their knowledge of best practice.

2.3.1.3 Retrospective evidence - justifying solutions already made

Sometimes health benefits of ALI were used to justify decisions post hoc. For example transport planners, who prioritised tackling congestion, acknowledged health benefits of walking and cycling infrastructure to support such investment over roads; developers justified spending on greenspaces to investors with research about impact on house prices [175], and sometimes used health evidence to justify less road construction which was expensive, affecting profits.

> *“…if we need to justify the fact that we do spend quite a lot of money on greenspace we always feel quite comfortable that you can justify it because we have created an attractive space and actually the value of the homes is more than a development where you don’t have a nice space around it … [and] the more you can do by cutting down trips by the way you design a place, and investing in public transport, then you do reduce your big spend on big bits of road… I don’t think that is a driver, but it’s a way we then look to justify if anyone questions us as to why*

we're spending a lot of money on active neighbourhoods..." – Private urban planner B07

2.3.2 Resistance, power and relationships

2.3.2.1 Limitations of evidence

A lack of clear evidence of ALI impacts made it difficult for public health practitioners and developers to know what to promote. Urban planners reportedly focussed on outputs rather than outcomes, for example that the construction of cycle routes was completed rather than whether routes would be well used.

> *"I think planning's notorious, I mean the planning system can get you information on how many houses are built and whether they're occupied and whether the infrastructure that developers have to deliver is in, like have they built their roads…? Planning doesn't, planning kind of falls away a bit in terms of effectiveness when you're into places actually being used and lived in by people." – Local government urban planner B02*

Councillors were reluctant to try new designs based on examples from other places that did not appear contextually relevant and were fearful of seemingly wasting resources on apparently 'risky' solutions which could be politically damaging. This was particularly a problem where good practice demanded a step change in quality from the status quo and opposition from car drivers or restricting housebuilding were concerns.

> *"…what we're effectively doing is spending a lot of public money on the basis of a hunch here and a good idea there. Quite often things can be a good idea in one context, I think this is another thing that doesn't go on, which is actually contextualising the situation properly." – Private urban planner C09*

> *"…if there is an example where it's worked previously or it's showing benefits and you can take any sceptic sort of person along and say, 'Look, this is what we're going to do here' or you show a photograph of it, most people would be fine with that, but if, I think there is a reluctance to be the first to try something out in some ways." – Greenspaces stakeholder D03*

> *"…while I'm often told to look at what the Netherlands are doing and why can't we do that here, that's not really much help... local evidence is better, if there were more of it it would be helpful." – Councillor B04*

Developers were also reluctant to invest in walking and cycling infrastructure in areas with apparent low local demand because they did not believe it would increase house prices.

Economic effects of ALI were rarely considered because financial savings from health benefits of ALI did not directly affect local government budgets, therefore many councillors were sceptical of its value.

> *"…enlightened members will care if it saves the NHS money, but many will say, 'Well, that's got nothing to do with us, that's not part of our responsibility.'" – Local government urban planner B01*

Also, cost benefit analysis was difficult to use in the planning system because urban planners negotiated financial contributions from developers, without monetising potential benefits.

> *"…the cost benefit of the various contributions doesn't come into play, it's just the absolute value of it." – Councillor B04*

2.3.2.2 Influential individuals

Public health stakeholders could be influential, firstly as knowledge brokers sharing evidence about the health effects of ALI and providing practical solutions, but potentially also acting as leaders, building strong relationships to inspire decision-makers to raise up health in their consciousness and motivate them to argue for ALI.

> *"For me, the data and evidence part is important but it's also shaping it in the context of what the outcomes are for the other areas and departments and seeing it in that context as well and a lot of it is about building up the right relationships with the right people to be able to influence those developments and areas and programmes of work as well" – Public health practitioner C05*

Where public health practitioners had a defined planning role, urban planners described them as "passionate" and a "force of nature" and participants explained that they broke down silos to motivate stakeholders across sectors, creating mutual benefits with other sectors' outcomes, including air quality, noise, flooding, biodiversity, congestion, social cohesion, crime and house prices.

> *"You wouldn't be able to achieve what we've achieved if you didn't have people who were passionate about what they were doing and wanted to do things differently. I've worked in three local authorities and it's quite easy for people to get into the tick box mentality. … I think when you've got passionate people who are committed to achieving a positive change in communities, it makes a real difference and it doesn't take a lot, it just takes a few people and they can have that ripple effect … in terms of improving longer term public health outcomes." – Local government urban planner C04*

Urban planners met most regularly with developers and negotiated with multiple stakeholders who were said to push their own agendas. ALI could be difficult to achieve because of other demands but urban planners appeared to be able to influence designs if knowledgeable and motivated, however they lacked specialist health understanding.

> *"I am going into a meeting this afternoon with the promoters for [development], and I'm going to specifically ask them what are they doing in their master planning*

to allow for healthy lifestyles, so that's something, me or the person who is in my [urban planning] job five years ago might not have asked specifically, and that is a direct result of public health coming into the councils … But I have only got … a little bit of understanding of all of the health outcomes that we might want to achieve…." – Local government urban planner B02

Multiple stakeholders were said to push their own agendas and ALI may be difficult to achieve, particularly with no defined minimum standards, highlighting the need for stakeholders to be motivated to promote ALI.

"…because there isn't a rule book that says for a new development you need to do this, then it's individual people that then can make a difference or not… what arguments are you willing to have with developers and with colleagues to an extent, you know, you don't necessarily have a consensus within an organisation about what infrastructure's needed, how it should be designed, what it should look like, how are people going to use it... " – Local government transport planner B08

2.3.2.3 The value of early involvement

Most interviewees said that early engagement with developers, before planning applications were submitted, provided the greatest opportunity to influence ALI designs and some were frustrated that local government urban planners involved them too late.

"…we are brought into it too late in the planning stage… I think if we were brought in at the stage earlier our options would be bigger, we'd have more options to do something innovative." – Other D11

It therefore appeared that local government urban planners needed to either understand the health impacts of a scheme themselves, which they struggled with, or be able to bring in other sources of knowledge and influence via public health practitioners.

2.3.3 Barriers to innovation and change

2.3.3.1 Limited by policies

Stakeholders discussed a lack of national level standards and policies for ALI, which restricted quality. Participants said that local policies generally supported healthy developments, but wording was vague without specifications for walking and cycling infrastructure and only quantities of open space required per population, not quality.

"… we tend to apply the national standards, both in terms of areas, floor space, layout, spatial locations… So the better the national standards can be, the better provision will be made across the country." – Local government urban planner B05

Stakeholders described tensions between ALI and competing demands, including national planning and transport policies that promoted housebuilding [161] and transport assessment methods that focussed on road traffic analysis rather than "fluffy active travel stuff" (Local government transport planner C07). It seemed that local policies were important to set minimum standards for developments which local government urban planners could then use to hold developers to account.

> *"…[local government] planning teams, they can be very good enablers and they can be very supportive, but they're only supportive if the local plan has the right policies in that they can then fight…" – Public health practitioner B03*

> *"…if you're going to say that you want to shift the mode of travel to cycling and walking and have a real dramatic change, you've got to have a dramatic policy change to enable that to happen…" – Public health practitioner C05*

Without defined policies stakeholders said developers would only provide the minimum that they could get away with, unless they saw financial value in doing more.

> *"We are given parameters to work to, that's what we work to. If we are going to go overboard and provide more than what is required, it's because we think it adds more value to our bottom line, yeah, but otherwise we just stick to what we are told we need to do…" – Private urban planner B13*

Participants talked about difficulties in producing policies that risked being unpopular to car-drivers as councillors feared public backlash if congestion increased as a result of new development. So whilst some planners and developers wanted to be innovative, they were restricted by local policies, for example, specifying a minimum number of car parking spaces per house.

2.3.3.2 Watering down good designs

Even when ALI was initially well-designed participants described situations where plans could later change because minimum designs standards were lacking – developers might try to reduce costs, plans were not enforced, or concerns about crime led to watering down designs. Sometimes the impracticality of plans became apparent too late, for example discovering that a football pitch was located on a slope, resulting in its purpose being changed.

> *"…quite often some developers will make promises in an outline planning consent, but by the time it comes to delivering stuff on the ground other hidden costs have emerged, which they didn't foresee, and then perhaps certain pieces of, you know, fairly important walk cycle infrastructure get watered down or removed…" – Private transport planner B10*

Safety auditors often recommended changes to walking and cycling infrastructure because of safety concerns and developers agreed to these changes to improve their chances of receiving planning permission and to ensure the local authority would take on long-term management of roads.

> *"…it tends to be that Road Safety have the final say on everything, which isn't always to the benefit of cycling and walking, and in actual fact sometimes to the*

disadvantage of cycling and walking, because we'll have created a nice little shared use route to modern design standards and gives priority to cyclists and walkers and is all lovely and ideal, and perfect in a perfect world for active travel, and Road Safety come along and say, no you can't do that, it's dangerous… Road Safety trump every scheme, every time." – Local government transport planner D13

Whilst public health practitioners also considered accident risks, they were more likely to take an holistic view. Finally, some participants were frustrated by schemes where walking and cycling routes were built after all houses were completed, apparently for cost reasons, because people then got "into bad habits" (Greenspaces stakeholder B14) and therefore were less likely to use them.

2.3.3.3 Not enough resources

Most interviewees were concerned that local government urban planners were under resourced to engage with the right people, learn about best practice, and ensure that health was adequately considered. Limited resources for monitoring and evaluation also restricted learning about effectiveness.

"…[local government] planning teams can be a barrier if they're under pressure, so if they're under pressure to get an application turned round in the eight weeks then all the 'nice to do' stuff that I want to see in, gets dropped, all the other bits and pieces that we would fight for becomes that much harder to fight for, so the Planning Team is key, because they're the ones that make the ultimate recommendations to the Planning Committee to approve or not approve… sometimes they get so bombarded with all the applications coming through they don't really have that time to sit down and do all the pre-app meetings and bring in everyone that needs to be." – Public health practitioner B03

Some stakeholders wanted to work more with public health, including master-developers, to get feedback on designs (in contrast to volume housebuilders whom interviewees said had no concern for health). However most local authorities in England did not have a public health practitioner dedicated to urban planning.

"I'd like to work with [public health] more but I don't seem to get an answer all the time… like most departments, they have restructured, reduced their services" – Cycling stakeholder D10

"So, typically, you know, on a lot of developments we're involved with, there isn't a 'health person'… who you can speak to at a local authority to sort of say, "Well, how do you think this master plan is shaping up?" – Private urban planner B09

2.4 Discussion

2.4.1 Main findings of this study

In this first qualitative study of my PhD I found that public health practitioners in local government could act as knowledge brokers and leaders, if engaged early enough, to motivate non-health stakeholders to consider health when designing and building new communities. 'Evidence' was found to be used to identify problems, inform solutions (noting that case study examples were often not considered contextually relevant), or justify decisions post hoc. However, it was influential public health practitioners who, if adequately resourced and with supportive policy environments, could share knowledge and inspire others not only to enable more ALI, but also to ensure that it was attractive, convenient, safe and functional [67,152]. This is summarised in Figure 2.2 as an 'evidence-output implementation gap' - the central box in the figure outlines the identified issues that, if missing, will likely result in a gap between evidence that demonstrates the value of ALI and the creation of ALI in practice: influential and supportive individuals; supportive national and local policies; and adequate resources.

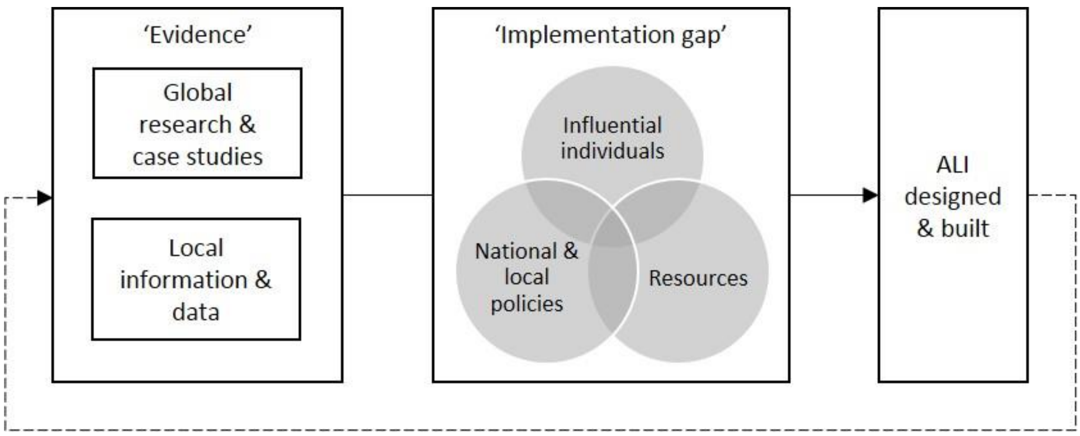

Figure 2.2: Evidence-output implementation gap

2.4.2 Discussion of findings

Findings about the types of evidence used reflect previous studies: scientific evidence hierarchies are unlikely to be considered in non-health disciplines [154,176], and local evidence of effectiveness and public opinion is highly valued [158], often for broad outcomes of interest including congestion and air quality; if academic research is used then its external validity is important in determining whether a solution is applicable to decision-makers' local contexts [76]. There are demands for improving the quality of evidence around effectiveness of ALI for population physical activity [67,152] which could be supported by wider monitoring and evaluation in local governments. A lack of research in this area has been explained previously as an 'inverse evidence law' [177] whereby the least amount is known about interventions that are most likely to influence whole populations, and previous research has highlighted challenges in creating evidence to inform practice [178].

Knowledge exchange literature advocates for knowledge brokers to translate research into policy and practice, enabling joint working for mutually beneficial outcomes and 'learning to speak the same language' [109,126,179,180]. I found that public health practitioners in local government can adopt knowledge broker roles to promote ALI. However, scientific evidence alone is insufficient to influence policy and practice in local government [181] and political feasibility must be considered [154]. Research has demonstrated decision-making to be non-linear and influenced by multiple factors [179]. This study also echoes findings from policy theory, recognising the importance of actors, institutions, networks, ideas/beliefs, policy context, and events [182], and specifically relationships and leadership in local government [155,157]. A popular policy analysis framework is Kingdon's multiple streams framework which describes three streams of problem, policy and politics that need to coincide to provide a 'window of opportunity' for change [148]. This is also a helpful perspective in which to understand decision-making in this study: problem 'evidence' needs to be identified, policies and solutions made available, and politics supportive (aided by influential individuals) for healthy ALI. The advocacy coalition framework [183] also shares relevance with my findings, particularly for cycling infrastructure where opposing 'coalitions' of pro- and anti-cycling groups can be at loggerheads.

Central to Kingdon's framework is the 'policy entrepreneur' whose role is to influence agenda setting by identifying problems and offering solutions to exploit a window of opportunity and instigate change. In my study this appeared to be a role that could be shared between urban planners acting as negotiators and public health practitioners acting as knowledge brokers and charismatic leaders [184]. Lipsky wrote about 'street-level bureaucrats' who he saw as able to interpret policy when top-down requirements were not possible to be met and therefore people used their discretion to interpret policy into practice[168]. This concept also appears relevant for local government urban planners as they interpret policy and negotiate outcomes with developers, particularly as written policies tend to be vague. This goes some way to explain why policy may not be 'perfectly implemented' in practice, as discussed by policy theorists Sabatier and Mazmanian [185] and Hogwood and Gunn [186]. Further understanding is needed about the nuances underlying these 'broker', 'champion', 'street-level bureaucrat', or 'policy entrepreneur' roles, and what makes them influential or effective to practice the 'art', not only the science, of public health [187].

I developed a conceptual model with three factors needed to fill the 'evidence-output implementation gap' (Figure 2.2) for 'evidence' to support ALI: influential individuals, such as public health practitioners in local government, who can engage early with developers to improve designs and avoid later dilution; national and local urban planning and transport sector policies and standards that enable ALI; and adequate resources for collaborative working and learning.

This study highlighted a lack of contextually specific examples available to local decision-makers, which reduced political acceptability of change for ALI. Although complex interventions will not follow a formula [154], examples from similar places are likely more persuasive to local level decision-makers. I investigate this issue of contextual relevance of case study examples in more depth in my follow-up qualitative study described in Chapter 6.

Figure 2.2 includes a dotted line to show a translational framework approach [188] where greater monitoring and evaluation of ALI at scale could strengthen the evidence-base. This is likely to require motivational leadership and collaboration across local governments to change attitudes and emphasise effectiveness of ALI outcomes over potentially ineffectual outputs.

In this study I also identified: a reluctance for decision-makers to support investment in cycling infrastructure with low perceived public demand for cycling; the importance of demonstrating the value of ALI for non-health outcomes, such as potentially impacting on traffic congestion; and an assumption that new ALI will result in increased physical activity and health benefits. I investigate these issues further in my quantitative study described in Chapter 5. Whilst there appears to be difficulties in using cost benefit analysis to influence creation of ALI through planning negotiations involving developer contributions, there appears to be potential for this to influence local government investment in walking and cycling infrastructure. This is investigated further within my studies described in Chapters 5 and 6.

2.4.3 Strengths and limitations

Whilst my PhD focusses on public health, within the MRC Epidemiology Unit at the University of Cambridge, I began my career in civil engineering. This information was included in the participant information sheet used in this study because I thought that it might encourage non-health participants to engage with the research. It came up in interviews with several participants from urban planning and transport sectors, particularly in the private sector as I had previously worked for a large multi-national engineering consultancy. I think that this helped me to build rapport with these participants as I could ‘speak their language’ [179] and I was able to understand the culture of their organisations, although my engineering experience was in the water sector. I have also had experience working in a transport consultancy designing pedestrian crossings and road junction adaptations which also provided me with insights into that sector. Throughout my PhD I attended numerous urban planning and transport events, for example the Town and Country Planning Association (TCPA) seminar ‘Planning and delivering sustainable transport in large scale new communities' in December 2018 and the TCPA conference 'A new future for new towns' in March 2019. These allowed me to understand more about the motivations and working practices of urban and transport planning professionals and the general context in which they work.

I also have experience working with local government, having previously worked in a county council for six months, and gaining a place on the Local Government Association's National Graduate Development Programme in 2015 (although I decided against taking the job offered on this scheme). These experiences provided me with some understanding of local government issues, culture and processes which also helped me in my discussions with these types of stakeholder. Near the start of my PhD I attended an event hosted by the Centre for Science and Policy for the Department for Transport that looked at ways to double cycling by 2025. This event helped me to understand the limited role that central government appeared to play in influencing levels of cycling throughout the UK and the importance of decision-making at the local government level.

Local government areas are heterogeneous and focussing on three areas of England may have missed insights from other contexts. Taking the perspective that qualitative research is not aiming to be generalisable, but seeks to gain understanding of a particular phenomenon, I did not aim for saturation (a concept which I do not believe is appropriate for qualitative research of this nature) [142,146]. However, I did seek to include stakeholders of different types from each of the study areas. The variety of contexts between the three local government areas, as well as the learning from participants who discussed working in additional areas, helped to provide insights into decision-making for ALI in different places. The differences between contexts will be discussed further in my comparative study described in Chapter 4 which involves this qualitative study in England and my qualitative study in Jamaica, described in Chapter 3.

Conducting the interviews as a public health researcher appeared to lead to some participants taking a greater interest in the topic of the study – some interviewees discussed how my involvement was useful in getting them to think about these issues. Although there are risks that interviewees provide unreliable responses to depict themselves in a more favourable light, I felt that interviewees were generally relaxed and spoke frankly during the interviews. I triangulated responses during my analysis to support my findings [142]. A small minority of interviewees appeared to struggle to see the relevance of some of the questions to their role, with some reluctance to elaborate. I recorded this in my notes and tried to account for it during my analysis. Accepting the active role of the researcher within the analysis [146] it may be that alternative findings would have been developed had this study been conducted by other researchers.

Snowball sampling [171], following the recommendation of key stakeholders, might have led to like-minded participants included in the study, but it enabled access to important stakeholders from different sectors, some of whom were unanticipated.

The new developments discussed in the interviews were at different stages of design and construction. I had originally conceived of returning to conduct follow-up interviews specifically about the changes that occurred at these sites, but limited timeframes meant it was not feasible to follow decision-making through from conception to completion.

2.5 Chapter summary

This chapter described my qualitative evaluation of decision-making for new ALI involving semi-structured interviews with stakeholders from the public and private sectors in three areas of England.

I used thematic analysis to identify three main themes: problem and solution evidence; resistance, power and relationships; and barriers to innovation and change.

I found that public health practitioners in local government could act as knowledge brokers and leaders to motivate non-health stakeholders, such as urban and transport planners, to consider health when designing and building new communities. They needed to engage at the earliest stages and be adequately resourced to build relationships across sectors, supporting non-health outcomes such as tackling congestion, which often had greater political traction. 'Evidence' for decision-making identified problems (going beyond health), informed solutions, and also justified decisions post hoc, although case study examples were not always convincing if not considered contextually relevant.

I developed a conceptual model of the 'evidence-output implementation gap' with three factors needed to bridge the gap between evidence and ALI being built: influential public health practitioners; supportive policies in non-health sectors; and adequate resources.

2.6 Contributions

I conceived the original idea for this study and had support from David Ogilvie and Cornelia Guell to develop the methodology. I produced the ethics application with assistance from David Ogilvie, Cornelia Guell and Gwen Brierley. I recruited participants and conducted interviews and ethnographic observations. Data transcription was done by an independent transcription company and this was coordinated by Inge Loudon. I checked and anonymised the transcripts and conducted line by line coding. Cornelia Guell also coded two of the transcripts and we reviewed and discussed coding together. I conducted thematic analysis, with critical feedback from Cornelia Guell. David Ogilvie and Louise Foley also provided assistance with interpretation. I wrote the original paper of this study, which has been published in the Journal of Public Health [189] and is an abbreviated version of this chapter which received critical feedback from David Ogilvie, Cornelia Guell, Louise Foley, James Woodcock and Oliver Mytton. I also presented results from this research in oral presentations at the International Society for Physical Activity and Health (ISPAH) conference in London in 2018 and the International Society of Behavioural Nutrition and Physical Activity and Health (ISBNPA) in Prague in 2019.

3. Challenges for creating active living infrastructure in a middle-income country: A qualitative study in Jamaica

Visions of development

3.1 Introduction

This chapter describes decision-making for new walking and cycling infrastructure and open spaces ('active living infrastructure' (ALI)) in Jamaica. It follows a similar methodology to the qualitative study in England described in Chapter 2, in a middle-income country setting.

3.1.1 Chapter outline

This chapter describes the rationale and method I used to conduct this qualitative study, including participant selection and conducting semi-structured interviews. I present the findings from my thematic analysis of the qualitative data and in the discussion I compare these with other research and discuss strengths and limitations of the study. The chapter finishes with a summary.

3.1.2 Background

High levels of physical inactivity are a global, and increasing, problem [26,190] with associated healthcare costs affecting individuals and governments. Although high-income countries generally have higher levels of physical inactivity than low-income countries (37% and 16% respectively) [191], increasing income levels and associated lifestyle changes, which are often found in middle-income countries, mean physical inactivity is an increasingly important issue for national governments, as associated non-communicable disease prevalence and mortality increases. This is particularly concerning in countries with weak healthcare systems. Social and economic development is also likely to be adversely impacted from high premature mortality in the working adult population, so physical inactivity can have wide-reaching impacts that go beyond the health sector. However, most of the literature about environmental facilitators for everyday physical activity, such as safe and attractive walkways and cycleways [67,97] has been conducted in high-income countries.

International guidance, such as from the World Health Organization [150], promotes active urban environments as ways to tackle increasing levels of physical inactivity and associated diseases. Other resources, such as Sport England's Active Design principles [192], provide more detail about which physical features should be present to support active lifestyles. As discussed earlier in this thesis, the socio-ecological determinants of health [193] are influenced by decisions in non-health sectors, particularly urban planning and transport, and guidance documents lack clarity about *how* to put such policies into practice. This is particularly important where decision-makers from different sectors are likely to have many competing interests which may result in gaps between policy and practice [189].

This study aims to understand factors that limit the creation of walking and cycling infrastructure and open spaces (ALI) in Jamaica, a middle-income country [194] with low rates of physical activity - 33% of the population are classified as physically inactive [191]. Non-communicable diseases are estimated to account for 80% of all deaths in Jamaica (30% from cardiovascular disease, 20% from cancers, 3% from chronic respiratory disease, 12% from diabetes and 9% from injuries) [191]. In comparison, non-communicable diseases in the UK are estimated to account for 89% of all deaths (25% from cardiovascular disease, 28% from cancers, 8% from chronic respiratory disease, 1% from diabetes and 3% from injuries) [191]. Like many places in the Americas, Jamaica has had large increases in obesity in recent years - 29% of the population in the region was obese in 2016 compared to 20% in 2000 [195].

Recognising these problems, Jamaica adopted the Port of Spain Declaration on non-communicable diseases, committing to a range of multi-sectoral policy measures for non-communicable disease prevention and control, including to "promote policies and actions aimed at increasing physical activity in the entire population" [196]. Whilst Jamaican national policy for tackling non-communicable diseases states: "Promote the building or improvement of parks, walking trails and other facilities to promote increased physical activity" [197], the lead agencies are specified as the Ministry of Health and Ministry of Sports, neither of whom are responsible for infrastructure provision. Pedestrian safety is also discussed as important in national planning guidance and cul-de-sacs are supported, with through-routes and grid layouts discouraged in many cases [198]. This is likely done to reduce the risk of crime but could limit opportunities for walking and cycling. Therefore, like many countries, despite supportively written policy documents, Jamaica struggles to create ALI in practice.

Jamaica has a range of challenges that differ from high-income country settings in which research into environments supporting active living are typically conducted, for example, high levels of violent crime [199], corruption [200], poor road safety [201] and limited financial means for infrastructure investment and maintenance. It has an estimated per capita gross national income of US$4990 [202], estimated 17.1% level of poverty [203], 8% overall unemployment and 18% youth unemployment [204]. Other issues that may differ include urbanisation [205], increasing car ownership [206] and climate challenges such as tropical rains and heat, including vulnerability to natural disasters. I was interested in exploring the ways in which local policy and planning decision-making play out against the backdrop of such challenges, which differ from England. Therefore although this is a small study in only one middle-income country it provides opportunity to reflect explicitly about contextually, which is a thread that runs throughout this thesis.

As in the England study of Chapter 2, I investigate how different stakeholders use evidence and information in decision-making, including relatively generic international policy advice on creating ALI, alongside other influences. This can help to increase our understanding of the challenges of creating healthy, active living environments, not only adding to the burgeoning body of work from low- and middle-income countries, and the limited examples from the Caribbean [207–212], but increasing understanding about why progress is so limited in creating ALI more generally.

3.1.3 Jamaica and the United Kingdom

There is a colonial history connecting Jamaica with the United Kingdom, having been a British colony from 1655 until independence in 1962. Jamaican wealth came from plantations, especially sugar plantations, which was reliant on African slaves and their descendants until the end of slavery in 1838 [213].

After the Second World War there was high emigration from Jamaica to Britain for work. Those arriving during that period have been labelled ‘the Windrush generation’ after the Empire Windrush passenger ship which arrived in England from Jamaica with 492 migrants on 22 June 1948 [214].

3.1.4 The planning system in Jamaica

The urban planning system in Jamaica for ALI is a discretionary system with historical roots to the United Kingdom’s Town and Country Planning Act [215,216]. Local planning policies (‘Development Orders’) guide development planning, alongside other material considerations, and public sector urban planners provide recommendations on planning applications to the planning authority. Appeals can be brought to the Minister who can overturn decisions. Jamaica is divided into fourteen local government areas (‘parishes’), each of which can make planning permission decisions, whilst the public sector ‘Urban Development Corporation’ also supports larger, strategic urban development. The planning system is fragmented, involving over 20 different organisations in total with 103 pieces of related legislation. Government documents admit that the “slow responsiveness of the system creates opportunities for the system to be bypassed or ‘corrupted’” [217]. Like in many middle-income countries there is urbanisation, with 56% of people in Jamaica living in urban areas [218], and demand for increased housing supply. Public health does not have a statutory role in the planning process, despite potential health implications of design decisions.

3.1.5 Study aims

This study aims to understand barriers and opportunities for creating new ALI in the particular context of a middle-income country with its own set of challenges. Learning from this study could highlight similar issues in other low- and middle-income countries (LMICs) which face challenges of increasing non-communicable diseases related to physical inactivity, as well as providing an opportunity to reflect on challenges and opportunities for high-income countries, such as the UK, which is investigated further in Chapter 4. Like the England study, this research includes investigation of how different types of evidence and data associated with impacts of new walking and cycling infrastructure are valued by stakeholders.

The research was guided by three main questions that closely relate to the study described in Chapter 2 in England: (1) How does evidence, information or data influence decisions relating to designing and building ALI? What else is influential? (2) What opportunities are there to influence plans of new residential developments which affect walkability, cycling or open spaces? (3) What evidence or data could support more effective planning of ALI across countries?

3.2 Methods

As in Chapter 2, I chose to use semi-structured interviews to investigate what influences decisions relating to ALI in Jamaica. This provided flexibility to understand issues in depth. Ethical approval for this study was granted by the University of the West Indies Ethics Committee, Mona Campus, Jamaica on 21st February 2019 (Reference: ECP 62, 18/19). It was also approved by The University of Cambridge, School of the Humanities and Social Sciences, on 22nd February 2019 (Reference: SHSS 22/02/19).

3.2.1 Scoping

Two initial scoping discussions were conducted by me, Ishtar Govia and Mia McMorris: one with an urban planning academic with experience of working with government to understand issues within the sector in Jamaica; and one with a senior police officer to understand issues related to the high levels of violent crime in Jamaica and potential implications for ALI.

3.2.2 Setting

Although I initially aimed to focus the study on two (anonymous) local government areas ('parishes') in Jamaica, I decided to expand the case under investigation to the country as a whole once it became apparent from the first few interviewees that many decision-makers were operating at national, rather than parish, level.

3.2.3 Participants

Nine semi-structured interviews were conducted with ten stakeholders (two stakeholders from one entity participated in one interview) purposively sampled across the sectors of urban development (urban planners and architects), public health and from civil society (including running, cycling and neighbourhood organisations). Six were from urban development of whom one was involved with a neighbourhood organisation; three were from the health sector, of whom one had also been involved with a cycling organisation; and one was from a running organisation. The sampling criteria was defined in advance to provide diversity in stakeholder sample, alongside snowball sampling [171] involving advice from local expert interviewees to identify participants from particular sectors and organisations. To protect the anonymity of interviewees in this relatively small policy setting, only broad umbrella terms are used to refer to interviewees' roles: 'urban development' or 'health' (which included the civil society organisation) and localities are not disclosed.

Interviewees were contacted and invited to participate either via telephone or email. They were sent copies of the participant information sheet and consent form in advance (see Appendix 3.A).

3.2.4 Data collection

Semi-structured interviews were conducted to allow for flexibility of questioning and to investigate emerging issues which were not identified a priori, similar to my approach described in Chapter 2. They aimed to explore what influenced the design and construction of ALI in Jamaica, including how public health interacted with non-health sectors and the role of evidence, information and data. The original topic guide was based on the one I used in my qualitative study in England, described in Chapter 2. I piloted it during the first two interviews to check contextual relevance and minor changes were made, mostly to improve the flow of questions (see Appendix 3.B).

All semi-structured interviews were conducted face-to-face at the participants' places of work, either by myself or by a research assistant from the University of the West Indies, Mia McMorris, whom I trained to conduct semi-structured interviews for this project. These were conducted in February, March or July 2019 (I conducted the first two semi-structured interviews with Mia McMorris as an observer; and Mia McMorris conducted the remaining interviews with myself or Ishtar Govia as observers). All participants provided written informed consent and interviews were audio-recorded, taking an average of an hour (range 39 – 95 minutes). As later interviews were conducted by Mia McMorris after I left Jamaica, I listened to each audio recording soon after she conducted each interview and provided feedback to improve the quality of future interviews. This included both supporting her interview technique, such as encouraging her to try to direct responses that were going too far off-topic, and also directing the focus for future interviews, such as investigating emerging issues in greater depth.

Audio recordings were transcribed verbatim by a third party in Jamaica and checked by myself. I removed any identifiable terms, including people and place names.

3.2.5 Analysis

I conducted thematic analysis [170], supported by qualitative analysis software NVivo 12 [172]. This involved line-by-line coding of all interview transcripts, with one interview coded independently by Cornelia Guell to allow for discussion of the codes. I considered using the same codes as for the England study, described in Chapter 2, and tested this with the first interview transcript. However, I felt that this framework was not appropriate for this study, because of the different issues that were discussed in the interviews, and therefore developed a new set of codes. This was done by first reading the first seven interview transcripts, making notes as I went and keeping an ideas log of possible codes and general issues. Since the analysis was informed by the research questions my analysis was partly deductive, but I also used free inductive coding for unanticipated concepts, based on the data.

Using post-it notes I re-ordered my initial codes into categories, and inputted them into NVivo [172]. I then conducted line-by-line coding of all interview transcripts, allowing for additional codes to be added as necessary, and a small number of the original codes were merged. Following this stage, I re-grouped the codes again into categories which were conceptually related (using cut-up print-outs and post-it notes) and my final list of codes is included in Appendix 3.C.

Post-it notes and print outs of the codes were again used in the development of higher-level themes as I sought to make sense of the data and I used an iterative approach for this, involving discussion with Cornelia Guell and Ishtar Govia, to repeatedly reorganise and re-frame findings. This was also supported by creation of domain summaries, with preliminary findings outlined in a Word document of around 20,000 words. This helped to investigate the potential theme ideas through summarising findings from associated codes, as well as providing an opportunity to select quotes that I could use to demonstrate particular themes. For added rigour during the analysis I compared responses from different interviewees with comments from the scoping discussions and a review of some relevant policy documents, such as local development orders and the Jamaican national development plan [217,219].

3.3 Results

I identified three main themes from the data: lack of public support for ALI due to conflict with aspirations for economic development; problem framing of issues associated with lack of ALI; and challenges of creating quality ALI.

3.3.1 Aspirations for 'development' and perceived lack of public support for active living infrastructure

3.3.1.1 Political focus on economic growth: jobs and housing

Stakeholders across all roles felt that ALI had little policy or public attention in Jamaica. Interviewees suggested there was political pressure for economic development related to road construction and private car use but not for walking and cycling. Interviewees indicated that the vision of 'development' being promoted in Jamaica was one of modern, high-rise blocks, focused on economic activity.

> *"…there is a big demand for apartments and for increased density and the Prime Minister is talking about Kingston being like the Miami Skyline kind a thing which is his vision of development…" – Urban development J02*

Interviewees discussed housebuilding in popular higher income neighbourhoods, with increasing density creating higher profits. Planning policy specified open space requirements in new developments (although these were only for residents and not publicly accessible). However, there was criticism that it was not always provided, or were very poor-quality spaces. In some older communities, interviewees said that open space had historically been used for on-site sanitation but provision of modern piped sewerage removed this purpose. If assessed as 'surplus to requirements' policy allowed apparently 'useless' open space to be built on [198].

Road construction was reportedly valued because it provided employment and "people love roads" (Urban development J02). One interviewee thought that taxi drivers were a powerful lobby group against investment in mass transit (which may increase levels of physical activity [220]) because "they have a lot of power and there are a lot of them and it's their livelihood" (Urban development J02).

Some participants talked about a lack of will by decision-makers to support ALI, noting that "the political will to get it done is crucial" (Health J08). There were examples given where decision-makers appeared to support infrastructure but "it get shelved, by the will, the will is not there." (Health J01).

3.3.1.2 Green spaces under-valued

Interviewees perceived the natural environment to be a low priority. They noted a common view of it as unkempt and vegetation often being removed during construction. Maintenance of open spaces was understood to be costly and demanding resources that the government did not have. On the other hand, some interviewees said that if quality open spaces were provided people valued them. While commending the few high quality public parks that existed, some interviewees mentioned the high cost of maintaining one particular park as the reason why others had not been built. Interviewees were unable to identify ministerial responsibility for green spaces and said that communities were likely to be given responsibility for maintaining their open spaces. However, several interviewees were concerned that this resulted in poor management and maintenance which could lead to degradation of quality and the spaces becoming unusable or attracting homeless people (squatting was estimated between 5% and 20% of the housing stock [217]).

> *"…what happen in a lot of communities is that the green space is not maintained and it becomes a safety hazard in and of itself and it's just become unusable. So it should have a field but the field is not cut so it's overrun with trees, sometimes there is garbage or you just have people lurking in the area." – Health J08*

Despite resource constraints some urban development interviewees wanted new open spaces to be transferred to local government ownership, rather than to communities. Some, from the public sector, heralded public-private partnerships as a solution to overcome limited resources and failure of community-management. They indicated this could assist with both maintenance and with providing facilities within open spaces (e.g. running tracks or outdoor gym equipment). Interviewees said some private companies did this as corporate social responsibility and to raise their public profiles, but that wealthier areas were more likely to have this investment.

> *"…like say [high-income area] they have you know a big open area. In fact, I hear now that they have gotten help to, isn't [company] or somebody has fix it up for them with running track and all kind of things." – Urban development J05*

Funding from the Ministry of Tourism was reported to be available for open spaces for up to three years, after which time places needed to be self-sustaining for on-going maintenance through income-generation activities.

Nature was reportedly pushed out by construction - interviewees noted that road construction could remove vegetation which reduced walkability because footpaths were less likely to have trees which offered shade from the heat (also recognised in national planning policy documents [198]). Interviewees reported some tokenism for tree planting but noted that without a budget for maintenance it was unlikely to be sustainable.

"…they get the budget for the road, they have absolutely no budget for any landscape and so it's like only roads…"- Urban development J02

3.3.1.3 Infrastructure reducing safety

Interviewees indicated that ALI was generally not available to poorer members of society, reporting that pedestrian and cycling infrastructure were generally quite unsafe. Interviewees explained that high-income residents were increasingly putting up high walls around their homes to improve security but some interviewees believed this reduced safety for pedestrians as it impaired natural surveillance.

"…people put up these tall walls which happening a lot around here too, where you can't, it really makes you feel very insecure if you're on the street because you're not being overseen but I guess within your compound you feel safer." – Urban development J02

Similar to other middle-income countries, road safety was highlighted as a problem [201,221]. Interviewees noted tension between increasing traffic capacity in the name of economic development and resulting deterioration of road safety, restricting pedestrian movement and without provision of cycling infrastructure. Interviewees said that accidents raised the issue of safety in the public's consciousness but that this attention was not sustained. They said roads for cars were prioritised, for example one urban development participant noted "a politician is judged by the condition of the roads" (J02).

"…in an effort to widen the road and to ease the congestion for vehicular traffic, the sidewalks, and the people are saying now there are no place to walk… in the name of development and advancement I think sometimes … walking spaces are sacrificed… and persons with disabilities have significant challenges being able to just walk." – Health J03

3.3.1.4 Lack of public voice and inequality of access to quality ALI

There appeared to be unequal access and demand for ALI from different socio-economic groups. Interviewees suggested that wealthier people drove (often long distances) to reach safe, well-maintained parks, had access to private open spaces within their compounds, or could pay to access places such as golf courses. In contrast, they reflected, people living in poorer communities had limited access to those resources.

"… [in poorer areas] persons play in the gullies because there are no formal parks or open spaces in their communities to play. We know that kids play on the streets, football, cricket all kinds of stuff" – Urban development J04a

Interviewees considered recreational cycling as a wealthy person's activity because racing bicycles were expensive. They, however, acknowledged that poorer people often cycled for transport. They noted that wealthier leisure cyclists mainly used the roads during weekends when it was quieter because it was dangerous cycling amongst traffic.

> *"There is nowhere to ride…there is no allowance made for cyclists on the road whether commuters or hobby cyclists… we have the drains in the side of the road, which we can't ride over but the cars won't give us space to go around them. There are potholes, there is glass…" – Health J08*

Interviewees said that the lack of reliable public transport made it an unattractive option and people preferred to drive rather than walk or cycle because of the hot, humid climate, a desire for air conditioning and a lack of showering facilities at workplaces.

> *"…it's not our culture. Some people say 'Okay that is all well and good in the temperate countries where you can cycle to work.' Most people are moving towards wanting to acquire a motor vehicle that they can sit in a comfortable AC because of our climate and everything" - Health J03*

Interviewees noted that in higher income communities streets were used for leisure activities: they said that early morning walking was common and felt safe, and that road running was an increasingly popular activity for the middle- and upper-classes. Interviewees said that people were less likely to walk for leisure in poorer communities because of the risk of crime.

Generally lobbying for ALI and related agendas was said to not be a priority for most people whose main concerns were on day-to-day survival.

> *"…the mass is more interested in bread and butter right now and that is a serious issue... the public don't have any money, it don't make any sense, all they have is one voice. And I don't see them demonstrating, I don't see that. Most cases when we have projects, they are thinking about employment." - Urban development J06*

Although it could be difficult to engage the public, urban development interviewees thought that community consultation for local planning policy development was useful. However, public consultation was unlikely for individual developments and some interviewees complained that development planning was opaque and even corrupt.

> *"…it is not very transparent. There is very little opportunity to see what's being proposed… I think it's a pretty corrupt system because some things just fly through and no one, I mean I don't know how they got the permit over here." – Urban development J02*

Being able to influence politicians to lobby for a particular agenda appeared possible through informal access to decision-makers.

> *"I should influence the process, because the Prime Minister is a man that like to run, the Minister of Health he likes run. I see him this morning was exercising at [location] same like me, so the fact is that how can we show them… so let's try to influence the process" – Health J01*

3.3.2 Framing the problem

3.3.2.1 Behaviour change focus of public health

Public health professionals tended to focus on exercise-related behaviour change interventions rather than engaging with urban planning and transport sectors to support active living environments. Interviewees explained that the Jamaican health sector tended to focus on behaviour change campaigns, such as 'Jamaica Moves', a government initiative that included the promotion of physical activity, rather than engaging with urban planning or transport sectors to influence environmental determinants of health. Providing walking trails within communities was a health policy goal but it was reportedly not yet a focus for public health. Health sector interviewees recognised that "health doesn't sit in the box of health, it has to be infiltrated into every sector" (Health J03), but interviewees talked about silos in government.

> *"…the Minister is all into getting people to exercise and things but it's not a big, you know it certainly doesn't show up in planning. So people still expect to get into a car and go somewhere…" – Urban development J02*

Some health sector interviewees were sceptical about providing cycling infrastructure because of the cultural change believed necessary to encourage cycling.

> *"I doubt that there's any intention of putting in cycling lanes and if you were to ask for that now, people would like 'What?', you know… [cycling]'s not our culture " – Health J03*

Interviewees explained that environmental impact assessments were conducted for new developments, but that this did not extend to wider health impact assessments. Notably poor air quality due to vehicle emissions was not raised as a concern during interviews, despite it being a problem in Jamaica [217].

3.3.2.2 Visionary urban planners

Urban development interviewees said they understood the health value of physical activity. They communicated ambition for promoting ALI, aligning with good place-making principles.

> *"…any planning guideline, anything at all they are encouraging walkable cities……We talked about actually ensuring about the sidewalks … to make sure that people can walk. We spoke about actually putting in place facilities that encourage cycling… that they were age friendly… that people have rest stops along the way, ensuring that people can cross... ensuring we have proper landscaping" – Urban development J06*

There was an apparent enthusiasm for learning amongst urban development interviewees although they noted that health was not formally included in their training. International case studies and information from other countries were discussed – one interviewee talked about planners from Colombia coming to Jamaica to share ideas. Another said that international best practice for ALI reached Jamaica from people studying or working abroad returning to the island. They said that sometimes international examples were difficult to adopt in Jamaica because of the cost. For example, an urban development interviewee (J06) discussed the replacement of wilting flowers in a park in Canada as being unachievable in Jamaica.

Urban planners expressed frustration that their role was advisory, rather than decision-making, so they often struggled to influence decision-making for ALI with either private sector developers or the Jamaican transport authority.

> *"…we can comment, but comment is different from approval because if you comment you can ignore right… [The Jamaican transport authority] and other people are going to be looking and saying 'listen… traffic is not moving freely.' So their position is widen the roads, right. But my position and what we're pushing is not that. Put in place mass transit. Try and densify certain urban areas, right. And actually close off certain roads... because the best form of mass transit by the way is walking you know"* – Urban development *J06*

3.3.3 Difficulties of ensuring quality

3.3.3.1 Evidence and influence

We enquired about the use of evidence, information and data in influencing decision-making. This was purposefully kept broad to allow for individual interpretation of what this meant to people in varied sectors. The health sector interviewees discussed using academic evidence to inform policies, such as systematic reviews. They also used local data sources, such as the Jamaica Health and Lifestyle Survey [222], and international guidance, such as from the World Health Organization. It did not appear that public health professionals tried to use health evidence to influence other sectors such as urban planning or transport, and silos in government limited collaboration and knowledge sharing between sectors (although one health interviewee thought that collaboration was improving).

"…cycling lanes have been written into one of our [health] policies. However we have major construction of about three different road ways in [City] and none of them have taken cycling lanes into account. Zero of them… there is clearly a disconnect between maybe the Ministry of Transport, Works and whatever and the Ministry of Health. So the inter-sectorial collaboration, communication I think that's one, that would be one of the main pit falls." - Health J08

Some urban development interviewees thought that more information about healthy environments was necessary to lead to change.

"I believe as we understand more and realize how vital those are to the future health of the population I'm sure it will be something that would actually become part of the norm of operation..." – Urban development J04a

Many interviewees thought that framing issues of ALI and non-communicable diseases as economic problems could raise their profiles, demonstrating return on investment, and increase political concern because of the cost of ill health. However, it was also thought very challenging in practice to influence ALI decision-making on economic-health grounds.

Urban development interviewees thought that quality open spaces in high-end residential developments would increase house prices which could be evidence to present to developers to encourage provision of open spaces.

"I think it's market driven, because people now are becoming more health conscious, so you get to ask for a nicer price... especially because outside you have to consider safety. For example, if you live in a gated community… you can stay inside, in your community and be safe, that would be I think a major attraction to the market for purchase." – Health J08

3.3.3.2 Explicit policies and enforcement

Jamaica has a discretionary planning system and interviewees said that policies were often designed to be vague, allowing for flexibility. Whilst interviewees said that policies supporting ALI were present "it's the follow through afterwards" (Health J08) that was challenging. Where requirements were specified interviewees complained they were not enforced and developers did not follow them. This was reportedly likely with private sector investors who focused on short-term profit.

"… you may find that they are not doing something they should have… it's pretty common. And especially where you have external investors, companies external to Jamaica, they don't always follow the rules. But I don't know if much happens afterwards." – Health J08

Easy to measure quantity metrics, such as space per dwelling, were criticised as 'tick box' exercises which did not account for quality. Volume housebuilders (private and public sector) reportedly maximised numbers on a plot to maximize profit and were criticised for "not designing healthy communities they just designing things to make money" (Urban development J07). One development stakeholder perceived politicians as not truly valuing urban planners and architects.

> *"…it's kind of an administrative exercise to check boxes… all they're doing is trying to control things according to density and not actually, I don't think considering the public realm at all… well it's a disastrous approach! … I think there is no recognition by the politician that you need this kind of [urban] planning" – Urban development J02*

3.3.3.3 International influence

A range of multilateral agencies, non-governmental organisations and international companies working in Jamaica were discussed in the interviews. It appeared that international funding organisations could enable ALI, either directly through financing infrastructure, or indirectly through influencing government decision-making. One interviewee thought that multilateral agencies could raise standards and their involvement was the only way to ensure regulatory compliance.

> *"The only time I think that we actually as a country… comply with some regulatory framework is when the multilateral or lending agency requires it. They have specific international standards that you must abide by if you expect to get a grant or a loan." – Urban development J07*

However, some interviewees felt that Jamaica should develop its own standards, supported by international guidance, instead of adopting international standards. They noted that international advisors sometimes appeared to weaken government sovereignty and expressed concern that international advisors may not provide contextually appropriate solutions. One interviewee even wondered whether there was an element of racism, suggesting that international agencies did not trust Jamaicans.

> *"…the foreign donors do not in my estimation give even one-tenth of the money to the organizations that are run by non-whites or 'pass-for-whites'." – Urban development J05*

Interviewees said the government had limited budget for infrastructure and they discussed difficulties in funding that often resulted in plans being watered down or cancelled. One urban development interviewee said that international funding opportunities were being investigated. However, unsolicited foreign investment proposals were sometimes received, for example for new transport networks, rather than via government calls for tenders, and interviewees said these proposals could be difficult for government to evaluate because of a lack of capacity.

> *"I know there have been talk of a light railway that some Chinese company came to the government wanting, but you know I was talking to someone in government and they say they don't have any way of accessing whether it's a good idea or not… They can come with an unsolicited proposal and you can take them up on it and borrow their money and build your railway but unless you know that it is something that would actually would make sense, hopefully they won't do it." – Urban development J02*

3.4 Discussion

3.4.1 Main findings of this study

In this second qualitative study, conducted in Jamaica, I found that new ALI was challenging to provide because it did not fit with widely held views of 'development' which focused on road construction, driving and economics, not walking, cycling or nature. Public open spaces were lacking, particularly in poorer neighbourhoods, and the few good examples were expensive to maintain, deterring additional investment. Unsustainable community management was highlighted as a factor associated with poor quality or unusable public green spaces.

Pedestrian infrastructure was poor quality and cycling infrastructure non-existent, making it dangerous for people to walk or cycle which particularly adversely affected people from deprived communities who appeared to lack political voice. Silos in government limited collaboration and knowledge sharing between government departments. It appeared that urban developers were natural allies for public health given the health sector's need to promote active living, with an enthusiasm for good place-making seen among urban planners. However, the role of the public sector urban planner was often more advisory than decision-making.

Although policies were generally supportive of ALI, they were rarely followed, particularly by private sector investors who were noted to focus on short-term profit. Interviewees also discussed a lack of attention to the wider economic benefits of ALI related to health. Providing infrastructure in Jamaica may involve trade-offs between international financial agencies and national government sovereignty. Whilst international financial agencies were identified as potentially raising standards, there was scepticism that they ensured contextually relevant solutions.

3.4.2 Discussion of findings

This study adds to understanding particular challenges of LMIC contexts, but contributes more widely to the research about decision-making for ALI, demonstrating that stakeholders have multiple influences which go beyond health evidence, including local acceptability [158,189].

On the surface, ALI may appear low in the hierarchy of needs for Jamaican policy-makers [223,224]. However, findings suggest complex tensions between ALI and aspirations for economic development. On the one hand, car travel and new housing are held up as signs of socio-economic advancement, with car ownership related to social status [225]. On the other hand, pedestrian and vehicular traffic safety, active travel and quality green spaces are also noted as markers of economic development. As found in my study in England, discussed in Chapter 2, quantity of housebuilding and private profit were facilitated rather than quality of place-making [189]. Income level was reportedly linked to use and perception of need for ALI - interviewees noted a prizing of green spaces and walkability especially among persons in middle and upper socio-economic groups.

As in Chapter 2, I discuss the findings in relation to Kingdon's multiple streams framework [148] which provides a way to understand policy processes, which are messy and non-linear [111,226]. In Kingdon's policy analysis framework, he suggested that *problems* need to be identified for attention; *policies* need to be available as solutions; and also supportive *politics* to act. When all three occur a 'windows of opportunity' is created, and so called 'policy entrepreneurs' can offer solutions to decision-makers at these opportune moments. This Jamaican study presented similar issues which help to explain challenges for creating ALI.

3.4.2.1 Highlighting problems

The problem of physical inactivity was widely recognized but the lack of ALI was not framed as a cause of that problem. Road safety and vehicle emissions were also rarely framed as issues needing attention. Green spaces and vegetation were seen as problematic due to maintenance costs and concerns about attracting homeless people. Therefore, the lack of ALI was not framed as a problem in and of itself. Knaggård argues that the multiple streams framework would benefit from inclusion of a 'problem broker', as someone who can help identify a problem in the first place [227], unlike Kingdon's 'policy entrepreneur' who connects problems to policy and politics to identify solutions. I suggest this problem broker role appeared necessary to highlight the problems of inadequate ALI, including the wider economic impacts which could link to the more popular economic development agenda. Therefore re-framing transport problems as economic and health problems related to sedentary lifestyles, air quality and road safety (road crashes are estimated to cost low- and middle-income countries five percent of GDP [228]) could help to promote walking and cycling infrastructure, for example using the World Health Organization's Health Economic Assessment Tool [134] which calculates an economic value for new pedestrians and cyclists. However, Knaggård also acknowledged the importance of access to influential individuals, credibility and willingness in the knowledge broker role [227], which may point to non-health actors to promote this agenda, for example urban planning professionals, or influential individuals from other spheres, such as the health stakeholder who expressed enthusiasm to try to influence senior politicians with whom they socialised.

3.4.2.2 Implementing policies and providing solutions

Supportive policies for ALI were generally present but were rarely implemented. For example, policy documents recognised the need for cycle paths for safety and to benefit disadvantaged groups, such as poorer women through travel time reduction [229] and stating that cycling was a 'main mode of transportation' [219]. However, there was no cycling infrastructure. Lack of enforcement of developer obligations were recognised by the Planning Institute of Jamaica as resourcing problems [217].

Urban planners supported creating active urban environments, appearing to be natural allies with public health. The policy literature suggests that this could be an effective strategy, in particular the advocacy coalition framework [183] recognises that groups with shared sets of beliefs can work together to influence decision-making [230,231]. However, it appeared that urban planners and public health actors may have shared sets of interests, rather than shared beliefs as the advocacy coalition framework suggests, since public health professionals relied more on academic evidence (associated with evidence-based medicine [232]) compared with urban planners who considered multiple influences in decision-making, including public opinion, international examples and established place-making principals. These differences in beliefs may go some way to explain the difficulties in collaboration between sectors, alongside fiscal challenges [233], and limited recognition of mutual benefits from ALI such as quality place-making, tackling congestion, and increasing physical activity, all of which can provide economic benefits. It appeared more challenging for the transport sector to recognise these shared interests, as they prioritised private car-focused road widening strategies, which is not unusual in low- and middle-income countries [234].

Urban planners' enthusiasm to support ALI potentially suggest this group as Kingdon's 'policy entrepreneurs' to provide solutions to decision-makers, although their advisory nature provided few 'windows of opportunity' [148]. International agencies may also have potential to act as 'policy entrepreneurs' and encourage ALI.

Relying on community-management for open spaces was problematic, as has been found with public goods in other sectors, such as water supply [235]. Open spaces were required to be financially self-sustaining, but this appeared to potentially exacerbate inequality if poorer areas are unable to do this and relying on housing developers for provision limited access for the general public. Findings suggest that it is important to test assumptions that public-private-partnerships solve long-term maintenance and management issues. Increasing perceived value of open spaces by local people may help leverage funding by demonstrating multi-functional purposes, as well as designing in crime prevention measures [236], to mitigate cycles of poor maintenance, quality and use.

There is a growing body of evidence about associations between urban environments and physical activity [55,67,80,89,237], including from middle-income countries like Jamaica [207,212]. However, lack of clarity about mechanistic pathways, which is a challenge in cross-sectional studies [97,212], adds to the challenges of influencing ALI design and more research with natural experiments could be beneficial [77], particularly in middle-income countries to investigate transferability between contexts. Clearer evidence on the economic impacts of ALI within low- and middle-income countries could also demonstrate value and encourage the health sector to diversify from individual behaviour change strategies [238] to approaches that tackle the upstream determinants of physical activity. Contextually relevant examples could also help address concerns that ALI is too difficult, especially for cycling. However, other transport policy research has found that socio-political issues, rather than simply geography, affects which international examples are influential, such as the case with South Africa's bus rapid transit system which looked to South America for inspiration [239]. Therefore, clearer understanding of where examples should be drawn from to influence ALI decision-makers appears necessary.

3.4.2.3 Gaining political support

ALI decision-making appeared to be a political, rather than a technical decision, so scientific evidence alone is unlikely to be highly influential [240]. This points to the potential futility of following an evidence-based strategy (which the public health sector may be inclined to do) in what is a complex, political problem [153]. Political support for ALI was lacking because aspirations for economic development did not account for the full value of ALI; deprived communities, who were likely to benefit most from new ALI, lacked political voice; there was challenge from the road building lobby, including the taxi lobby; and funding was limited, particularly for on-going management and maintenance. Physical inactivity and associated chronic non-communicable diseases may not have received the focus of disease outbreaks, such as Zika and Chikungunya (which were pressing issues at the time of the study), because conditions may need to deteriorate to crisis point before gaining political support for action [148].

Research has highlighted the importance of political leadership for ALI creation in middle-income countries, for example strong political will and clear policies helped facilitate high levels of cycling in Bogotá, Colombia [241], and strong leadership supported implementation of strategic plans involving ALI in Buenos Aires, Argentina [242]. Influencing 'insiders' [179] who can lobby policy-makers may be a useful strategy, however change can be slow, as described in the enlightenment concept within the advocacy coalition framework which suggests that a person's core beliefs are difficult to change and may be influenced slowly over many years [183]. Reframing the debate about the environment and physical inactivity could influence public opinion to support ALI, but immediate economic issues are more pressing for many poorer people.

3.4.3 Strengths and limitations

This small study undertaken with limited time and resources included stakeholders across urban development and public health, looking beyond the UK setting (the focus of this thesis) to understand how the global agenda of active infrastructure plays out in a different setting. Although it is only one other setting, with its own specific set of challenges, it demonstrates the importance of understanding complex contexts involving urban planning processes and public health's place within that. As with the study described in Chapter 2, I did not seek to identify generalisable findings, which are not appropriate for qualitative research, but rather develop an understanding of decision-making within this particular context, which is possible with a small sample [142,146].

I collaborated with researchers in Jamaica for the data collection and analysis of this study. I also have some wider experience from LMICs (having previously worked in international development), including living and working in multiple LMICs. This helped in interpreting the findings of this study. However, it would also be useful to repeat this study in other LMICs to investigate transferability of findings. The use of similar studies in other settings is discussed in the final chapter of the thesis (Section 7.3.3.1).

A more in-depth research design would include more interviewees from other sectors (specifically, I was unable to include the transport sector), as well as politicians involved in planning decisions, as I did with my qualitative study in England, described in Chapter 2. Additional insights could also have been drawn from international actors, including regional stakeholders, such as The Caribbean Public Health Agency (CARPHA). There were some recruitment difficulties in this study which I believe related to the relatively low priority of ALI in local policy-making agendas, as well as being health-focused (some interviewees were initially concerned that they would not have much to say on this topic). Also, in accordance with the protocols of specific institutions, requests for interviews had to be directed to senior individuals which created delays and scheduling difficulties that may not have been an issue for more junior colleagues. A more transport-oriented emphasis may produce additional insights and is worth exploring in future research. I also recognise that there were hierarchical complexities between researchers and participants due to the hierarchical professional context in Jamaica since the interviewees held senior professional roles and I and Mia McMorris were relatively young but arguably privileged women, representing the University of Cambridge. As discussed in the previous chapter, accepting the active role of the researcher in qualitative research [146], alternative findings could have been identified if this study had been conducted by other researchers.

Finally, additional perspectives may have been possible through conducting a comprehensive policy analysis involving policy documents to complete an audit of the gaps between policy and practice.

3.5 Chapter summary

This chapter described my qualitative evaluation of decision-making for new ALI involving semi-structured interviews with stakeholders from the public and private sectors in Jamaica.

I used thematic analysis to identify three main themes: aspirations for ‘development’ and perceived lack of public support for ALI; framing the problem; and difficulties of ensuring quality.

New ALI was challenging to provide in Jamaica because it did not fit with widely held views of ‘development’ which focused on road construction, driving and economics, not walking, cycling or nature. Public open spaces were lacking and the few good examples were expensive to maintain, deterring additional investment. Pedestrian infrastructure was poor quality and cycling infrastructure non-existent, making it dangerous for people to walk or cycle which particularly adversely affected people from deprived communities who may lack political voice. Greater collaboration between public health and urban planning, which appeared to be natural allies with shared interests, could help re-frame the multi-sectoral (including economic) benefits of ALI. Brokers may highlight problems associated with lack of ALI and also provide contextually relevant examples which go beyond generic international guidance.

3.6 Contributions

The idea to conduct the study described in this chapter arose following my study described in Chapter 2. I explored a number of potential country locations and had support from Cornelia Guell to develop this study in Jamaica, with Ishtar Govia from the University of the West Indies. I wrote the ethics application with assistance from Ishtar Govia, Cornelia Guell and Louise Foley. Ishtar Govia and Mia McMorris recruited participants for the study. I conducted the first three interviews with Mia McMorris, who then conducted the remainder, with support from Ishtar Govia. Data transcription was done in Jamaica by Sharol Henry. I checked and anonymised the transcripts and conducted line by line coding, followed by thematic analysis, with critical feedback from Cornelia Guell and Ishtar Govia. I wrote the original paper of this study, which Cornelia Guell and Ishtar Govia provided feedback on, and which has been published in Cities & Health [243]. This chapter is an extended version of the paper.

4. Understanding decision-making across contexts for active living infrastructure: A synthesis of two case studies

Informal networks & popular politics

4.1 Introduction

This chapter builds on the analyses of the qualitative studies described in Chapters 2 and 3 to arrive at additional insights about new walking and cycling infrastructure and open spaces (‘active living infrastructure’ (ALI)). I am approaching this as a multiple case study [141] across the two different country contexts of England (a high-income country) and Jamaica (a middle-income country).

4.1.1 Chapter outline

This chapter describes the rationale and method I used to further investigate decision-making for new ALI using a meta-ethnography approach [244]. I present my findings, discuss these in relation to other research, and explore the strengths and limitations of this study. The chapter finishes with a summary.

4.1.2 Background

Evidence synthesis can be used to gain insights beyond those derived from individual studies. In quantitative research meta-analysis is commonly used to synthesise findings from multiple studies, with individual studies controlling for contextual issues as potential confounders. Methods for synthesising qualitative data are increasingly common and expanding [245], including using meta-ethnography, to gain additional insights beyond those of the original studies. These do not attempt to control for context as a confounder but seek to understand the importance of context whilst also understanding issues across contexts [244]. Often this is conducted using secondary data sources, such as published papers. Methods for synthesis of primary qualitative data are less common despite this being the original aim of meta-ethnography [244].

Acknowledging the similarities and differences between places, and gaining additional insights beyond those from the original studies, can help to demonstrate the relevance of qualitative studies across contexts, and inform concepts of transferability. This could demonstrate value of findings for apparently disparate audiences, whilst still preserving important issues of context so that findings appear relevant to decision-makers to inform policy and practice (an important point raised in Chapter 2). Improved understanding of applicability and transferability of research findings may appear to be particularly valuable for low- and middle-income countries (LMICs) which are likely to have fewer resources with which to conduct primary research [246]. However, findings from LMICs may also support the creation of healthier, more active neighbourhoods globally, including within high-income country contexts.

In the previous two chapters I outlined learning about decision-making for ALI from England (a high-income country) and Jamaica (a middle-income country). These countries differ in physical, social, economic and political contexts, including terrain, climate, culture and history, although both have increasing levels of urbanisation - 83% of people in the UK and 56% of people in Jamaica live in urban areas [218]. Although there may be difficulties in translating findings from places with very different contexts, learning across contexts can help towards understanding more overarching challenges, structures, processes and principles. In a globalised world, products, lifestyles and values seem to disperse and homogonise through the cross-border movement of ideas, people, goods and finance, with increasing interdependence between countries. Many people believe that Western-inspired values, relating to capitalism, commercialisation and individualisation are increasingly dominant [179]. Therefore, despite contextual differences across countries there are likely commonalities from which it can be useful to learn.

The dispersal of ideas and knowledge includes scientific evidence and policy recommendations, at least partly driven by international institutions, such as the World Health Organization, and their guidance and recommendations. A lot of these recommendations are built on an evidence base produced in high-income countries [80] and translated to LMICs (although there are also examples of exchanges between LMICs [239]). This study is an opportunity to take an alternative perspective, using research from both contexts to build on one another and demonstrate how research from LMICs can be useful for insights into high-income country contexts.

4.1.3 Aims

This synthesis seeks to gain additional insights from the findings of the previous two chapters which looked at decision-making for ALI in England and Jamaica respectively to understand what influences the creation of new active living infrastructure across different contexts. I analysed these as a multiple, or collective, case study [141,247] to understand similarities and differences across contexts, and followed Baxter and Jack's suggestion of exploring issues through "a variety of lenses which allows for multiple facets of the phenomenon to be revealed and understood" [141]. The research was guided by the research question: What additional insights can be gained from comparing and learning from a high-income and a middle-income country context about decision-making for new ALI? By exploring how data, information, and evidence was used, I also sought to gain additional insights into how different methods may be valued to demonstrate the impact of new walking and cycling infrastructure.

4.2 Methods

The methods for conducting and analysing the original studies in England and Jamaica are described in Chapters 2 and 3 respectively. I further analysed the results from my England and Jamaica studies based on approaches developed for qualitative evidence synthesis. In particular, I chose steps developed by Noblit and Hare for meta-ethnography [244], a method initially developed to 'translate' study findings of several primary qualitative studies into each other. Meta-ethnography has since developed into a common approach for evidence synthesis of research outputs in qualitative systematic reviews, alongside thematic analysis [142], in a form of 'thematic synthesis' [245,248]. Meta-ethnographic synthesis takes an interpretivist approach to systematically compare multiple accounts of a particular phenomenon to obtain across-case findings that are greater than the sum of the original parts. It can help to provide 'meaning in context' [249]. This approach goes beyond summarising the findings, as is a form of positivism, to lead to translations [250], rather than generalisations, through consideration of context and meaning to gain greater understanding [244,251].

Noblit and Hare suggest seven steps for this process [244]:

1. Getting started
2. Deciding what is relevant to the initial interest
3. Reading the studies
4. Determining how the studies are related
5. Translating the studies into one another
6. Synthesising translations
7. Expressing the synthesis

Different approaches may be taken for conducting meta-ethnographic type syntheses [245,251] although Noblit and Hare's approach is usually used as part of a qualitative evidence review that systematically identifies relevant research outputs (steps 2-4) to be included in a subsequent synthesis. In my synthesis described in this chapter, however, I chose to focus on obtaining additional insights from across different contexts, so I decided to only use my two studies described in Chapters 2 and 3, rather than conducting a systematic search of similar qualitative studies. This allowed me to consider context without also needing to account for differences in study aims and design which would have been necessary if I had expanded the synthesis to include other studies. Furthermore, with this approach I was able to use primary data, rather than secondary published papers, which may not have been possible with the inclusion of other studies. Therefore my method was an adaptation of Noblit and Hare's meta-ethnography approach whereby I combined steps 1-3 and concentrated on steps 4-7 to focus on synthesising rather than identifying studies, as outlined below.

I began by re-reading early versions of my original studies' analyses - domain summary write-ups, which elaborated on codes used in each category. This allowed me to re-familiarise myself with the original studies beyond the finalised papers and allowed me to consider additional issues which were not a focus of the original studies. To support the early stages of this analysis I also produced a table summarising the similarities and differences between the two studies (see Appendix 4.A).

I conducted steps 5 and 6 together (translating the studies into one another and synthesising translations), as a form of thematic analysis [142] to develop key theoretical framing from across the different contexts [252]. This involved comparison of the themes between each study, analysing the relevance of themes from my England study to explain the Jamaica data and vice versa, and identifying where the transfer of original themes was inappropriate. The inductive approach included summarising concepts and ideas from each study to develop higher-order, overarching themes that were relevant across contexts.

During the synthesis, I aimed to move "from viewing the cases as parts of a collection to viewing the collection as a whole" [253] to develop deeper insights, with the aim of identify new "storylines" [252]. Throughout the translational steps I referred back to early stages of analysis of the England and Jamaica studies, re-reading my domain summaries and reviewing the coding that I previously used in NVivo 12 [172].

To support the investigation of a theme about power I produced power-position maps, as described by Buse et al. [179]. This is a visual representation of key stakeholders involved in decision-making for ALI in the two study countries. I conducted qualitative assessments of key stakeholders' level of agency and ability to influence decision-making ('power') and the extent to which they appeared to support new ALI ('position'). These were based on a combination of my interpretation of what was said in the interviews, including perceived power as recounted by interviewees, and my understanding of the planning systems. I decided to produce one map for the England study, despite the differences in contexts between local government areas, but acknowledge potential differences in power and position of particular stakeholder groups depending on the context, for example whether there was a public health practitioner dedicated to urban planning or not. I produced a separate map for Jamaica, where many of the interviewees were at national, rather than regional level.

4.3 Results

This section describes the new themes developed by synthesising findings from across my two qualitative studies. It involves two main themes: formal and informal power; and values and popular politics.

4.3.1 Formal and informal power

4.3.1.1 Advising versus designing

Power to influence ALI designs appeared to take different forms. I used power-position maps [179] to depict my perceptions of these different levels of power held by different types of stakeholders, considering them in relation to the level of support or opposition towards creation of ALI. In England, there was a group of stakeholders who tended to support creation of ALI but had low or medium power to actually influence designs (top-left circle in Figure 4.1). This included cycling groups, public health practitioners and greenspaces stakeholders since these were all advisory roles. Private sector transport planners could also fall into this group - although they could conduct actual designs for new developments they were limited by the design brief assigned to them by developers.

There was a second group of stakeholders that varied their level of support for ALI: from supportive master-developers, down through public transport planners, urban planners and councillors (who were likely to vary in their views depending on the local context), to housebuilders who were least likely to promote ALI (right-hand side circle in Figure 4.1). I found that the master-developer role could potentially help to balance out any opposition of ALI from volume housebuilders in the design of large developments – master-developers and local government urban planners in England said that they avoided allowing volume housebuilders to design green or grey infrastructure, which would include ALI.

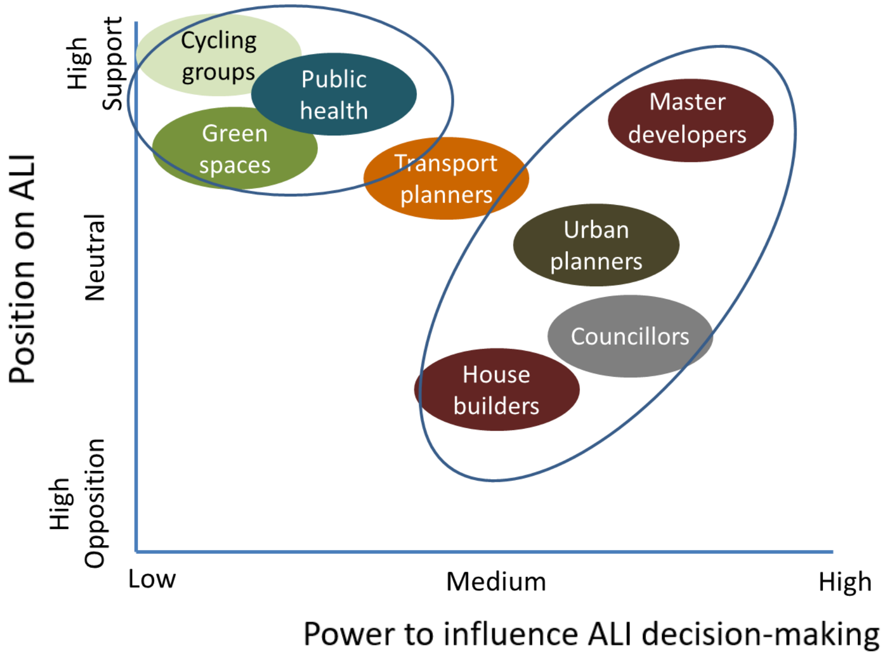

Figure 4.1: England power-position map

In Jamaica, I identified a low/medium power group involving civil society, public health and urban planners (top-left circle in Figure 4.2). There was also a group that tended to limit creation of ALI consisting of transport planners and developers, yet it was this group that actually designed infrastructure, therefore they had high levels of power (bottom-right circle in Figure 4.2).

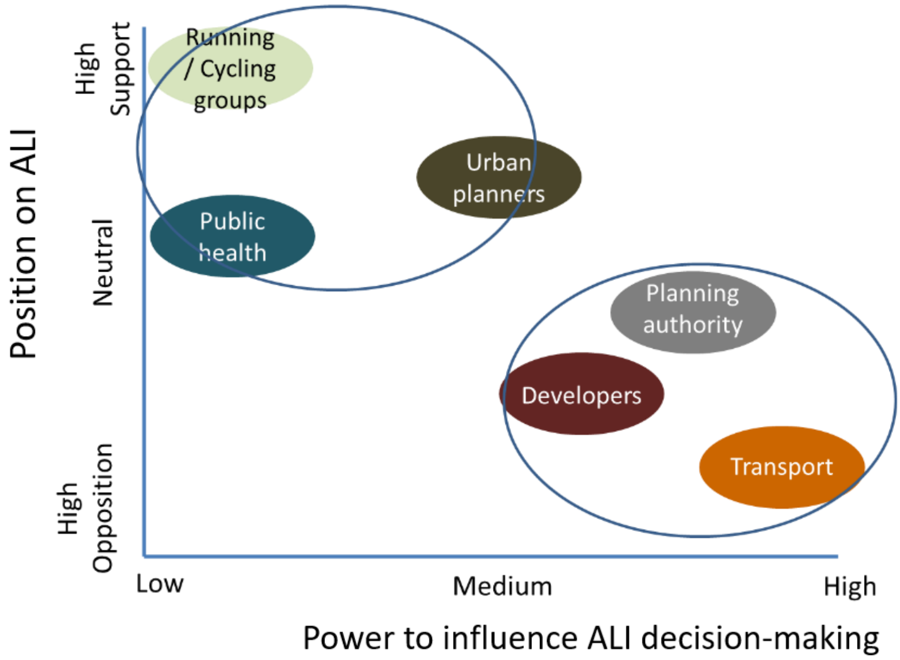

Figure 4.2: Jamaica power-position map

Although cycling groups in the high-cycling area in the England study appeared able to influence cycling infrastructure design since they reportedly could be consulted with by the local government urban planners early in the planning process, even before public consultation, they had no formal decision-making powers. At the other extreme, greatest decision-making power for new neighbourhoods tended to be held by developers in both countries, predominantly from the private sector. For them ALI was a low priority as it was not generally recognised as able to increase profits (except for greenspaces at the top end of the market), which was the main driving force for private sector developers. This points to a divide between stakeholders that were advisory, with low levels of formal power to influence ALI, and those with decision-making or design responsibilities with associated higher levels of power to influence creation of ALI.

There appeared some difference in perspective from the transport sector between countries – in Jamaica it was said that they only considered road building, not walking or cycling. In England there was support for active travel from the transport sector interviewees, however, they were often directed to focus their efforts on road building. Unfortunately, no transport sector participants were included in the Jamaica study therefore first-hand accounts from this group could not be obtained.

4.3.1.2 Not walking the talk

Position and power of stakeholders matter because systems may set out formal structures of working, but these can be conducted in discretionary ways. This meant that although policies were generally supportive for ALI in both countries, there was lack of 'follow through' between policy and implementation, therefore ALI may not be built in practice.

England

"Strategic policy has always been singing the benefits of… active planning, but it doesn't ever seem to ripple through onto the ground, you know, a lot of policy documents, even local policy documents talk about walking and cycling, but there just seems to be this disconnect from this policy wording and implementation."– Private transport planner B10

Jamaica

"I don't think there is a problem getting the polices approved, it's the follow through afterwards. …cycling lanes have been written into one of our policies. However, we have major construction of about three different road ways in [City] and none of them have taken cycling lanes into account. Zero of them." – Health J08

The planning systems in England and Jamaica were discretionary systems, requiring interpretation of policies. They were based on multiple pieces of legislation, which made the decision-making process opaque to outsiders, with accusations of corruption. Both systems were said to suffer from a lack of enforcement of planning requirements, there were challenges in engaging with stakeholders, and developers were able to appeal nationally against local planning decisions. These issues appeared to reduce public confidence in the planning system and demonstrate difficulties in influencing developers who were profit maximising, which could reduce quantity and quality of ALI.

England

"…they propose to do certain things and then, you know, five years later they'll put the planning application in and we'll look at it and go, 'Well that doesn't comply with the local plan, you said five years ago you would do…' A lot of it I'm sure is corruption that happens … they say they're going to put in affordable housing but they don't, and then once it's done you can't do anything about it, you have to get a judicial review… and then it just all becomes too much. We can't do things like that." – Cycling stakeholder B11

Jamaica

"…it is not very transparent, there is very little opportunity to see what's being proposed … I think it's a pretty corrupt system because some things just fly through and no one, I mean I don't know how they got the permit over here." – Urban development J02

4.3.1.3 Reliance on informal networks

Actors could hold formal roles within defined processes and structures, which are broadly reflected in Figures 4.1 and 4.2; however, it was informal personal relationships that also determined how people interacted and therefore their level of influence. In this study it was clear that formal roles could support interaction – areas in England with public health practitioners with dedicated urban planning functions were more likely to influence decision-making for ALI, particularly as it provided opportunity to influence designs at the earliest stages when change was most likely to occur. This is in contrast to Jamaica where public health tended not to engage with non-health sectors. However, in England it appeared that relationships between actors were important to influence non-health colleagues to value ALI.

In the England study, I described public sector urban planners as 'street-level bureaucrats' due their ability to interpret policy and negotiate with developers. However, in Jamaica, there appeared to be frustration about the advisory nature of public sector urban planners which limited their influence. Being reliant on individual attitudes may be risky because without formal collaborative roles across departments (with associated resourcing), changing an individual could change the willingness of people to engage with one another, which could reduce the quality and quantity of ALI.

England

"..staff come, they go, there's no guarantee that somebody that in the past was very open to passing sort of informal comments on things, there's no guarantee that their replacement is open-minded to want to do that or has the skills or perhaps the experience to do it..." – Greenspaces stakeholder D03

Jamaica

"…we can comment, but comment is different from approval because if you comment you can ignore right." – Urban development J06

Urban planning interviewees supported healthy place-making principals, which made them natural allies with public health, who appeared most suited to act as knowledge brokers since they engaged with scientific evidence. Public health practitioners also needed skills to inspire non-health stakeholders. However, limited resources in both countries meant that collaboration and learning across sectors was challenging and in Jamaica the public health sector did not yet actively engage with urban planning. Competition between departments for limited funding was apparent across contexts, suggesting that highlighting the non-health benefits of ALI could be important, as well as the need to inspire non-health sectors to take a 'health in all policies' approach [107,254,255].

4.3.1.4 Importance of leadership

Political support and leadership for ALI also appeared important across contexts since it was this support that allowed policies to be implemented in practice. In England, several interviewees discussed the importance of strong leadership from city mayors to promote active travel. The political will to support ALI was also discussed by interviewees in Jamaica, with one interviewee saying that they had been inspired to try to influence a senior political figure with whom they socialised. However, the local political context could result in unequal access to ALI - in England certain local authorities placed greater importance on ALI, which were reflected in local planning policy requirements, whereas in Jamaica it appeared that people from more deprived areas (who had least political voice) had the least access to ALI.

England

"…there are other [Local] Authorities that I wouldn't go close to because they'd just be such a nightmare trying to drive through this sort of agenda… you're going to focus your resources on those where you'll get people round you that are sympathetic and supportive." - Private urban planner C03

Jamaica

"…the city could actually design things you know …Block off some roads after certain hours, a lot of things can be done. I believe that it just takes leadership" – Urban development J06

4.3.2 Values and popular politics

4.3.2.1 Economics easier to promote than health

Economic arguments appeared very important. In Jamaica, Miami was heralded as a vision for the future. There were environmental similarities and geographical proximity, however, it was the economic development, with high-density construction that was aspirational, rather than the ALI. There was high public demand for new housing across contexts and quantity of new homes was prioritised over quality of place.

England

"…every time we refuse a housing application because they haven't done cycling and walking, we're potentially increasing homelessness, increasing overcrowding." – Local government urban planner C04

Jamaica

"…[government agencies] never build the parks. Their site planning is what you call repetitive boring plot ratio. Get as many lots on the land to maximize whatever. So they are not building communities, they are building housing schemes. They are just like a private developer." – Urban development J07

In some settings ALI was said to increase house prices, which could motivate housebuilders to provide it. However, reliance on developers for ALI appeared likely to increase inequality of access to ALI as car-dominant places were more likely to value roads and car parking, whilst people on low incomes were less likely to afford places with quality open spaces as these were more likely in more expensive areas. Policies supporting higher density developments, which increased land-values, incentivised developers to try to reduce open spaces for greater profit, with cases of open spaces reportedly being built on.

4.3.2.2 The vicious cycle of low supply and low demand for cycling infrastructure

In both countries, places with low levels of cycling were reluctant to build cycling infrastructure. This was blamed on a lack of existing cycling culture, difficulty of transferring space allocated to road traffic, and unsuitable climates (too hot in Jamaica; too wet in England). Instead transport planning in these contexts prioritised roads and car parking for private vehicles, which had public support, particularly as car driving had an association with status in low income contexts. In Jamaica road building was also associated with employment.

England

"I think it is politicians in areas not making the decision to implement tough choices, penalising car use which is often the by-product of promoting walk cycle use, because there is finite amount of carriageway space, it's often not considered a vote winner." – Private transport planner B10

Take cars off the road, oh, that's a difficult one, people love their cars, don't they, I don't think you're going to get cars off the road, to be honest." – Councillor C08

Jamaica

"…the building the road section kind of run the country in a sense, they can get the funds and build roads… I mean road building is, it employs people who are otherwise unemployable. People love roads [laughter]. It's the thing by which politicians are judged is how well they do roads and patch roads and restore roads and it's not how many trees they plant [laughter]." Urban development J02

Considerations of safety for cyclists (and pedestrians) differed between the countries: in England there were frustrations voiced about designs being watered down because of safety concerns, restricting ease of cycling and walking. This could be because of the strong health and safety culture in the UK, as well as low demand for ALI that could benefit pedestrians and cyclists to the possible detriment of traffic flows and car drivers. In Jamaica, like in many LMICs, road safety for pedestrians and cyclists was not a high priority compared to facilitating car journeys (which were associated with economic development) – there was little consideration of vulnerable road users when building roads.

In both countries cycling groups (predominantly made up of middle-class, or high-income groups) wanted safer cycling infrastructure to protect existing cyclists, rather than necessarily to increase levels of cycling. However, in low cycling areas it was low income residents who tended to cycle for transport because they couldn't afford other modes, although it was said that they had greater economic concerns that prevented them from demanding improved cycling infrastructure.

England

"…in some places it's almost, to cycle to work you must be poor." – Cycling stakeholder B12

Jamaica

"…the mass is more interested in bread and butter right now and that is a serious issue." - Urban development J06

4.3.2.3 Low value and high price for open spaces

Poor quality open spaces tended to be used less, which could in turn lead to a reduction in supply as parks in both countries could be built on if it could be demonstrated that they were not used.

England

"…some areas of land which are maybe designated as open space but haven't been used and have been put forward for sort of small-scale housing or employment use… but again it just comes down to maintenance and did that use stop because we stopped maintaining the area or did it stop because genuinely nobody wanted to use it, and I suspect it's more about we had to save some money..." – Greenspaces stakeholder D03

Jamaica

"…the mass wasn't objecting [to building on open space] it was just a few and the few that were objecting in a sense all live where they can access all the parks that they want in the world." - Urban development J06

Maintenance of open spaces was problematic across contexts because of the associated costs. Although in England local authorities or management organisations tended to be responsible, in Jamaica community management was often used but this was reportedly unsustainable, risking spaces becoming unusable. The lack of maintenance of open spaces was said to result in reduced safety. In England, poor quality park design, which did not provide for all sections of society, appeared to attract anti-social behaviour, or simply not be used.

England

"We do get some antisocial behaviour and people who are not, you know, not sort of that friendly looking, really, at times, you know, you do sort of have the occasional drinker and, in the kiddie's play area and stuff like that, which is not very nice at all...." – Councillor C08

"…after a storm branches would have fallen and that has to be cleared up because otherwise it's not safe, particularly after dark when it's not brilliantly well lit and you can't see what's under your foot." – Councillor D09

Jamaica

"….what happen in a lot of communities is that the green space is not maintained and it becomes a safety hazard in and of itself and it's just become unusable. So it should have a field but the field is not cut so it's overrun with trees, sometimes there is garbage or you just have people lurking in the area." - Health J08

In Jamaica, a lack of open spaces reportedly led to children playing in the streets. Multi-functional spaces were also discussed in Jamaica, such as daytime car parks which could be used by the community at night. However, nature appeared to be particularly under-valued in Jamaica where it was more likely to be viewed as scruffy, in conflict with widely held views of economic development. In both countries there were reports of trees being removed: in Jamaica it was street trees which were said to be removed during road widening; in England, it could be by developers who faced small fines in comparison to the profit obtained from adding an additional housing unit to a site.

4.4 Discussion

4.4.1 Main findings of this study

In this multiple case study about decision-making for new ALI I identified two main themes: formal and informal power; and values (including perceptions of economic value) and popular politics.

Using power-position maps [179] I highlighted tensions between stakeholder groups who were likely to differ in relation to support for ALI and their ability to influence it, with differences in power between those who had advisory roles compared with those who actually conducted infrastructure design. A lack of policies being followed in practice, a reliance on informal networks to inspire decision-makers and the importance of political support were also discussed in the theme of formal and informal power.

I also identified a preference for decision-making for short-term economic outcomes, rather than health outcomes, which appeared to garner public support more easily. This was associated with a lack of perceived demand for ALI and subsequent low supply.

4.4.2 Discussion of findings

This analysis highlights complexity in influencing ALI. Although a ‘health-in-all policies’ approach is promoted in England [107], in practice there are numerous barriers to collaboration between sectors which go beyond ‘speaking the same language’ [109,126,179,180], to issues of public perception and political priorities that inform how resources are allocated. In Jamaica, there was more of a short-term, firefighting attitude towards infectious disease, compared to England, with a preference for behaviour change messaging rather than trying to tackle the environmental determinants of health which are associated with chronic non-communicable diseases [34]. ALI closely resembles a public good [256] and treating it as a private commodity may increase inequality of access, which could limit opportunities for physical activity and exacerbate health inequalities.

In Chapter 2, I developed a conceptual model to explain the ‘evidence-output implementation gap’ (see Figure 2.2). By investigating decision-making for new ALI through synthesising my England and Jamaica studies I build on this to highlight important issues around gaining public and political support for investing in ALI.

My original conceptual model included the role of an influential individual and I suggested that public health practitioners in local government could take up this role, but from this synthesis it became apparent that public health or urban planners could take on this role as they were natural allies. They could act as problem brokers, as well as knowledge brokers, although often these roles had little formal power, being advisory only. Other formal roles had more power, such as those held by developers. However, decisions may not be made using official channels and despite policies generally being supportive of ALI they may not be created in practice. Informal networks could be used by influential individuals which could directly influence political leaders, despite having no formal role. This may require charismatic authority [184] to be influential, which is potentially more precarious than formal alliances, with risks associated with relying on individuals who can change. Therefore I have identified two types of possible knowledge broker: those with formal power associated with a formal role, such as public health for urban planning practitioners (with low formal power in advisory capacities) and developers (with high formal power in design capacities); and those with informal power, such as well-connected individuals able to lobby politicians, as well as informal relationships within local government by actors across sectors. The latter points to findings from management research which discusses the importance of interplay between formal structures and informal networks [257]. This explains why public health practitioners with a formal urban planning role may be highly influential, using both formal and informal power.

Lukes recognised three dimensions of power: decision-making, non-decision-making and power as thought control [258]. Power as non-decision-making enables people to influence agendas, which could be achieved by brokers. He argued that the 'thought control' dimension of power could influence people's preferences and perceptions, which could result in support of the status quo [179,258]. This could be particularly relevant for informal power, although the opaque nature of informal relationships could be more challenging to identify [231].

Where formal power lies with transport departments with large road building budgets, or developers with housebuilding and profit targets, there may be a lack of incentive to support increases in demand for ALI. Informal power may be used to lobby for the status quo. To overcome vicious cycles of low demand and low supply political leadership appears necessary, which may be made more likely if economic benefits are emphasised to local people as these may be more likely to be persuasive than potential impacts on long-term health outcomes. For example, there is often concern from business owners that limiting access for cars nearby can negatively impact on businesses, whereas the opposite can be true [259]. Wider appreciation of the benefits of ALI could help to facilitate its creation. This could be used by brokers to influence decision-makers, however, additional monitoring and evaluation of schemes may be necessary.

Relying on private sector developers to provide ALI, a public good [256], will unlikely be sufficient to provide access, particularly to disadvantaged groups and greater resources are needed, which may require innovative financial mechanisms to fund on-going maintenance. However, this has been achieved for other services in LMICs, such as in the water and sanitation sectors [235], although it may require re-framing of ALI as a valuable resource or service. This requires high quality design to ensure that people choose to use ALI, which in turn can facilitate natural surveillance and make it feel safe and attractive for yet more people.

4.4.3 Strengths and limitations

A number of considerations about limitations and strengths need to be acknowledged. Firstly, I used principles from meta-ethnography and qualitative synthesis, and this approach often includes a range of published studies by different authors. However, I conducted this with my own two studies and one was only a small study. This meant that I was very familiar with the data and ‘second order’ constructs [244] before commencing this comparative investigation. I was able to call on the large amount of original source material to help in developing new insights, including additional interview quotes from participants who were not directly quoted in my earlier chapters. This avoided difficulties that could arise in other meta-ethnographies based on qualitative papers that are not highly descriptive [251] and it also avoided the need to base this synthesis on “storylines” [252] from interpretations of the original data. Being familiar with the data, and importantly the contexts, also helped to not lose sight of each context and be very aware of these. I also found it easier to integrate findings from very similarly conducted studies. However, it was a challenge to develop ‘third order’ constructs [244] that might be more readily developed with a fresh, outsider, perspective and with a larger pool of studies to compare with each other. Therefore evaluation by other researchers may have led to different findings, accepting the active role of the researcher, as discussed in the previous two chapters [146]. I note that I was much more familiar with the England context, and whilst I visited Jamaica for the study, I was less familiar with that context and this may have been a limitation in the synthesis.

The iterative discussions on the new themes with Cornelia Guell and Louise Foley helped to provide critique of my interpretations. This helped to develop the analysis beyond simple summaries identifying commonalities, to provide translation [251] and compare the studies interpretively [260].

Repeating the studies in other contexts, or from the perspective of other disciplines [245,261], could build on the findings of this synthesis. In particular to investigate whether different planning systems lead to different issues – zonal systems used in many countries may not be open to the same level of negotiation as the discretionary planning systems used in England and Jamaica and it would therefore be useful to see the impact of that on decision-making for ALI. This is discussed further in the final chapter of the thesis (Section 7.4.5).

4.5 Chapter summary

This chapter described additional insights gained from re-analysing the findings from my qualitative studies about decision-making for new ALI in England and Jamaica.

I identified two main themes: formal and informal power; and values and popular politics.

Re-evaluating two qualitative studies from a high-income country and a middle-income country using a modified meta-ethnographic approach allowed identification of additional translational insights across contexts. I found that informal networks, as well as formal roles, could influence decision-making for new ALI in different ways. ALI could be under-valued where quantity and quality were low and short-term economic issues were prioritised over long-term health issues.

4.6 Contributions

I developed the original idea for this study with assistance from Cornelia Guell. I conducted the analysis and interpretation, using data from my two qualitative studies described in Chapters 2 and 3, with support from Cornelia Guell and Louise Foley. Results of preliminary comparative findings were presented in an oral presentation at the Healthy City Design conference in London in 2019.

5. A natural experimental study of new walking and cycling infrastructure across the UK: The Connect2 programme

Build it and some will come

5.1 Introduction

This chapter describes a natural experimental study of new walking and cycling infrastructure across the UK. It leads on from some of the findings from my qualitative studies about factors influencing decision-making for new active living infrastructure (ALI) in earlier chapters, where I discussed the value of contextual relevance for case study examples; the difficulties of investing in cycling infrastructure in areas with perceived low demand for cycling; economic impacts of ALI and the value of mutually beneficial outcomes across health and non-health sectors. My previous qualitative studies also raised inequality considerations since low income areas appeared more reluctant to invest in walking and cycling infrastructure because of potential stigma associated with these modes. This study provides an opportunity to investigate some of these issues quantitatively, to demonstrate impacts of new walking and cycling infrastructure across multiple contexts and for different types of people.

I use data from two related studies: the iConnect study, which was approved by the University of Southampton Research Ethics Committee (reference number CEE 200809-15); and the Connect2 programme evaluation, led by Sustrans, which was not conducted for academic purposes and therefore ethical approval was not sought.

5.1.1 Chapter outline

In this chapter I describe the rationale and method I used to conduct this quantitative study about use, users, benefit-cost ratios (BCRs) and overall physical activity associated with new walking and cycling infrastructure across contexts, involving multivariable binary logistic regression analyses. I present the findings from my analyses, and discuss my results alongside other research, as well as the strengths and limitations of the study. The chapter finishes with a summary.

5.1.2 Background

Walking and cycling is advocated as a way to incorporate physical activity into daily lives [262,263] and reduce risks of non-communicable disease [264]. An estimated 86.3% of people in England walked at least once a month in 2014/15, but only 14.7% of people cycled at least once a month and utility cycling was even lower with only 9.2% of men and 3.8% of women cycling at least once a month for utility purposes [265]. However, the UK government had ambitions to double levels of cycling in England between 2013 and 2025 [119].

Evaluating environmental interventions that are likely to affect population levels of walking and cycling, such as provision of new walking and cycling infrastructure, can be difficult because research of this nature typically requires natural experimental designs [69] with multiple pathways for impact and potentially long timeframes for behaviour change to be seen [188,266]. Whilst clearer understanding about impacts of such infrastructure could influence decisions to build it, infrastructure investment is likely to be provided by transport departments that may not conduct extensive evaluations, despite a stated emphasis on delivering value for money [137]. Therefore it is important to understand the utility of monitoring data (e.g. manual counts and surveys of route users) alongside public health research data, which tend to be more scarce [177], to demonstrate the outcomes, including economic value, associated with new walking and cycling infrastructure.

We know that elements of physical and social context are important determinants of use of new and upgraded walking and cycling infrastructure [267,268] and these contextual issues may be important in influencing decision-makers, as discussed in previous chapters. However, there is a lack of published evaluations of use of new and improved walking and cycling routes across different contexts and limited understanding about context-related mechanisms for behaviour change [79,97]. Greater understanding about the environmental factors that may influence behaviour change could help explain how features such as bridges, tunnels and transport interchanges impact on facilitating use of new and upgraded walking and cycling routes. This may help to understand heterogeneity of impact of new routes which have been found in other evaluations[269].

User sampling (counts or surveys) conducted as part of monitoring programmes only provide information on users, rather than the general population, but these approaches are cheaper and simpler than longitudinal cohort studies that can compare changes in the behaviour of individuals exposed and unexposed to new infrastructure. In addition, cohort studies tend to have smaller samples than transport monitoring methods which can make the analysis of sub-groups more difficult. Greater understanding of the impact of new infrastructure on sub-groups, including less active groups, would also identify potential impact on inequalities [73,152,270,271], especially since the greatest health gains are expected to arise from increased physical activity by the least physically active [15].

Some studies have suggested that new walking and cycling infrastructure may increase the frequency of journeys for existing users rather than attracting new users [138]. Transport sampling methods may not account for displacement of journeys from alternative routes, nor distinguish interventions that encourage existing pedestrians and cyclists to travel further or more frequently from those that encourage new people to walk or cycle, which may produce a greater health gain if they were previously relatively inactive. This may result in an over-estimation of new users and subsequent impact on population health. This can result in associated impacts on calculated BCRs, which indicate the value for money of a project. It is therefore important to further investigate the association between use of new infrastructure and overall physical activity.

5.1.3 Study aims

This study aims to understand how the context in which new and upgraded walking and cycling infrastructure is built may influence changes in use, users and BCRs of new walking and cycling infrastructure. This helps to understand more about whether perceived low demand for walking and cycling infrastructure (where baseline levels of walking and cycling are low), results in low use, or whether the creation of new routes induces new demand in different contexts. I also investigate changes in types of user to understand more about inequality of use and also the economic impacts associated with the new routes across contexts, which may be useful to influence investment decisions [138,152]. This chapter also explores the value of using different methods to demonstrate the impacts of new walking and cycling infrastructure, using routine monitoring data and academic research. Using these different types of data I also aim to understand the association between use of new walking and cycling routes and meeting guideline levels of physical activity.

The research was guided by three main research questions: (1) How do use and estimated BCRs of new walking and cycling infrastructure vary by the nature and local contextual factors of schemes? (2) How does use of new walking and cycling infrastructure by different population sub-groups vary by the nature and local contextual factors of schemes? (3) What is the association between type of use of new walking and cycling infrastructure and overall physical activity?

5.2 Methods

I conducted a repeat cross-sectional, uncontrolled pre-post analysis of data for 84 new and upgraded walking and cycling routes across the UK, built between 2009 and 2013, involving counts and surveys of route users, and estimates of total users (based on a combination of automatic counter data, counts and surveys of users), to answer the first two research questions about use, BCRs and users of new walking and cycling infrastructure and the association with local contextual factors of schemes. I then combined analysis of the survey data with a longitudinal analysis of repeat postal questionnaire data from a cohort of residents living near three of the routes to answer the final research question about the association between type of use of new walking and cycling infrastructure and overall physical activity. The final research question also enables novel investigation of the utility of different methods by combining insights from routine monitoring data alongside public health research data.

5.2.1 Intervention

The Connect2 programme involved the creation or upgrading of 84 walking and cycling routes. Each scheme crossed a physical feature such as a river, railway line or major road, for example via new bridges, rehabilitating disused bridges or improving road crossings, as well as networks for local traffic-free journeys. These walking and cycling routes were provided across the four countries of the UK, in England (N=64), Scotland (N=4), Wales (N=11) and Northern Ireland (N=5).

The Connect2 programme was led by the UK walking and cycling charity Sustrans which secured £50 million of investment from the Big Lottery Fund in 2008. Sustrans worked with dozens of stakeholders, including local government, statutory and non-statutory bodies and local community groups to raise matched funding against the original award and deliver the schemes on the ground. The overall investment in the Connect2 programme was £175 million.

5.2.2 Measures of use

I used four datasets to understand use, involving pre and post data from Sustrans' Connect2 programme between 2009 and 2013, and the longitudinal iConnect study conducted between 2010 and 2012:

1. Four-day counts of users (71 schemes)
2. Surveys of route users (84 schemes: 78 schemes with pre data; 81 schemes with post data)
3. Estimated total annual scheme users and BCRs (77 schemes)
4. iConnect cohort questionnaires (3 schemes)

The application of each dataset relative to the research questions is described in Table 5.1. The available data for each Connect2 scheme, alongside contextual features, are described in Table 5.2.

5.2.3 Connect2 cross-sectional measures of use and benefit-cost ratios

5.2.3.1 Counts of users

Cross-sectional manual counts of route users were undertaken on behalf of Sustrans by market research companies. The manual counts were conducted pre and post construction at one or more monitoring points for each scheme between 7am and 7pm on four days covering term time, holiday, weekday and weekend. All route users were classified subjectively by surveyors as either child, working-age man, older man, working-age woman or older woman and mode of travel was recorded as either cycling, walking, running, horse riding, wheelchair or other.

5.2.3.2 Surveys of users

Cross-sectional user surveys were undertaken on behalf of Sustrans by market research companies at the same times as the manual count. Selection was on a next-to-pass basis, such that when the surveyor had finished one survey, the next adult (16 years or older) to pass them in either direction was invited to take part in the survey. Informed consent was obtained. The user survey asked questions about frequency of journey on the route; mode of travel; purpose of trip; how long the journey would take; how many days in the previous week at least 30 minutes of physical activity had been conducted; and demographic information (see Appendix 5.A). Extreme values for length of journey greater than 480 minutes were excluded (188 responses, 0.5%).

5.2.3.3 Total annual scheme users and benefit-cost ratios

Total annual scheme users were estimated by Sustrans using a combination of automatic counter data, counts of users, user survey data and trip lengths from the UK government's National Travel Survey [272]. Proxy routes were used for the baseline usage figures for completely new routes. For example, where a new pedestrian and cycling bridge was built, a nearby traffic bridge was used for the baseline measurement.

BCRs were calculated by Sustrans [273] in line with the UK Department for Transport's web-based transport appraisal guidance (WebTag) [274], involving the Health Economic Assessment Tool (HEAT) [275]. It also included car kilometres replaced to provide estimated carbon dioxide reduction, collision and absenteeism benefits, and amenity benefits from distance and time travelled. See Appendix 5.B 5.B for addition details of the methods used by Sustrans for estimating total annual scheme users and BCRs.

5.2.4 Cohort survey of residents living in the vicinity of a Connect2 scheme

The longitudinal iConnect study was conducted with a cohort of adult residents, randomly sampled from the electoral register, living within 5km of three Connect2 schemes in Cardiff, Kenilworth and Southampton. Postal questionnaires were completed at baseline (before scheme construction) and at one-year and two-year follow-up. Further details of the iConnect methods are published elsewhere [75]. The iConnect questionnaire asked whether the local Connect2 route had been used; whether on foot or by bike, and for what purpose; time spent doing physical activity in the previous week; and demographic questions (see Appendix 5.C). Participants who reported that they used the relevant route were classified as users at that time point (i.e. at one-year follow-up and/or two-year follow-up), as pedestrians and/or cyclists, and as users for the particular purposes reported. Previously published iConnect research found that overall physical activity was associated with distance from the new routes[266]. This study extends earlier findings to evaluate the association between use of the new routes and meeting guideline levels of physical activity.

Table 5.1: Research questions, variables and datasets

<table>
<tr><th>Research question</th><th>Exposures</th><th>Outcomes</th><th>Covariates</th><th>Level</th><th>Dataset</th></tr>
<tr><td>1: How do use and estimated BCRs of new walking and cycling infrastructure vary by the nature and local contextual factors of schemes?</td><td rowspan="3">Contextual factors:
• Population within 0.5 mile
• Public transport interchange within 0.5 mile (Yes/No)
• Baseline number of users (pedestrian and/or cyclists)
• IMD quintile
Nature of scheme:
• Cost
• Length
• Bridge/ tunnel constructed (Yes/No)</td><td>Percentage change in use (pre-post):
At least 50% increase (Yes/No); Double (Yes/No):
• Pedestrians
• Cyclists
Benefit-cost ratio:
≥4 (‘very high’)</td><td rowspan="3">Time from scheme completion to post-monitoring</td><td rowspan="3">Scheme level</td><td>Total annual scheme users</td></tr>
<tr><td rowspan="2">2: How does use of new walking and cycling infrastructure by different population sub-groups vary by the nature and local contextual factors of schemes?</td><td>Percentage change in user sub-groups:
At least 50% increase (Yes/No); Double (Y/N):
• Women
• Older people
• Peak time users
• Women cyclists</td><td>Counts of users</td></tr>
<tr><td>• Disabled/long term illness
• Living in deprived area</td><td>Surveys of users</td></tr>
<tr><td rowspan="2">3: What is the association between type of use of new walking and cycling infrastructure and overall physical activity?</td><td>• Frequency of journey
• Time
• Mode
• Trip purpose</td><td>At least five* days with self-reported 30 minutes physical activity in the previous week: (Yes/No)</td><td rowspan="2">Demographics:
• Gender
• Age
• Employment status
• Ethnicity†
• General health
• Disabled/ long term illness
• Deprivation quintile
• Children in household (Yes/No)
iConnect only:
• Baseline physical activity
• Scheme</td><td>Trip level</td><td>Surveys of users</td></tr>
<tr><td>• Use (Yes/No)
• Mode
• Purpose</td><td>At least 150 minutes of self-reported physical activity in the previous week: (Yes/No)</td><td>Individual level</td><td>iConnect</td></tr>
</table>

IMD = Index of Multiple Deprivation (UK-adjusted quintiles; see section 5.2.5.1)
* Four days for users who were running on the route at the time of the survey (see section 5.2.6.4)
† Ethnicity was only a covariate in the user survey analysis because the sample of non-white participants was very small in the iConnect cohort

Table 5.2: Features of Connect2 schemes and sample size for each dataset (Number of schemes = 84)

Connect2 scheme	Country	New/ Upgraded route*	Cost (£ million)	Length (km)	Bridge /tunnel present?	Population within 0.5 mile	Counts of users		Survey of users		Estimated annual route users ('000s)		Estimated benefit-cost ratio	iConnect cohort	
							n pre	n post	n pre (% of count)	n post (% of count)	n pre	n post		n 1-year	n 2-year
Argoed bridge	Wales	New	0.3	0.04	yes	700	222	852	65 (29)	62 (7)	15	35	17.2	-	-
Ballymoney railway bridge and links	Northern Ireland	Upgrade	1.2	1.91	yes	6,300	1,166	-	133 (11)	140 (-)	93	197	11.5	-	-
Bath 2 tunnels greenway	England	Upgrade	5.2	6.34	yes	33,200	1,326	4,648	268 (20)	398 (9)	114	264	3.4	-	-
Bedlington network	England	Upgrade	2.0	9.48	no	26,700	1,823	2,333	150 (8)	99 (4)	325	552	3.3	-	-
Bethnal Green local link	England	Upgrade	2.2	2.90	yes	78,100	2,985	6,628	258 (9)	240 (4)	267	584	9.0	-	-
Birmingham links to New Hall Valley	England	Upgrade	2.1	19.15	no	61,900	-	-	337 (-)	743 (-)	351	437	4.0	-	-
Blandford – Stourpaine Trailway	England	New	0.7	3.67	no	3,700	-	1,626	- (-)	358 (22)	-	186	15.0	-	-
Blyth network	England	Upgrade	2.5	14.45	no	36,600	2,538	3,152	192 (8)	241 (8)	661	769	3.5	-	-
Bradford links	England	Upgrade	3.7	1.87	yes	34,800	2,454	3,237	87 (4)	129 (4)	255	403	1.4	-	-
Bristol – Nailsea: 'The Festival Way'	England	Upgrade	1.4	15.25	no	29,300	5,676	9,176	720 (13)	285 (3)	481	877	15.2	-	-
Brompton-on-Swale rural links	England	New	0.5	2.94	yes	3,900	294	161	56 (19)	58 (36)	42	20	1.0	-	-
Bury greenway	England	New	1.0	2.58	yes	18,100	3,112	6,240	340 (11)	315 (5)	265	324	9.4	-	-
Cardiff - Penarth link	Wales	Upgrade	4.9	4.56	yes	17,500	2,254	15,704	614 (27)	1,099 (7)	275	512	3.0	589	487
Carlton-Le-Moorland – Bassingham link	England	New	0.5	2.05	no	1,900	377	1,118	67 (18)	102 (9)	46	79	5.4	-	-
Cheshunt: A10 crossing and links	England	Upgrade	2.9	5.01	yes	25,100	139	2,185	29 (21)	101 (5)	32	259	0.8	-	-
Chester greenway extension, links and riverside path	England	Upgrade	1.7	5.86	yes	32,100	1,438	1,206	167 (12)	122 (10)	1,641	2,129	21.9	-	-
Clydach links	Wales	Upgrade	1.1	5.38	yes	8,300	164	1,821	44 (27)	236 (13)	60	105	3.5	-	-
Conkers path in the National Forest	England	Upgrade	1.2	0.55	no	400	247	219	76 (31)	59 (27)	20	11	0.3	-	-
Conwy – Penmaenmawr coastal path	Wales	New	0.9	1.31	yes	600	155	413	49 (32)	96 (23)	17	44	3.2	-	-
Croydon parks links	England	Upgrade	1.9	2.34	no	31,300	3,041	17,175	149 (5)	291 (2)	331	1,208	16.1	-	-
Dartford: Darent Valley Path	England	Upgrade	1.9	6.40	yes	27,200	2,621	1,436	123 (5)	122 (8)	164	222	3.0	-	-
Derry greenway	Northern Ireland	New	15.7	5.80	yes	14,800	11,462	10,644	477 (4)	347 (3)	-	-	-	-	-
Dewsbury greenway links	England	Upgrade	1.2	2.80	yes	15,100	260	734	90 (35)	198 (27)	35	106	3.2	-	-

Connect2 scheme	Country	New/ Upgraded route*	Cost (£ million)	Length (km)	Bridge /tunnel present?	Population within 0.5 mile	Counts of users		Survey of users		Estimated annual route users (‘000s)		Estimated benefit-cost ratio	iConnect cohort	
							n pre	n post	n pre (% of count)	n post (% of count)	n pre	n post		n 1-year	n 2-year
Dover greenway to city centre and seafront	England	Upgrade	0.8	2.84	yes	20,700	5,584	7906	256 (5)	328 (4)	555	813	22.3	-	-
Dumfries: Connecting two railway paths	Scotland	New	0.6	2.96	yes	12,000	750	1,278	161 (21)	444 (35)	68	108	5.8	-	-
Everton Park – Mersey waterfront links	England	Upgrade	1.2	3.72	no	24,200	2,270	1,407	164 (7)	518 (37)	287	235	0.8	-	-
Falkirk canal towpath repairs	Scotland	Upgrade	0.3	2.64	no	12,000	707	329	35 (5)	81 (25)	44	45	3.1	-	-
Foryd Harbour(Rhyl): Bridge and link	Wales	New	6.0	0.88	yes	4,400	6,664	5,273	369 (6)	- (-)	-	388	-	-	-
Glasgow network	Scotland	Upgrade	3.3	2.50	yes	27,000	5,451	11,343	114 (2)	146 (1)	681	902	1.4	-	-
Hamilton – Larkhal link	Scotland	Upgrade	2.2	10.55	no	16,900	1,008	1,327	39 (4)	142 (11)	305	368	2.1	-	-
Haringey traffic-free environment	England	Upgrade	0.4	0.50	no	30,600	9,503	-	245 (3)	149 (-)	773	902	10.8	-	-
Harrogate: The Nidderdale Greenway	England	New	0.7	4.48	yes	5,000	2,879	9,405	145 (5)	269 (3)	166	561	44.4	-	-
Hastings – Bexhill coastal path	England	Upgrade	0.5	2.27	no	6,400	968	2,172	185 (19)	382 (18)	104	218	17.5	-	-
Havering – Ingrebourne Valley links	England	Upgrade	4.5	20.66	no	66,800	1,272	2,897	88 (7)	258 (9)	627	754	3.3	-	-
Hereford links	England	Upgrade	0.5	10.57	yes	32,600	-	496	- (-)	49 (10)	106	109	2.6	-	-
Huyton local greenway	England	Upgrade	0.4	2.80	yes	14,000	518	715	78 (15)	93 (13)	63	46	1.0	-	-
Islington local link	England	Upgrade	1.5	2.67	no	79,500	5,396	5,664	219 (4)	121 (2)	874	1,070	8.0	-	-
Kenilworth – Burton Green greenway and link to the University of Warwick	England	New	1.2	9.98	no	16,400	297	2,115	96 (32)	303 (14)	71	255	10.9	734	602
Killamarsh – Halfway Tram Terminus – Rother Valley Country Park	England	New	2.1	3.78	no	11,300	738	1,245	120 (16)	123 (10)	139	179	5.2	-	-
Kirkby local links	England	Upgrade	0.8	3.01	no	19,600	2,704	2,482	237 (9)	218 (9)	272	244	3.4	-	-
Leeds: The Wyke Way green corridor	England	Upgrade	0.4	2.07	no	13,500	1,378	4,156	84 (6)	142 (3)	166	254	12.4	-	-
Leicestershire: Watermead Park links	England	Upgrade	1.7	7.78	yes	20,700	3,033	7,819	412 (14)	175 (2)	431	607	8.0	-	-
Luton – Harpenden link	England	Upgrade	1.0	8.38	yes	24,700	583	1,141	207 (36)	216 (19)	64	146	6.5	-	-
Merthyr Tydfil local links and to the Taff trail	Wales	New	0.6	6.20	yes	14,100	404	187	48 (12)	54 (29)	60	79	4.7	-	-

Connect2 scheme	Country	New/ Upgraded route*	Cost (£ million)	Length (km)	Bridge /tunnel present?	Population within 0.5 mile	Counts of users		Survey of users		Estimated annual route users (‘000s)		Estimated benefit-cost ratio	iConnect cohort	
							n pre	n post	n pre (% of count)	n post (% of count)	n pre	n post		n 1-year	n 2-year
Monmouth links along the River Monnow	Wales	Upgrade	0.6	1.77	yes	7,700	536	1,906	175 (33)	205 (11)	207	244	2.2	-	-
Nantwich – Crewe link	Wales	Upgrade	1.6	6.34	no	21,600	742	2,496	155 (21)	353 (14)	110	169	4.0	-	-
Newport – Caerleon link	Wales	Upgrade	2.5	8.97	yes	41,300	214	608	52 (24)	146 (24)	153	405	7.9	-	-
Newton Abbot – Kingsteignton links	England	New	3.0	7.77	yes	19,100	1,741	2,670	258 (15)	335 (13)	298	379	3.1	-	-
Newtownabbey local links	Northern Ireland	New	1.3	9.35	yes	24,500	332	-	65 (20)	92 (-)	82	87	0.5	-	-
Northampton local links	England	Upgrade	2.3	6.62	no	22,900	1,090	1,981	168 (15)	- (-)	137	217	2.9	-	-
Northwich network	England	Upgrade	2.5	4.94	yes	18,800	1,071	3,653	149 (14)	291 (8)	100	308	7.9	-	-
Norwich network and riverside routes	England	Upgrade	3.0	9.80	yes	60,100	1,568	1,014	290 (18)	145 (14)	371	534	7.6	-	-
Omagh riverside path	Northern Ireland	New	0.8	0.46	yes	1,900	2,537	2,536	252 (10)	241 (10)	38	42	0.7	-	-
Ottery St Mary local links	England	New	1.0	1.83	yes	4,300	587	1,236	115 (20)	138 (11)	70	103	3.7	-	-
Padiham, Burnley and villages: Greenway, linear park and links	England	New	2.8	10.17	no	33,000	2,861	4,423	190 (7)	288 (7)	332	427	4.1	-	-
Plymouth network	England	Upgrade	2.1	10.86	no	52,200	5,674	8,266	126 (2)	287 (3)	783	1,231	9.2	-	-
Port Talbot –Pontrhydyfen – Afan Forest Park	Wales	Upgrade	0.7	16.70	yes	20,000	621	624	262 (42)	139 (22)	108	170	8.8	-	-
Radstock – Midsomer Norton ‘5 Arches’ route	England	New	0.9	2.62	no	12,000	1,498	3,579	178 (12)	347 (10)	19	69	2.8	-	-
Rochdale network and greenway	England	Upgrade	1.5	20.74	no	75,300	1,474	1,629	399 (27)	438 (27)	246	291	3.1	-	-
Royston subway	England	Upgrade	3.6	2.40	yes	13,700	638	754	69 (11)	85 (11)	75	113	1.0	-	-
Rugby links	England	New	1.2	9.29	yes	29,600	2,526	2,244	124 (5)	321 (14)	306	295	3.3	-	-
Sale – Stretford network	England	Upgrade	0.7	15.05	no	70,700	895	10,726	138 (15)	193 (2)	188	799	31.7	-	-
Scunthorpe Ridgeway and links	England	Upgrade	4.1	12.40	no	36,000	2,053	5,762	262 (13)	342 (6)	181	239	0.7	-	-
Shoreham bridge	England	Upgrade	11.1	0.80	yes	8,800	-	-	75 (-)	- (-)	757	880	3.6	-	-
Shrewsbury riverside path and network	England	Upgrade	2.3	5.29	no	19,800	7,642	5,560	320 (4)	414 (7)	940	558	1.4	-	-
Sleaford – Leasingham link	England	Upgrade	0.9	2.62	yes	8,700	349	481	77 (22)	102 (21)	341	594	3.7	-	-
South Bermondsey (South East London) links	England	Upgrade	1.1	8.12	yes	132,300	-	6,410	- (-)	299 (5)	-	2,096	-	-	-
Southampton: Itchen Riverside Path and links	England	Upgrade	4.0	8.04	no	57,900	7,480	8,851	310 (4)	341 (4)	873	652	1.7	529	431

Connect2 scheme	Country	New/ Upgraded route*	Cost (£ million)	Length (km)	Bridge /tunnel present?	Population within 0.5 mile	Counts of users		Survey of users		Estimated annual route users ('000s)		Estimated benefit-cost ratio	iConnect cohort	
							n pre	n post	n pre (% of count)	n post (% of count)	n pre	n post		n 1-year	n 2-year
St Helens: access to greenspace	England	New	0.3	2.33	no	13,100	-	936	- (-)	90 (10)	-	92	-	-	-
St Neots network	England	Upgrade	3.5	16.78	yes	24,800	1,675	2,613	111 (7)	114 (4)	307	362	2.1	-	-
Stockbridge rural link	England	New	0.2	5.75	yes	1,300	-	105	- (-)	7 (7)	-	38	11.6	-	-
Stockport – Marple through Chadkirk Country Park	England	New	1.6	7.06	yes	21,500	199	162	58 (29)	54 (33)	34	31	0.6	-	-
Swindon links to industrial sites	England	New	0.5	2.33	no	6,600	446	1,670	109 (24)	105 (6)	268	247	11.2	-	-
Titanic Quarter – Belfast city centre: Comber Greenway extension	Northern Ireland	Upgrade	0.4	5.15	no	34,700	2,048	10,900	127 (6)	822 (8)	365	448	32.5	-	-
Topsham bridge	England	New	0.6	0.80	yes	3,100	1,638	9,567	160 (10)	102 (1)	135	146	13.2	-	-
Treforest: part of the Valleys Cycle Network	Wales	Upgrade	1.4	4.09	no	13,500	-	338	197 (-)	106 (31)	37	37	0.6	-	-
Tyne Dock safety improvements	England	Upgrade	0.6	1.60	no	13,100	1,256	1,650	208 (17)	241 (15)	129	161	7.6	-	-
Watton – Griston links	England	New	1.1	6.30	no	9,100	715	1,543	170 (24)	136 (9)	97	224	7.5	-	-
Westminster: Connection across A40	England	Upgrade	0.3	0.19	yes	38,700	2,323	3,240	144 (6)	219 (7)	173	276	14.6	-	-
Weymouth network	England	Upgrade	2.6	14.74	no	32,900	25,386	25,660	1,825 (7)	1,788 (7)	2,405	2,375	6.8	-	-
Whitstable: Costal path and links	England	Upgrade	0.5	23.26	yes	44,800	1,413	2,331	270 (19)	172 (7)	1,199	1,260	17.0	-	-
Wicken Fen: The Lodes Way and rural links	England	New	2.0	14.50	yes	3,400	-	325	23 (-)	114 (35)	6	41	1.1	-	-
Worcester links and canal towpath	England	Upgrade	4.4	17.10	yes	57,800	12,161	18,734	237 (2)	304 (2)	2,095	3,346	30.8	-	-
Workington bridge	England	New	2.5	0.17	yes	6,000	-	2,283	- (-)	285 (12)	-	206	-	-	-
TOTAL							**189,250**	**319,531**	**15641 (8)**	**20253 (6)**	**25,312,896**	**37,799,119**		**1,853**	**1,524**

*Many Connect2 routes were a combination of new and upgraded sections. The variable in this column refers to the majority of the route (for example, a new bridge was also built as part of the Cardiff - Penarth scheme.

5.2.5 Contextual measures

I chose a range of physical and socio-economic contextual measures for the analysis, involving the areas around each scheme and features of the schemes themselves.

5.2.5.1 Contextual factors

The local residential population and presence of a transport interchange within 0.5 miles of the routes were determined using mapping software and 2011 UK census data by Sustrans, except for a minority of schemes where transport interchange data was missing which required me to deduce this information. I used the estimated annual route users before each scheme was constructed (details in Appendix 5.B) as the baseline numbers of pedestrians and cyclists. I used IMD scores as a proxy for deprivation and I chose to use local government level IMD ranks for schemes rather than the much smaller Lower Super Output Areas (LSOA) because many of the schemes were very long and crossed multiple LSOAs in different IMD deciles. I felt that this was appropriate given the problems of determining an average across ranked areas. Separate deprivation indices were available for rankings in England, Scotland, Wales and Northern Ireland. To allow comparison I calculated UK-adjusted IMD quintiles using Abel et al.'s percentage of the population living in areas in each deprivation quintile by country [276].

5.2.5.2 Scheme level characteristics

Scheme designs provided by Sustrans gave details of route length, cost and if a bridge or tunnel was present. Cost per mile was not included as a variable because it was not comparable between schemes that often involved a mixture of shorter, higher-cost sections (e.g. new bridges) and longer, lower-cost sections (e.g. upgrading an existing path). Instead, length and cost were included as these variables tend to be more relevant to design criteria. They were not strongly correlated (Spearman's rho 0.42) and were therefore treated as independent variables, as were length and population within 0.5 mile (Spearman's rho 0.59).

5.2.6 Outcome measures

5.2.6.1 Percentage change in use

I calculated the percentage change in use by pedestrians and cyclists from the total annual scheme users (pre and post). Most schemes reported some increase in cyclists (N=69 out of 77 schemes (90%)) and pedestrians (N=63 out of 77 schemes (82%)). I chose doubling, and increases of at least 50%, of the number of users as outcomes. This is because these can provide clear outcomes which are likely to be understood by decision-makers. I go on to use these results in my final qualitative study described in Chapter 6. The outcome of doubling numbers of cyclists also relates to the UK government's target of doubling cycling by 2025 in England [119].

5.2.6.2 Benefit-cost ratio

The UK's Department for Transport defines BCRs of at least 4 as 'very high' value for money [137]. I chose this as an outcome because I thought it was likely to be persuasive to decision-makers. This is investigated within my qualitative study in Chapter 6. BCR of at least 4 was achieved in 49% of Connect2 schemes.

5.2.6.3 Percentage change in user sub-groups

I chose to include older people, people with long-term illness or disability, and people living in the most deprived areas (a proxy for low socio-economic status) as sub-groups of primary interest. This is because levels of physical activity tend to be lower for these groups [41] and increases could lead to greatest health benefits, and impact on health inequalities [3,5,8,15,36]. Women's physical activity is generally lower than men's [26] and there is an increasing realisation of the importance of understanding gender impacts of interventions [277,278], so I also included women as a sub-group. Peak time users were chosen because these may impact on levels of traffic congestion and therefore be of interest to the transport sector. Women cyclists were included as a separate sub-group because they were under-represented in the UK [119,265].

Separate outcomes of 50% increase or doubling sub-group users were analysed because these are large increases which may be influential to decision-makers.

I calculated percentage changes of women, older people, peak time users and women cyclists from their proportion of total users, as recorded in the counts of users, multiplied by the total annual users at pre and post time-points. I classified peak time as between 7am - 9am and 4pm – 7pm on weekdays. I calculated percentage changes of people with disability or long-term illness, and those living in the most deprived areas from their proportion of total users, as recorded in the surveys of users, multiplied by the total annual users at pre and post time-points. Users from the most deprived areas were those with home postcodes in the most deprived UK-adjusted IMD quintile, based on LSOA rank, following Abel et al.'s methodology [276] to adjust for differences between countries within the UK.

5.2.6.4 Meeting physical activity guidelines

The survey of users asked: "In the past week on how many days have you completed 30 minutes or more physical activity that was enough to raise your breathing rate? (This may include sport, exercise and brisk walking or cycling for recreation)" with response options of 0-7 (see Appendix 5.A). The iConnect questionnaire asked how much time over the last seven days participants walked and cycled for different purposes, as well as time spent doing moderate and vigorous intensity leisure-time physical activity [279] (see Appendix 5.C). Since the UK government's guidelines recommend at least 150 minutes of physical activity of at least moderate intensity per week [280] I chose to use outcomes of at least 5 days of 30 minutes, or at least 150 minutes in total, of physical activity as proxies for meeting the guidelines in the surveys of users, and iConnect questionnaires, respectively (extreme values of reported minutes of physical activity were truncated at 1260 minutes). Because the guidelines include the option of 75 minutes of vigorous activity per week, or a mixture of vigorous and moderate intensity physical activity[18], I made an exception in the case of users who were running at the time of the route user survey. I assumed that the average intensity of their physical activity throughout the week would be higher than for other route users,[281] and therefore applied a threshold of at least 4 days of 30 minutes' activity to define the meeting of guidelines in this group.

5.2.7 Contextual factor covariates

The Connect2 schemes differed in the time between completion and post-monitoring. Previous research has found that it can take many months for people to start using new routes [266], therefore this needed accounting for as a potential confounder. Where month of completion was not stated, only the year, I took a conservative estimate of 1 month between completion and post-monitoring. Where monitoring dates were stated as the same month as scheme completion, I used 0.5 months since I assumed that some time passed between completion and monitoring. I calculated the time between completion and post-monitoring from the end of the first phase of construction, where applicable (assumed to include the 'core' component of the scheme, such as a bridge, which may have attracted the most users), and the latest post-monitoring date. Some schemes had pre-monitoring completed years before construction began. I assumed that minimal change in use occurred between pre-monitoring and start of construction.

Since car ownership has been found to be associated with levels of cycling [282] I considered including this as a covariate. However, I tested the correlation between local government level percentage car ownership, from the UK's 2011 Census [283], and deprivation quintile, and found it to be strongly correlated (Spearman's rho 0.81; p-value <0.005), so I did not include local government level car ownership as a separate covariate.

5.2.8 Demographic variables

I included demographic information that may influence physical activity outcomes as covariates: gender, age, employment status, general health, whether respondents had a disability or long-term illness, whether they had children in the household and their UK-adjusted IMD deprivation quintile. I also included ethnicity as a covariate in the user survey analysis, although not in the iConnect cohort analysis due to low numbers of non-white respondents in the sample. Demographic variables for respondents are shown in Table 5.4.

5.2.9 Statistical analysis

I conducted my analyses using R [284].

Since data were positively skewed I used a Wilcoxon non-parametric test to identify significance in median change and percentage change of pedestrians and cyclists across schemes, as well as for percentage change of user sub-groups.

I conducted multivariable binary logistic regression analyses, firstly unadjusted, and then with models adjusted for each outcome (walking or cycling separately with 50% increase or double users; or meeting guideline levels of physical activity): I adjusted scheme level analysis models for each independent contextual/scheme characteristic variable (baseline users, bridge or tunnel present, cost, index of multiple deprivation quintile, length, population within 0.5 miles, public transport interchange with 0.5 miles), and then additionally for the time from completion to post-monitoring; I adjusted physical activity models for demographic variables, and for analyses with iConnect data I also adjusted for baseline physical activity and scheme.

I conducted sensitivity analysis for the outcome of 50% increase and double number of users with disability/long-term illness and from the most deprived quintile, because these used data from the surveys of users and some schemes had low numbers of respondents for these sub-groups. Where zero sub-group users were recorded I reassigned these as one, and where the number of survey respondents differed by less than four (equivalent of one sub-group user per monitoring day) then I reassigned the post-monitoring survey value to the same value as at baseline. I also conducted sensitivity analysis for meeting guideline levels of physical activity for runners using five days of thirty minutes physical activity in the previous week, rather than four, since intensity of each bout of activity was unknown.

5.2.9.1 Missing data

The surveys of users did not distinguish between zero children in the household and missing data, therefore both were treated as indicating zero children in the household. Where home postcodes were missing for user survey responses, which were used to determine UK-adjusted IMD quintiles, I assigned participants with the local government IMD quintile of the scheme they were using since the majority of route users were local (77% of user survey respondents reported travelling 10 km or less to reach the route). Where demographic information was missing at baseline for iConnect but available at follow-up, I used the value from one-year follow-up, or if not available, from two-year follow up (age was adjusted down accordingly). I reassigned missing recreational physical activity values in the iConnect data as zero where responses for transport physical activity had been completed as zero (this applied to 18 cases at baseline; 5 at one-year follow-up and 14 at two-year follow-up).

5.3 Results

5.3.1 Descriptive findings

5.3.1.1 Scheme level use and benefit-cost ratio

The median increases in cyclists and pedestrians on the 77 Connect2 schemes with pre and post data were 51.8% and 38% respectively ($p<0.001$). Doubling of cyclists and pedestrians occurred in 22 and 17 schemes respectively, and at least a 50% increase occurred in 39 and 32 schemes respectively. Table 5.D.1 and Table 5.D.2, in Appendix 5.D, show the estimated annual users for each scheme and overall change, respectively.

Table 5.2 includes each scheme's estimated BCR, as calculated by Sustrans. The median BCR was 3.7 (IQR 6.6), a comparatively high value as defined by the UK's Department for Transport [137].

5.3.1.2 Scheme level route users

As shown in Table 5.3, demographic characteristics of users in the pre and post user surveys were similar overall. However, the proportion of cyclists significantly increased after scheme construction. This was found in both the manual count and survey of users. This was mostly due to increases in working-age men and women cyclists, with larger increases among men and experienced, regular cyclists, although there were also significant increases in new cyclists and those starting to cycle again, and borderline significant increases in occasional cyclists. Overall, most route users were pedestrians, white, without disability/ long-term illness, travelling off-peak for recreational purposes. They were most commonly working-age men, and not from the least deprived areas.

The counts of users found increases in women and older adults in 36 schemes (52%), in peak time users in 42 schemes (61%) and in women cyclists in 47 schemes (68%). The survey of users found increases in people with disability/ long-term illness in 44 schemes (62%) and users from the most deprived areas in 31 schemes (43%).

Table 5.3: Change in types of users across schemes using counts of users (Number of schemes = 69) and user survey (Number of schemes = 73)

Type of user		Pre				Post				Change pre-post		
		Total n	%	Median n	IQR	Total n	%	Median n	IQR	Median %	IQR %	p-value
COUNTS OF USERS (69 schemes)												
Mode	Pedestrians	123,448	77.1	947	1,802	201,427	69.2	1,413	2,947	-3.1	13	0.116
	Cyclists	29,589	18.5	260	324	76,899	26.4	498	913	**3.5**	**12**	**0.048**
	Wheelchair users	658	0.4	4	9	1,124	0.4	7	12	0.1	0	0.878
	Horse riders	131	0.1	0	2	257	0.1	1	4	0.0	0	0.377
	Runners	6,297	3.9	37	56	11,388	3.9	63	111	0.3	3	0.346
Age group and gender	Children	31,121	19.4	250	447	51,097	17.6	476	783	-1.2	12	0.483
	Working-age men	64,393	40.2	539	766	124,331	42.7	993	1,646	1.5	9	0.164
	Working-age women	47,789	29.8	393	582	86,747	29.8	602	1,521	0.1	5	0.891
	Older men	9,944	6.2	73	106	17,159	5.9	154	222	0.2	4	0.743
	Older women	6,876	4.3	51	73	11,761	4.0	94	164	0.3	3	0.729
	All women*	54,665	34.1	458	654	98,508	33.8	736	1,611	0.3	6	0.946
	All older people*	16,820	10.5	120	175	28,920	9.9	249	403	0.1	6	0.604
Time of use	Peak*	34,387	21.5	224	469	58,799	20.2	525	727	1.3	6	0.498
	Off-peak	125,736	78.5	1,145	1,484	232,296	79.8	1,839	3,444	3.5	8	0.498
Type of cyclist	Child cyclists	6,844	4.3	60	101	13,802	4.7	123	509	0.1	4	0.920
	Working-age men cyclists	15,557	9.7	120	211	43,114	14.8	275	509	**3.0**	**7**	**0.019**
	Working-age women cyclists	5,157	3.2	34	53	15,088	5.2	80	209	**1.1**	**3**	**0.040**
	Older men cyclists	1,483	0.9	9	17	3,526	1.2	19	45	0.2	1	0.269
	Older women cyclists	548	0.3	2	7	1,369	0.5	6	19	0.1	0	0.172
	All women cyclists*	5,705	3.6	37	56	16,457	5.7	85	229	**0.9**	**3**	**0.021**
Counts of users TOTAL		160,123	-	1,413	1,951	291,095	-	2,331	4,428	-	-	-
SURVEYS OF USERS (73 schemes†)												
Age	16-24	1,158	8.0	10	16	1,540	8.2	15	18	0.1	5.7	0.827
	25-34	2,149	14.9	20	23	2,756	14.7	29	35	0.0	7.4	0.759
	35-44	2,876	20.0	28	30	3,762	20.1	38	36	-0.8	7.3	0.787
	45-54	3,091	21.5	30	30	4,060	21.7	38	47	0.0	8.2	0.491
	55-64	2,547	17.7	24	38	3,394	18.1	31	40	0.4	8.5	0.264
	65+*	1,968	13.7	18	24	2,838	15.2	26	36	1.3	7.5	0.329
Gender	Female*	5,948	41.3	64	63	7,641	40.8	70	91	1.2	12.5	0.352
	Male	8,305	57.7	84	93	11,064	59.1	110	104	-0.2	11.92	0.172
Mode	Pedestrian	11,063	76.8	114	127	13,288	71.0	127	151	**-5.6**	**15.4**	**0.002**
	Cyclist	2,858	19.8	19	31	4,799	25.6	40	68	**5.9**	**14.8**	**0.002**
	Runner	376	2.6	3	5	452	2.4	3	6	-0.1	2.4	0.863

Type of user		Pre				Post				Change pre-post		
		Total n	%	Median n	IQR	Total n	%	Median n	IQR	Median %	IQR %	p-value
	Wheelchair	67	0.5	0	1	104	0.6	1	2	***0.0***	***0.46***	***0.052***
	Roller skating	8	0.1	0	0	12	0.1	0	0	0.0	0.0	0.412
	Horse riding	6	0.04	0	0	17	0.09	0	0	0.0	0.0	0.130
Type of cyclist‡	Women cyclist*	754	5.2	4	9	1,155	6.2	10	16	**1.4**	**4.0**	**0.030**
	New to cycling	48	0.3	0	1	73	0.4	0	2	**0.0**	**0.4**	**0.034**
	Starting to cycle again	171	1.2	1	3	296	1.6	2	4	**0.02**	**1.8**	**0.018**
	Occasional cyclist	225	1.6	1	4	388	2.1	2	5	***0.3***	***2.1***	***0.052***
	Experienced, occasional cyclist	536	3.7	4	6	895	4.8	7	11	0.7	3.6	0.142
	Experienced, regular cyclist	1,581	11.0	10	19	2,861	15.3	23	37	**4.3**	**10.0**	**0.001**
Journey purpose on route	Commuting	1,892	13.1	14	25	2,679	14.3	21	45	0.8	7.9	0.508
	Recreation	7,757	53.9	73	76	10,042	53.6	99	95	1.9	17.8	0.763
	Shopping	1,767	12.3	16	26	2,267	12.1	17	41	-0.8	5.1	0.851
	Visit friends/family	630	4.4	6	9	939	5.0	10	15	0.2	4.1	0.538
	Social/entertainment	819	5.7	8	12	988	5.6	7	15	-0.3	4.4	0.163
	Other§	1,451	10.1	13	19	1,781	9.5	16	22	-0.04	6.0	0.784
Ethnicity	White	12,091	84.0	138.5	123.75	17,497	93.5	170	189.5	0.04	3.5	0.930
	Non-white	507	3.5	2	5.5	729	3.9	2	5.25	0.0	2.0	0.672
Disabled/ long term illness	Yes*	1,807	13.4	16	20.5	2,549	14.4	25	31.5	1.4	8.7	0.104
	No	11,708	86.6	125	137.5	15,121	85.6	168	159	-1.1	9.2	0.364
UK-adjusted IMD quintile (1=most deprived)	1*	3,196	22.2	14	61	4,121	22.0	22	70	-0.01	5.6	0.703
	2	3,328	23.1	24	44	4,132	22.1	33	51	-0.2	9.2	0.956
	3	2,803	19.5	24	42	3,756	20.1	35	51	1.1	7.6	0.654
	4	2,859	19.9	22	34	3,807	20.3	34	52	-1.4	7.1	0.669
	5	2,216	15.4	12	43	2,903	15.5	23	41	0.1	3.7	0.731
User survey TOTAL		14,402	-	149	163	18,719	-	198	192	-	-	-

* Sub-group of interest (peak time defined as 7am – 9am and 4pm – 7pm on weekdays; older people classified subjectively by surveyors)

† 71 schemes were used in analyses of users from the most deprived quintile and those with a disability/long-term illness due to missing data.

‡ Type of cyclist was selected by each participant (excluding the option 'women cyclist')

§ 'Other' includes in course of work, education, personal business, holiday base, escort to school, other escort, and other.

Total percentages may not add to 100 due to rounding and missing values.

5.3.1.3 Participant descriptive statistics

As seen in Table 5.4, respondents differed in demographic characteristics between datasets – the user survey respondents were most commonly male, working-age, employed full time, white, in good health, from more deprived areas and without children. The iConnect cohort were most commonly female, older, white, in good health, from the least deprived areas and without children. Users of the new routes were most commonly employed full time, whereas non-users were most commonly retired.

Just over half of the cross-sectional survey sample reported meeting guideline physical activity levels (pre 52.6%; post 53.2%). Higher proportions of the iConnect cohort reported meeting the guidelines: 66.1% of non-users and 86.8% of route users at one-year follow-up; 63.9% of non-users and 83.6% of users at two-year follow-up. The percentage of respondents in the iConnect cohort who reported using the routes increased between one-year and two-year follow-up: from 52% to 53% at Cardiff; from 17% to 23% at Southampton; and from 23% to 37% at Kenilworth.

The percentage of survey respondents reporting that their decision to use the routes was influenced by an aim of achieving exercise rose from 55% at baseline to 61% at post-monitoring. 67% of users of the routes in the post-survey reported that they thought that the routes increased their physical activity. (See Table 5.D.3 and Table 5.D.4 in Appendix 5.D for further details about reasons for using the routes and other modes used to access them.)

Table 5.4: Comparison of participant characteristics in cross-sectional survey of route users and iConnect cohort at baseline

Variable	Survey of users		iConnect			
			1-year follow-up		2-year follow-up	
	Pre (n=13,343) (%)	Post (n=19,544) (%)	Non-users of route (n=1,322) (%)	Users of route (n=531) (%)	Non-users of route (n=945) (%)	Users of route (n=579) (%)
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Sex						
Male	7,696 (57.7%)	11,479 (58.7%)	591 (44.7%)	256 (48.2%)	405 (42.9%)	268 (46.3%)
Female	5,647 (42.3%)	8,065 (41.3%)	731 (55.3%)	275 (51.8%)	540 (57.1%)	311 (53.7%)
Age						
16-24	1,132 (8.5%)	1,645 (8.4%)	63 (4.8%)	9 (1.7%)	33 (3.5%)	7 (1.2%)
25-34	2,054 (15.4%)	2,984 (15.3%)	113 (8.5%)	72 (13.6%)	63 (6.7%)	56 (9.7%)
35-44	2,754 (20.6%)	4,017 (20.6%)	135 (10.2%)	82 (15.4%)	86 (9.1%)	78 (13.5%)
45-54	3,003 (22.5%)	4,389 (22.5%)	209 (15.8%)	117 (22%)	157 (16.6%)	130 (22.5%)
55-64	2,487 (18.6%)	3,559 (18.2%)	334 (25.3%)	127 (23.9%)	135 (14.3%)	160 (27.6%)
65+	1,913 (14.3%)	2,950 (15.1%)	468 (35.4%)	124 (23.4%)	371 (39.3%)	148 (25.6%)
Employment						
Employed full time	6,321 (47.4%)	9,973 (51%)	436 (33%)	229 (43.1%)	276 (29.2%)	235 (40.6%)
Employed part time	1,966 (14.7%)	2,682 (13.7%)	197 (14.9%)	85 (16%)	143 (15.1%)	96 (16.6%)
Retired	2,790 (20.9%)	4,083 (20.9%)	521 (39.4%)	169 (31.8%)	398 (42.1%)	202 (34.9%)
Other	2,266 (17%)	2,806 (14.4%)	168 (12.7%)	48 (9%)	128 (13.5%)	46 (7.9%)
Ethnicity						
White	12,840 (96.2%)	18,712 (95.7%)	1,256 (95%)	467 (87.9%)	903 (95.6%)	558 (96.4%)
Non-white	503 (3.8%)	832 (4.3%)	56 (4.2%)	15 (2.8%)	39 (4.1%)	19 (3.3%)
General health in last 4 weeks						
Excellent	3,507 (26.3%)	6,020 (30.8%)	213 (16.1%)	182 (34.3%)	289 (30.6%)	154 (26.6%)
Good	8,680 (65.1%)	11,866 (60.7%)	640 (48.4%)	316 (59.5%)	709 (75%)	307 (53%)
Fair	913 (6.8%)	1,281 (6.6%)	193 (14.6%)	70 (13.2%)	272 (28.8%)	64 (11.1%)
Poor	243 (1.8%)	377 (1.9%)	52 (3.9%)	11 (2.1%)	52 (5.5%)	6 (1%)
Deprivation quintile						
IMD 1 (= most deprived)	3,471 (26%)	4,700 (24%)	125 (9.5%)	24 (4.5%)	97 (10.3%)	23 (4%)
IMD 2	3,026 (22.7%)	4,261 (21.8%)	190 (14.4%)	55 (10.4%)	131 (13.9%)	59 (10.2%)
IMD 3	2,622 (19.7%)	3,834 (19.6%)	191 (14.4%)	90 (16.9%)	130 (13.8%)	90 (15.5%)
IMD 4	2,309 (17.3%)	3,793 (19.4%)	342 (25.9%)	162 (30.5%)	238 (25.2%)	175 (30.2%)
IMD 5	1,915 (14.4%)	2,956 (15.1%)	474 (35.9%)	200 (37.7%)	349 (36.9%)	232 (40.1%)
Long-term illness or disability						
Yes	3,745 (28.1%)	5,582 (28.6%)	377 (28.5%)	85 (16%)	294 (31.1%)	105 (18.1%)
No	9,598 (71.9%)	13,962 (71.4%)	945 (71.5%)	446 (84%)	651 (68.9%)	474 (81.9%)
Children in household						
Yes	3,772 (28.1%)	5,593 (28.6%)	162 (12.3%)	97 (18.3%)	103 (10.9%)	97 (16.8%)
No (inc. missing data for user survey)	9,633 (71.9%)	13,968 (71.4%)	1,160 (87.7%)	434 (81.7%)	842 (89.1%)	482 (83.2%)
iConnect scheme						
Cardiff	0 (0%)	1,049 (5.4%)	313 (23.7%)	277 (52.2%)	231 (24.4%)	258 (44.6%)
Southampton	306 (2.3%)	335 (1.7%)	441 (33.4%)	88 (16.6%)	333 (35.2%)	99 (17.1%)
Kenilworth	88 (0.7%)	303 (1.6%)	568 (43%)	166 (31.3%)	381 (40.3%)	222 (38.3%)

5.3.2 Use and benefit-cost ratio of new walking and cycling infrastructure by local contextual factors and scheme characteristics

Results for maximally adjusted models, shown in Figure 5.1 (see Table 5.D.5 in Appendix 5.D for full data table), indicated that higher relative increases in cyclists and pedestrians were associated with lower baseline levels of users. The odds of observing at least a 50% increase in cyclists were reduced by nearly a quarter for each additional 10,000 annual cyclists at baseline (OR=0.79, 95% CI=0.63, 0.92), and the odds of observing a doubling in cyclists were halved (OR=0.52, 95% CI=0.31, 0.77). The odds of observing at least 50% increase in pedestrians were reduced by more than a tenth for each additional 100,000 annual users at baseline (OR=0.86, 95% CI=0.68, 1.01) and the odds of observing a doubling in pedestrians were reduced by more than three-fifths (OR=0.39, 95% CI=0.14, 0.78).

An estimated BCR of at least 4 was associated with higher baseline levels of users (per additional 100,000 annual users at baseline: OR=1.24, 95% CI=1.05, 1.57), lower cost schemes (per additional £1 million scheme cost: OR=0.29, 95% CI=0.13, 0.57) and the presence of a public transport interchange within 0.5 mile (OR=4.64, 95% CI=1.00, 26.62), although 95% confidence intervals were wide and the association was not significant in the unadjusted model.

No other clear significant relationships were found.

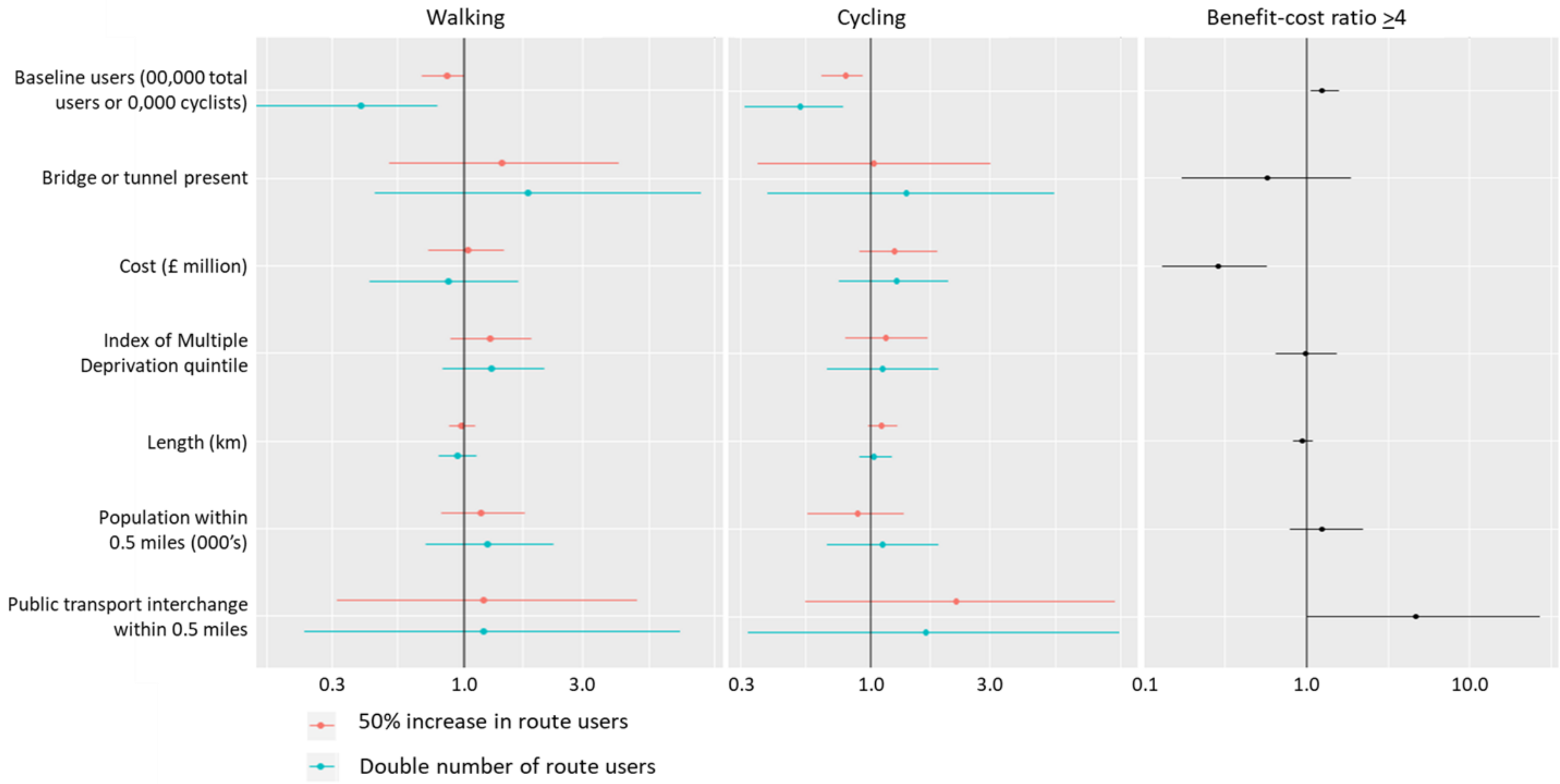

Figure 5.1: *Multivariable binary logistic regression analysis: ORs and 95%CIs for context/ scheme characteristics and either at least a 50% increase or a doubling in the number of route users, and BCR across schemes, maximally adjusted for each independent contextual/scheme characteristic variable and time from completion to post-monitoring (Total annual scheme users, Number of schemes = 77)*

5.3.3 Users of new walking and cycling infrastructure by local contextual factors and scheme characteristics

The maximally adjusted models, shown in Figure 5.2 (full data in Table 5.D.6 and sensitivity analysis results in Table 5.D.7 of Appendix 5.D), indicated that higher relative increases in sub-groups were associated with lower baseline levels of users, similar to the results found for overall use.

High relative increases of users from the most deprived LSOAs were associated with high population levels within 0.5 miles (odds of observing at least 50% increase almost doubled for each additional 1000 population: OR=1.93, 95% CI=1.18, 3.67; odds of observing a doubling increased by more than half: OR=1.54, 95% CI=1.01, 2.52) and a bridge or tunnel present (at least 50% increase: OR=3.51, 95% CI=1.12, 12.16), although 95% confidence intervals were wide. There were lower odds of doubling women cyclists with a bridge or tunnel present, also with wide 95% confidence intervals (OR=0.19, 95% CI=0.05, 0.64).

Doubling of users of the route with a disability or long-term illness and women users were associated with less deprived IMD local government quintiles (doubling women: OR=1.87, 95% CI=1.14, 3.32; doubling disabled/long-term illness: OR=1.56, 95% CI=1.03, 2.46).

Doubling of peak time users was associated with a public transport interchange present within 0.5 miles (OR=14.12, 95% CI=1.54, 386.86), although the 95% confidence intervals were wide.

No other clear significant relationships were found.

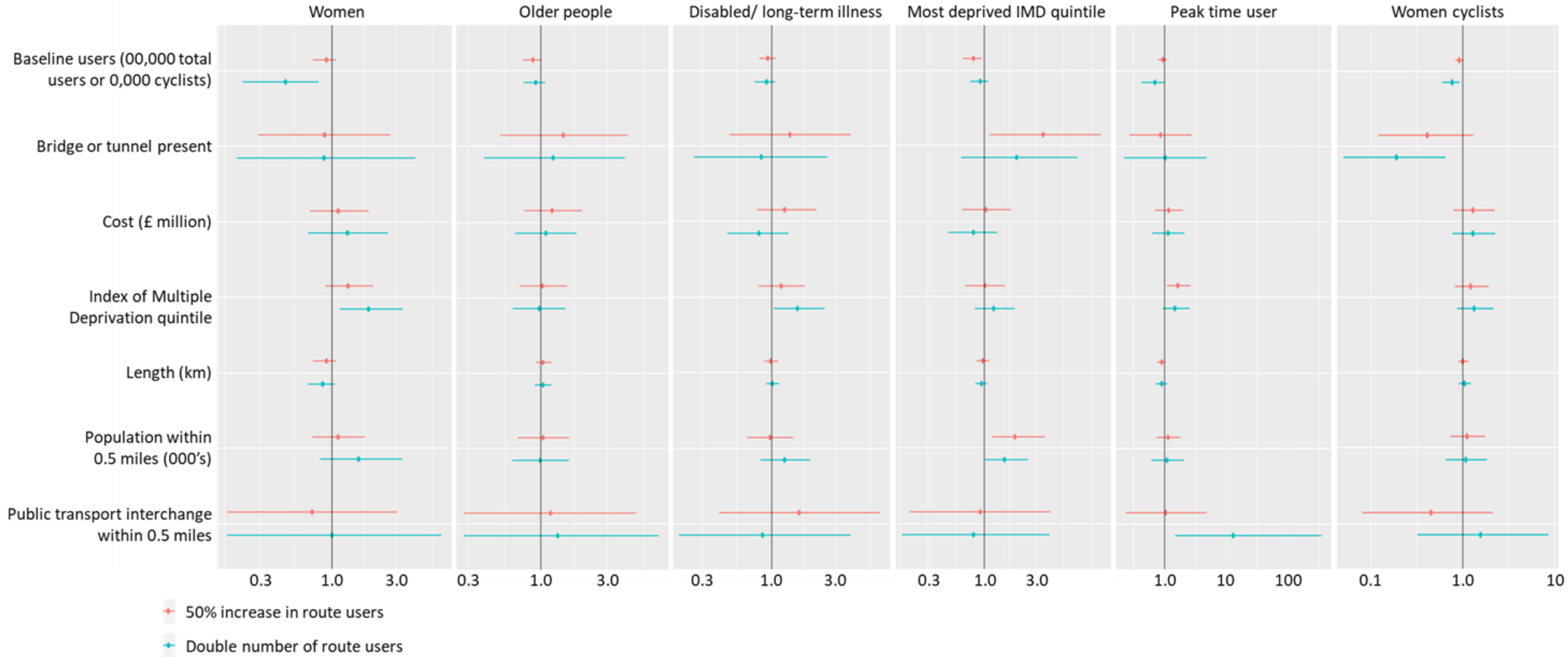

Figure 5.2: Multivariable binary logistic regression analysis: *ORs and 95%CIs for either at least a 50% increase or a doubling the number of users in each sub-group, maximally adjusted for each independent contextual/scheme characteristic variable and time from completion to post-monitoring*[3]

[3] Women, Older people, Peak time users, Women cyclists, Number of schemes = 69, data sets = counts of users and total annual scheme users; Disabled/long-term ill, N=71, Most deprived IMD quintile, Number of schemes = 73, data sets = survey of users and total annual scheme users.

5.3.4 Use and meeting physical activity guidelines

As seen in Table 5.5, walking and cycling on the Connect2 routes were associated with meeting physical activity guidelines. In the survey of users this was found for regular route users, compared with irregular users (pre: OR=1.80, 95% CI=1.67, 1.94; post: OR=1.93, 95% CI=1.81, 2.05). Non-commuting transport users were less likely to meet the physical activity guidelines, compared with recreational users (pre: OR=0.66, 95% CI=0.61, 0.71; post: OR=0. 77, 95% CI=0.72, 0.83) and runners were more likely than pedestrians to meet the guidelines (pre: OR=1.50, 95% CI=1.19, 1.90; post: OR=1.51, 95% CI=1.24, 1.84). There were no significant differences between pedestrians and cyclists, or recreational and commuting users, on the new routes.

The iConnect cohort analysis found that route users were more likely to meet the physical activity guidelines compared to non-users (at one-year follow-up: users at one-year only OR=2.07, 95% CI=1.37, 3.21 and users at one-year and two-year OR=3.02, 95% CI=2.02, 4.62; at two-year follow-up: users at two-year only OR=2.00, 95% CI=1.37, 2.96 and users at one-year and two-year OR=1.66, 95% CI=1.14, 2.45). As in the survey of users, non-commuting transport users were less likely to achieve the guidelines than recreational users (OR=0.22, 95% CI=0.06, 0.79), although 95% confidence intervals were wide. There was no significant difference at two-year follow-up. There were insufficient data to investigate this outcome for commuters only. Users for both recreational and transport were significantly more likely to meet the guidelines at two-year follow-up, compared with only recreational users (OR=2.07, 95%CI=1.18, 3.75). As in the survey of users there was no significant difference between pedestrians and cyclists in the adjusted models.

Table 5.5: Logistic regression - Survey of users: odds ratio (95% confidence interval) of meeting guideline levels of physical activity in previous week

Type of route user		Survey of users: at least 5* days of 30 min physical activity in previous week								iConnect: at least 150 min physical activity in previous week							
		Pre				**Post**				**1-year follow-up**				**2-year follow-up**			
		Sample n	**% of sample achieving 5+ days**	**Unadjusted**	**Adjusted[‡]**	**Sample n**	**% of sample achieving 5+ days**	**Unadjusted**	**Adjusted[‡]**	**Sample n**	**% of sample achieving 150 min**	**Unadjusted**	**Adjusted[§]**	**Sample n**	**% of sample achieving 150 min**	**Unadjusted**	**Adjusted[§]**
User time point	Non-user (reference)	-	-	-	-	-	-	-	-	1,156	65.1%	1.00	1.00	893	63.3%	1.00	1.00
	User at 1-year follow-up only	-	-	-	-	-	-	-	-	217	83.9%	**2.79 (1.93, 4.15)**	**2.07 (1.37, 3.21)**	58	77.6%	**2.00 (1.10, 3.93)**	1.29 (0.64, 2.74)
	User at 2-year follow-up only	-	-	-	-	-	-	-	-	172	73.3%	**1.47 (1.04, 2.12)**	0.96 (0.64, 1.44)	265	83.0%	**2.84 (2.02, 4.06)**	**2.00 (1.37, 2.96)**
	User at 1-year and 2-year follow-up	-	-	-	-	-	-	-	-	314	88.9%	**4.28 (2.99, 6.31)**	**3.02 (2.02, 4.62)**	314	84.1%	**3.07 (2.22, 4.31)**	**1.66 (1.14, 2.45)**
Frequency of journey on route	Irregularly (Weekly or less frequently) (reference)	4,562	43.2%	1.00	1.00	6,876	43.1%	1.00	1.00	-	-	-	-	-	-	-	-
	Regularly (Daily/ 2-5 times a week)	8,781	57.9%	**1.78 (1.66, 1.92)**	**1.80 (1.67, 1.94)**	12,668	59.1%	**1.89 (1.79, 2.01)**	**1.93 (1.81, 2.05)**	-	-	-	-	-	-	-	-
Journey purpose on route	Recreation (reference)	6,605	57.1%	1.00	1.00	10,358	55.6%	1.00	1.00	280	87.5%	1.00	1.00	316	81.3%	1.00	1.00
	Commuting	1,715	56.7%	0.98 (0.88, 1.09)	1.00 (0.90, 1.12)	2,751	56.5%	1.04 (0.95, 1.13)	1.06 (0.97, 1.16)	5	100%	*Insufficient data*	*Insufficient data*	4	50%	*Insufficient data*	*Insufficient data*
	Non-commuting transport*	4,997	46.2%	**0.64 (0.60, 0.69)**	**0.66 (0. 61, 0.71)**	6,404	49.0%	**0.77 (0.72, 0.82)**	**0.77 (0.72, 0.83)**	19	69.4%	**0.31 (0.11, 0.93)**	**0.22 (0.06, 0.79)**	31	67.8%	0.48 (0.22, 1.12)	0.55 (0.21, 1.47)
	Recreation and transport	-	-	-	-	-	-	-	-	221	89.6%	1.07 (0.63, 1.86)	0.95 (0.53, 1.74)	222	90.0%	**1.99 (1.20, 3.39)**	**2.07 (1.18, 3.75)**
Mode on route	Walking (reference)	10,441	52.0%	1.00	1.00	14,046	53.6%	1.00	1.00	284	84.5%	1.00	1.00	307	79.5%	1.00	1.00
	Cycling	2,485	56.7%	**1.21 (1.11, 1.32)**	**1.12 (1.02, 1.23)**	4,839	53.6%	1.00 (0.94, 1.07)	0.98 (0.91, 1.05)	28	89.3%	1.53 (0.51, 6.61)	1.28 (0.38, 5.89)	34	82.4%	1.20 (0.51, 3.33)	0.73 (0.26, 2.26)
	Walking & cycling	-	-	-	-	-	-	-	-	213	90.7%	**1.77 (1.02, 3.16)**	1.23 (0.66, 2.37)	232	90.6%	**2.14 (1.31, 3.58)**	1.46 (0.83, 2.26)
	Running[†]	324	62.7%	**1.55 (1.24, 1.95)**	**1.50 (1.19, 1.90)**	476	63.9%	**1.53 (1.27, 1.85)**	**1.51 (1.24, 1.84)**	-	-	-	-	-	-	-	-
	Other	93	32.3	**0.44 (0.28, 0.67)**	**0.44 (0.28, 0.68)**	183	21.9%	**0.24 (0.17, 0.34)**	**0.26 (0.18, 0.38)**	-	-	-	-		-	-	-

Type of route user		Survey of users: at least 5* days of 30 min physical activity in previous week								iConnect: at least 150 min physical activity in previous week							
		Pre				Post				1-year follow-up				2-year follow-up			
		Sample n	% of sample achieving 5+ days	Unadjusted	Adjusted‡	Sample n	% of sample achieving 5+ days	Unadjusted	Adjusted‡	Sample n	% of sample achieving 150 min	Unadjusted	Adjusted§	Sample n	% of sample achieving 150 min	Unadjusted	Adjusted§
Journey time on route (hrs)		13,243	53.4%	**1.07 (1.04, 1.10)**	**1.05 (1.01, 1.08)**	19,406	54.0%	1.00 (0.98, 1.03)	1.00 (0.97, 1.02)		-	-	-		-	-	-

* Non-commuting transport includes travel for shopping, visiting friends/family, social/entertainment and other purposes.

† At least 4 days of 30 minutes of physical activity for users recorded as running.

‡ Adjusted for demographic variables: gender (male/female), age (16-24/25-34/35-44/45-54/55-64/65+), employment (employed full time/employed part time/retired/other), ethnicity (white/non-white), general health (excellent/good/fair/poor), disability/long-term illness (yes/no), home IMD quintile, and child under 16 in the household (yes/no).

§ Adjusted for baseline demographic variables: gender (male/female), age, employment (employed full time/employed part time/retired/other), general health (excellent/good/fair/poor), disability/long-term illness (yes/no), home IMD quintile, child under 16 in the household (yes/no), baseline physical activity (minutes) and scheme (Cardiff/Kenilworth/Southampton).

5.4 Discussion

5.4.1 Main findings of this study

The new and upgraded Connect2 walking and cycling routes were associated with increased use by pedestrians and cyclists. Large relative increases in walking and cycling were associated with low baseline levels. Use of the new routes was associated with meeting physical activity guidelines in both the cross-sectional and longitudinal evaluations, suggesting that this type of new walking and cycling infrastructure may help to increase levels of population physical activity. Combining findings from academic research and pragmatic monitoring data helped to understand the impacts of this type of complex intervention on sub-groups of users.

5.4.2 Discussion of findings

5.4.2.1 Route users and context

New routes were associated with increases in pedestrians and cyclists with large relative increases associated with low baseline levels of users. This could help to provide political support for investment in areas with existing low levels of active travel, which was discussed as an issue in my earlier qualitative studies (Chapters 2-4). However, places with high baseline users were associated with very high BCRs, which may create tension between investing in areas with the greatest potential for modal change (low baseline levels of walking and cycling) and apparent high BCRs where currently walkable and cyclable areas may be more likely to receive investment, perpetuating inequalities in infrastructure availability. This potential tension between relative and absolute change is investigated further in my qualitative study described in Chapter 6. Lower cost schemes were also associated with very high BCRs, which may be as a result of relatively minor changes in infrastructure, such as on existing routes that may have improved safety or increased connectivity between key locations, attracting relatively large numbers of users at low cost.

The similarity in demographics of users found in the pre- and post-user surveys suggest that increases were roughly proportional across the whole of the population. However, the user sub-group analysis found that doubling of users who were women or had disabilities/ long-term illness was associated with new routes in less deprived areas. This may be explained by people from these groups preferring to walk or cycle in places that are attractive and safe (see Table 5.D.3 in Appendix 5.D), but if this is used to justify investment in more affluent areas it could exacerbate health inequalities [41].

High relative increases in route users who lived in the most deprived LSOAs were associated with high population levels within 0.5 miles of the route and with the presence of a bridge or tunnel.

Creating convenient routes to access amenities on foot and by bike in high-density areas, or overcoming physical barriers, is likely valued by this group (see Table 5.D.3 in Appendix 5.D). Furthermore they are least likely to be able to afford a car and car ownership has previously been shown to be correlated with walking and cycling [266,282,285]. However, the number of women cyclists was less likely to double where a bridge or tunnel was present, an association that was not found for cyclists overall. This may be because these features reduce natural surveillance and therefore reduce perceptions of safety which tend to be highly valued by this group [286]. Also, if these features lead to employment centres they may appear less convenient for women cyclists who are more likely to conduct shorter, chain trips, such as those related to caring responsibilities [287]. It should be noted, however, that the Connect2 schemes all involved overcoming some sort of physical barrier which is not the case for many walking and cycling routes.

High BCRs and doubling of peak time users were associated with the presence of a public transport interchange within 0.5 miles of the routes. This is consistent with other research that walking and cycling is associated with public transport use [288] and these results could be used to justify investment in walking and cycling infrastructure near to public transport hubs because modal shift may reduce traffic congestion. Previous research from the iConnect study did not detect overall significant modal shift or carbon savings among local residents because most of their reported new use was recreational and did not replace motor vehicle trips [289,290]. This may reflect important differences in the ways the samples were recruited.

5.4.2.2 Use and physical activity

Results showed that walking and cycling on the new routes was associated with meeting physical activity guidelines, and greater use (in terms of frequency and purpose) was associated with increased likelihood of achieving the guidelines. This builds on findings from previous iConnect research by Goodman et al. which found that living closer to three of the Connect2 routes was associated with greater total physical activity after two years[266]. It also supports other research that demonstrates that building walking and cycling infrastructure can increase levels of physical activity to achieve public health benefits [84,266,291]. Whilst the baseline user survey found that people who met the guidelines were more likely to be cyclists compared with pedestrians and by those who travelled for longer, there were no significant differences between pedestrians and cyclists or by time travelled by users of the new Connect2 routes. This suggests that the new routes attracted more frequent use by a wider range of people, increasing physical activity across the population, rather than previously only attracting more active people. Runners were more likely than pedestrians to achieve the guideline levels of physical activity, however, this was not seen in the sensitivity analysis with five days of thirty minutes of physical activity, rather than four (see Table

5.D.8 in Appendix 5.D). This points to a limitation in this type of self-report data in that the intensity of activity in general was not captured in the survey, particularly since mode was not recorded for physical activity on other active days in the previous week. Self-reported physical activity is widely used, and provides the basis for informing the physical activity the guidelines [18], but it involves a trade-off between scale and cost [81,292,293].

People using the routes for non-commuting transport purposes were less likely to achieve the physical activity guidelines compared to recreational users in the survey of users and at one-year follow-up in the iConnect cohort, whilst by two-year follow-up there was no difference between these purposes, although the confidence intervals were large. This aligns with findings from other iConnect analysis showing that it may take time for behavioural change to occur following construction of the new routes [266]. Mechanisms for behaviour change are likely to involve a combination of physical environmental and societal factors [99], therefore changes in visibility of people walking or cycling on the new routes can take time to affect cultural norms and encourage physical activity across the population. This may be particularly true for non-employment destinations that were previously inaccessible or unattractive to reach by bike or on foot. Sustrans' Connect2 post-monitoring data and the iConnect cohort follow-ups were conducted over a relatively short time period and it would be advantageous to repeat measurements to understand longer-term impact.

5.4.2.3 Research and monitoring methods: strengths and limitations

This study used monitoring data from 84 new walking and cycling schemes alongside research data from three of those schemes to understand how these different methods may be useful in understanding changes in use associated with context, and the association of use with overall physical activity. I have demonstrated that both the research and monitoring methods had value - the longitudinal iConnect dataset was able to evaluate individual-level change over time, which was a major strength, whereas this was not possible in the survey of users which was unable to be adjusted for baseline levels of physical activity, nor to determine whether people continued to use the routes and the impact that may have. For example, the survey of users asked about levels of cycling experience and it was unclear whether new or occasional cyclists maintained behaviours to become experienced, regular cyclists, for which there was a significant increase. There may have been some route displacement, attracting pedestrians and cyclists from other places, but it was unclear to what extent this occurred with the questionnaire. This difficulty in understanding displacement is not uncommon [73] and is discussed further in the final chapter of this thesis (particularly Section 7.4.2). It was not possible to identify to what extent increases in use were due to new people moving into the area, which was also a limitation of the cohort dataset. An additional limitation was that baseline measurements of some of the Connect2 schemes were conducted months or even years before construction started and it is unclear to what extent the assumption of minimal change between pre-monitoring and construction is valid. The estimated annual users of the Connect2 schemes and BCRs were calculated by Sustrans following the method described in Appendix 5.B. These have a number of uncertainties, particularly about assumed distances travelled and associated potential double-counting from multiple monitoring points along the routes. The BCRs were calculated using an old version of HEAT [275] and included limited benefits, whereas more recent research, such as conducted by Hunter et al., has included wider social benefits in economic evaluations [294].

Whilst cohort studies like iConnect have advantages they are rarely conducted [177]. They also have limitations, as previously discussed, therefore understanding the value of multi-site cross-sectional evaluations is useful. A strength of Sustrans' Connect2 datasets (counts, surveys of users and total annual scheme users) was the number of locations that were included, following the same methodology, and their breadth of contexts, allowing assessment of the impact of context on use, which is rarely evaluated and not clearly understood [97,138,295]. The much larger sample size than the cohort study enabled greater disaggregation of sub-groups for the evaluation of use and meeting guideline levels of physical activity. However, understanding impacts by types of user sub-group at a scheme level often resulted in large confidence intervals due to the relatively small number of schemes included in the samples. It is therefore recommended that this type of multi-scheme evaluation is conducted at a greater scale to provide more reliable results about context on user sub-groups (this is discussed further in Section 7.4.3). I note that the routes were completed between 2009 and 2013 and evaluation of more recently constructed walking and cycling infrastructure would be valuable, particularly following improved cycle infrastructure design standards[296].

Contextual issues are important to consider in complex public health intervention research [87], but there were physical, social, economic and political contextual factors that were not assessed in this analysis that could have provided additional insights, for example, whether additional investment or behaviour change strategies were being conducted in parallel that could have influenced outcomes [100]. Also, because of the multi-purpose nature of the Connect2 routes, their often extensive lengths with variety of population densities along them, and the lack of information about the quality of the surrounding environment for walking and cycling, it was challenging to understand to what extent these contextual features influenced the impact of the new routes. Smaller scale qualitative or ethnographic approaches to unpacking the complexity of contextual influences could therefore be important alongside large-scale quantitative evaluation. My qualitative study described in Chapter 6 investigates how contextual features may be important to decision-makers for new walking and cycling routes. The issues about contextual features and the value of qualitative research to understand their importance is discussed further in Chapter 7

It appeared that the survey of users was broadly representative of route users, as measured by the manual count, however this data was captured over four days for each scheme, without adjustment for weather, as is often the case in transport assessments [73]. The collection of data on only a small number of days is a limitation of this study. The iConnect respondents who reported using the routes appeared to be less representative of route users, more likely being older, female, from less deprived areas and without children. Although representativeness of the general population may not be necessary for cohort studies since confounders can be controlled for in regression analysis [297], and in this study bias was reduced by inviting a random sample of local residents to complete the questionnaires, the low response rates of the iConnect cohort (15.6% response rate [290], of which 60% had complete data for inclusion in this analysis) resulted in some sub-groups of users unable to be investigated separately, such as commuters. In contrast, the survey of users found that about 14% of people overall used the routes for commuting (29% of users were recorded as commuters on the three iConnect schemes, including 52% during peak hours). However, the cross-sectional survey of users did not investigate other purposes that people used the routes for, whilst 8% of users in the iConnect cohort reported using the routes for commuting alongside other purposes. Therefore combining findings from both datasets gives a fuller picture of the impact of this infrastructure on commuting behaviour, which may be useful for influencing non-health sectors, such as transport planning, to influence the wider determinants of health [34].

5.5 Chapter summary

This chapter described my quantitative evaluation of use, users, benefit-cost ratios and overall physical activity associated with new walking and cycling routes across 84 locations.

I conducted repeat cross-sectional pre-post analysis of pragmatic monitoring data from a variety of new and upgraded walking and cycling routes in different contexts across the United Kingdom (the Connect2 programme), using four-day user counts, next-to-pass surveys of route users, and automatic counter data that generated estimates of total annual users. Using multivariable logistic regression, I identified contextual features associated with 50% increase and doubling of pedestrians, cyclists, and particular sub-groups of users, as well as with 'very high' value for money (BCR $\geq$ 4). I combined insights from this monitoring data with longitudinal cohort data (the iConnect study) from residents living near three of the Connect2 schemes, surveyed by post at baseline, one-year and two-year follow-up to investigate associations between use of the new infrastructure and meeting physical activity guidelines.

I demonstrated that new walking and cycling infrastructure can lead to large relative increases in pedestrians and cyclists and has the potential to increase population levels of physical activity, whilst also providing very high value for money. I was also able to understand more about the role of context in attracting people to use new and improved local networks for walking and cycling, particularly from less active groups such as older people, disabled/with long-term illness and people from the most deprived areas. This study suggests that construction of new and improved walking and cycling infrastructure at scale could improve population health and reduce health inequalities.

5.6 Contributions

The original concept for this work was developed through discussions with David Ogilvie, Louise Foley, Jenna Panter and James Woodcock. It also involved discussion with Jane Powell, and Emma Bird who had previously been involved in analysis of the Connect2 programme as part of the iConnect study. I developed the ideas and methods for this study with support from Louise Foley and Jenna Panter, building on the findings from my qualitative study described in Chapter 2. The Connect2 data was provided by Andy Cope, who, with his team, also helped me to understand Sustrans' monitoring and evaluation methods. I was not involved in the design or data collection of the original Connect2 evaluation, nor for the iConnect study. I conducted the analysis and wrote the original paper of this study, which has been published in Journal of Transport & Health [298], and is an abbreviated version of this chapter, which received critical feedback from Louise Foley, Jenna Panter, Andy Cope, David Ogilvie, James Woodcock, Jane Powell and Emma Bird. Members of the iConnect consortium were also provided with opportunity to comment on this work, although no additional feedback was received. I presented results of this research in an oral presentation at the Society for Social Medicine & Population Health 64th Annual Scientific meeting (online) in September 2020.

6. Understanding context for new walking and cycling routes

Believable stories

6.1 Introduction

In this chapter I investigate the role of context for use of case study examples of new walking and cycling routes in England. It follows on from my findings described in earlier chapters, particularly my qualitative study in England described in Chapter 2, in which a key finding highlighted that decision-makers, particularly councillors and those in urban planning, valued contextually relevant case studies. In that study I found that case study examples could be used to provide practical solutions, or to inspire stakeholders, but without perceived contextual relevance it could be difficult to persuade people to try new things and spend money on new infrastructure with low perceived demand (such as in areas with low levels of cycling). However, in Chapter 5, I demonstrated that increased levels of walking and cycling were associated with new walking and cycling routes across contexts, although some features were more likely to attract certain types of user. This suggests that the role of context may be related to *perceptions* of context for decision-makers and its apparent relevance to a local area and for particular groups. I explore these issues in this final qualitative study.

6.1.1 Chapter outline

This chapter begins with the rationale for this study. I then describe some preliminary work (Section 6.2.1) which supports development of the study design, using feedback from participants from my first qualitative study in England. I then explain the main methods I used to conduct this qualitative study (Sections 6.2.2 – 6.2.6), including participant selection and development of infographics, which used data from my quantitative study described in Chapter 5. I present the findings from my thematic analysis of the qualitative data and discuss my findings in relation to other research, as well as discuss the strengths and limitations of the study. The chapter finishes with a summary.

6.1.2 Background

Context can involve features that influence the development, implementation and evaluation of population health interventions and can include many different aspects, including physical, cultural, social, economic, historical, and political [87]. Population health interventions are widely recognised to be influenced by the context in which they are implemented, but poor reporting of context in primary studies has been raised as an issue in attempting to synthesise evidence.

There have been calls for greater clarity over reporting contextual features associated with public health interventions [87]. Burford at al. suggest that information on the following should be provided: study setting information, time periods, populations, factors affecting implementation, including resources required, baseline prevalence of health issues in the setting, and impact on different groups [299]. Because interventions can vary widely, specific requirements for reporting contextual features for complex public health interventions, such as place-based natural experiments, are relatively vague compared to reporting guidance for observational studies, such as Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) [300], and Transparent Reporting of Evaluations with Non-randomised Designs (TREND) [301].

Process evaluations can help to understand why an intervention worked, or did not work, in a particular context. This can help to translate findings to other contexts to maximise the likelihood of success. Contextual information related to public health interventions can also support understanding of the mechanisms that may lead to outcomes, for example why people may choose to use new walking and cycling routes [97,100,302], as well as the impact on particular segments of society, for example socially disadvantaged groups [295]. These are useful to encourage conditions that may maximise the impact of interventions and can be described as the 'transferability' of an intervention – the extent that the measured effectiveness is applicable in another specific setting [303]. It is also important to understand the contextual factors affecting decision-making and implementation of the intervention itself, to understand the conditions that can affect whether an intervention is adopted, and how that intervention is shaped. This can be referred to as the 'applicability' of an intervention – the extent to which an intervention may be implemented in another setting [246,303]. Inadequate assessment of applicability and transferability of research has been highlighted as a problem which may restrict provision of effective population health interventions in different contexts [246], and it has been suggested that these are more relevant considerations for public health interventions than issues of generalisability – the extent to which study results are relevant for broader situations, which may under-value contextual issues [304]. Although some authors have presented frameworks to evaluate applicability and transferability of public health interventions, there have been criticisms of a lack of empirical testing of these for decision-making [304]. Burchett et al. explored perceptions of relevance of interventions from across contexts through a qualitative study in Ghana, finding that applicability was highly relevant, whilst transferability was less emphasised by stakeholders [246].

Greater clarity on the perceived importance of particular types of contextual features associated with place-based interventions that may affect applicability and transferability could be useful. This could help public health researchers who plan, evaluate and publish findings of complex interventions. It could also be useful for knowledge brokers who share information and evidence [112,126,148] to increase the likelihood that examples are relevant and influential to decision-makers. Finally, clearer understanding about contextual relevance could also help shape future guidance material to support stakeholders from different sectors to create more effective walking and cycling infrastructure for healthier communities.

6.1.3 Study aims

This study aims to understand which contextual factors are viewed as important by local level decision-makers when planning and building new walking and cycling routes. It also investigates how different methods are used to demonstrate the impact of the new walking and cycling routes. The research was guided by four main questions: (1) What contextual issues are most important to decision-makers in order for case-study examples of walking and cycling routes to appear relevant? (2) Are aggregate findings across multiple contexts and routes (such as those from the Connect2 analysis described in Chapter 5) useful to decision-makers, or do they prefer individual project examples? (3) Is information about the type of user of walking and cycling routes influential to decision-makers? Do decision-makers consider potential impacts on inequality? (4) How can case study examples be made more useful?

6.2 Methods

I conducted a qualitative study, using data and findings from my previous qualitative and quantitative studies, to elicit insights into perceptions of contextual relevance for case studies of new walking and cycling routes. I used semi-structured interviews and thematic analysis to explore issues of context in depth with stakeholders across different sectors, most of whom were included in the interviews in my qualitative study described in Chapter 2. This allowed for flexibility of questioning and to investigate emerging issues which were not identified a priori. Ethical approval for this study was granted by The University of Cambridge, School of the Humanities and Social Sciences, on 11th March 2020 (Reference: 20/243).

6.2.1 Study development

To develop this final qualitative study I conducted some preliminary activities to improve its relevance for stakeholders. These are described in this section (6.2.1).

6.2.1.1 Gap analysis

I originally sought to provide the interview study participants from Chapter 2 with additional information or evidence that might be useful to them, alongside feedback from that study. To identify these potential issues, I conducted a gap analysis of my stakeholder interviews of Chapter 2 involving line-by-line coding of transcripts, supported using NVivo 12. I identified issues where three or more participants appeared to lack knowledge or understanding, or explicitly sought additional information. This resulted in six topics, as shown in Table 6.1, including: use of new walking and cycling routes; economic impacts of walking and cycling routes; and examples of good cycling infrastructure and other active living infrastructure (ALI) designs.

6.2.1.2 Obtaining participant feedback

I identified resources related to the topic areas identified in the gap analysis. I sent links of these to all the study participants and their colleagues who had expressed interest in the study (n=43). Participants were contacted individually by email in late October 2018 with the summary report (see Appendix 6.A).

Feedback from participants was sought about the identified topics, as well as preferred formats of information using a short questionnaire with Likert scales [305], shown in Table 6.1 and Table 6.2. This was to check the demand for each topic area by different types of stakeholders to help shape this project. The request for the questionnaire to be completed was included within the summary report, and also in the covering email, asking for it to be returned by email. Reminders were sent to participants together with an additional resource link about health and transport (http://www.urbantransportgroup.org/resources/health-and-wellbeing) in December 2018.

Table 6.1: Feedback questionnaire: Usefulness of additional information

Q1. How useful would further evidence summaries on these topics be for you?

Topic	Very Useful	Useful	Unsure	Of Little Use	Not Useful
1. Health benefits of physical activity, including walking and cycling					
2. Health benefits of green or open space					
3. Health impact of living in different environments/ place-making					
4. Use of new walking and cycling routes					
5. Economic impacts of walking and cycling routes and other place-making					
6. Examples of good cycling infrastructure and other ALI designs					

Table 6.2: Feedback questionnaire: Format of information

Q2: How likely is it that you would engage with the following formats?

Type of resource	Very Likely	Likely	Unsure	Unlikely	Definitely Not
Report (10-40+ pages)					
Short summary (1-4 pages)					
Academic research article					
Podcast (5-10 minutes)					
Infographic					
Other (please specify)					

A summary of findings from my qualitative England study [306][4], as well as a link to the published paper [189], were shared with participants who were still contactable, and their colleagues who had expressed an interest in the study, in October 2019 (n=37). The summary included the following text:

> *"**Guidance material and contextually relevant examples are important**. Urban planners, developers and public health practitioners use guidance such as Sport England's Active Design principles* [192] *and guidance from Public Health England* [307] *and the TCPA* [174]. *However, case studies may not always persuade councillors if local conditions are very different from those presented. This is especially true where austerity has made councillors reluctant to try new things for fear of wasting resources, particularly in areas with low rates of walking and cycling in which active living infrastructure may be seen as a threat to car driving or housebuilding. A lack of contextually relevant examples can also make it difficult for public health practitioners and developers to know what to promote. Urban*

[4] I originally wrote the summary for the journal of the Town and Country Planning Association. This was replicated online and the link sent to participants: https://www.cedar.iph.cam.ac.uk/designing-for-health-physically-active-communities/

planners can also struggle to get time to learn about best practice, despite an enthusiasm for learning." [306]

Providing feedback of this nature was also done for on-going engagement with participants, to increase the likelihood of them agreeing to be interviewed a second time for this follow-on study.

6.2.1.3 Results of participant feedback

Responses to the questionnaires were received from 56% of people (see Table 6.3). Feedback received from participants on the usefulness of evidence summaries and formats can be seen in Figure 6.1 and Figure 6.2 (a breakdown of responses from each type of stakeholder is included in Appendix 6.B). There was a high level of interest for more information about all the topic areas from most of those who responded, as seen in Figure 6.1, although sample sizes were small. This included apparent demand for more examples of good cycling infrastructure and greater understanding about use of walking and cycling infrastructure - 83% and 88% of respondents respectively thought additional information and evidence about these issues would be useful or very useful. Economic impacts of new walking and cycling routes were also reported to be useful or very useful by 83% of respondents.

Table 6.3: Questionnaire respondents by local authority area

Area	Total contacted	Total responses
1	19	12
2	9	4
3	15	8

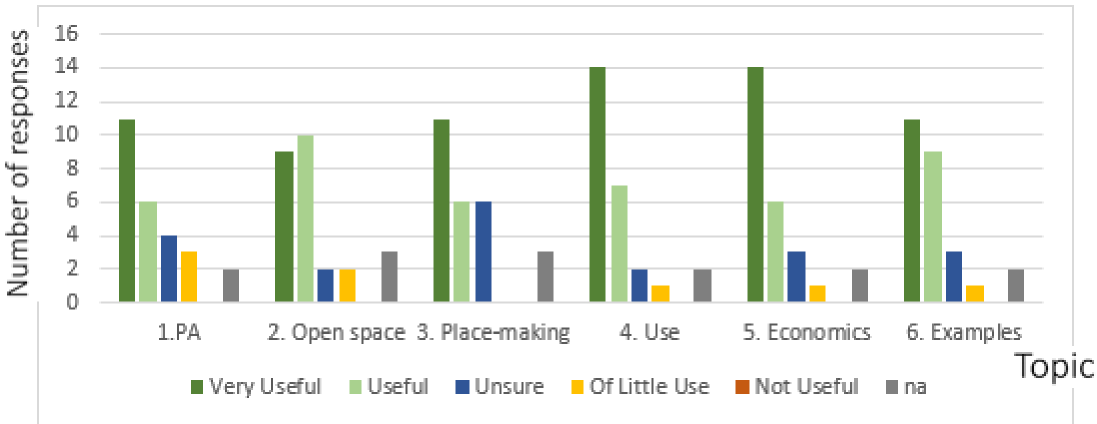

Figure 6.1: Summary of feedback about usefulness of identified topics[5]

[5] Numbered topics correspond to the topics includes in Table 6.1.

As seen in Figure 6.2, the most supported format was a short summary (1-4 pages), followed by infographics, which 100% and 88% of respondents, respectively, reported that they were likely or very likely to engage with. Academic research articles and podcasts were the least popular choices.

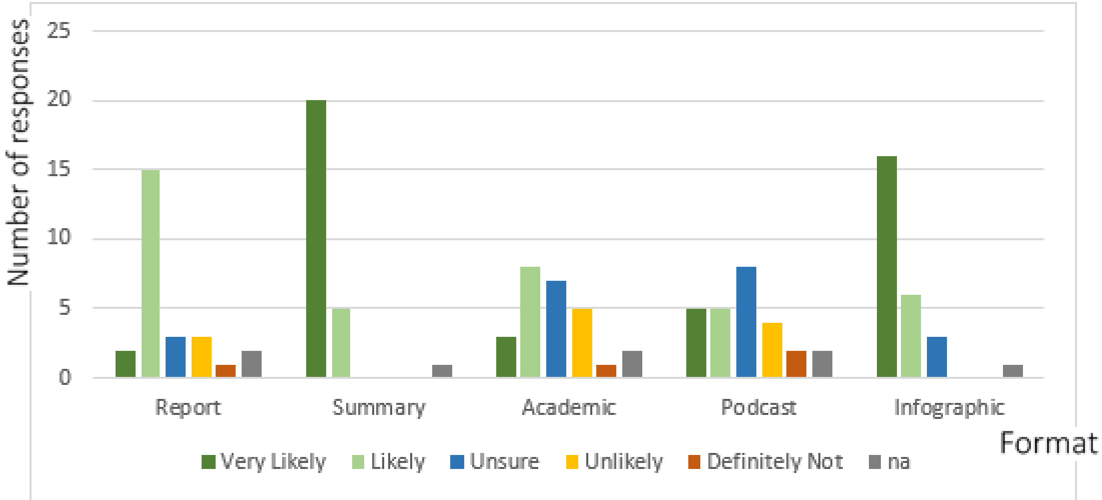

Figure 6.2: Summary of feedback about likely engagement with different formats of information[6]

This formative work guided my study design. As described in more detail below, I used short summaries and infographics to present information to interview participants about use of walking and cycling infrastructure, examples of good cycling infrastructure, and economic impacts of new walking and cycling infrastructure in the form of benefit-cost ratios.

6.2.2 Setting

I focused the study on two of the three local authority areas used in the England qualitative study described in Chapter 2. As in my earlier studies, areas are not identified to protect the anonymity of interviewees. Area 1 was a relatively wealthy semi-rural district with major growth areas; Area 2 was a deprived urban area undergoing regeneration. The third area from the original England qualitative study was not included because resource constraints meant that I could then include more types of stakeholder in this study, by recruiting people from just two areas. The two that were chosen were contextually different from each other in terms of deprivation, urbanisation, topography, and levels of cycling. They also both had a dedicated public health for urban planning practitioner, whereas the excluded area did not have anyone in this role. It seemed more useful to learn from these positive examples. Also, the excluded local authority area focussed on an original New Town[7], but the Connect2 schemes (used as selected case study example prompts in the interviews) were not built in

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[6] Formats correspond to the formats included in Table 6.2 Table 6.1.

[7] New Towns were developed by Development Corporations, predominantly during the 1940s and 1960s to increase housing supply after the Second World War.

these types of locations which may have reduced the likelihood of these examples being seen as contextually relevant by decision-makers.

6.2.3 Participants

Eight semi-structured interviews were conducted with nine stakeholders purposively sampled to include public health, urban planning, transport planning, councillors and private sector developers. Seven of these people were interviewed in the original study, described in Chapter 2 (all provided consent to be re-contacted). The two people not included in the original study were invited to participate because their colleagues, whom I had previously interviewed, had changed jobs, but I had been in contact with both these people previously (introduced by original study participants) and so they were aware of the previous stage of the research and its findings. I chose to invite people who spanned a range of sectors and who were likely to be information rich.

Some individuals from the original study who had moved jobs to other organisations were still invited to take part in this follow-on study, where they were still contactable. All interviewees were contacted by email and sent copies of the participant information sheet and consent form in advance (see Appendix 6.C).

Table 6.4 summarises the types of study participants included. Table 6.5 6.5 summarises people invited to be included, but who did not take part.

Table 6.4: Summary of study participants

Role	Area 1	Area 2	Private sector	Total
Public Health	1			1
Urban planning	1*†	1‡	1	3
Transport planning	1*		1	2
Councillor	2 (district† and county)	1		3
TOTAL	**5**	**2**	**2**	**9**

* Interviewed together
† New interviewee, not included in original study
‡ Changed organisations

Table 6.5: Summary of those invited who did not take part

Role	Area 1	Area 2	Private sector	Total
Public Health	0	1 - Busy	N/A	1
Urban planning	1‡ - No response	1 - Busy	1 - Busy	3
Transport planning	1‡ - Not contactable	1 – Not working	0	2
Councillor	0	0	N/A	0
TOTAL	**2**	**3**	**1**	**6**

‡ Changed organisations

I used the same assigned alphanumeric references for interviewees involved in the original study, described in Chapter 2. New interviewees were assigned the letter X and a number.

6.2.4 Interview structure

As described in Chapter 5, the Connect2 programme involved 84 new walking and cycling routes across the UK. I used results from my quantitative analysis involving context and use of the Connect2 schemes as interview prompts in this study to investigate contextual issues and relevance to stakeholders. These are described in more detail below.

6.2.4.1 Interview stages

The interviews involved three stages: the first stage involved discussion about how case study examples were normally used to influence decision-making and how they may or may not be useful; the second stage used selected case study examples from Sustrans' Connect2 programme of new walking and cycling infrastructure as discussion prompts to investigate particular contextual factors that may or may not be useful to decision-makers; the final stage used a summary of my Connect2 analysis results about context and use associated with new walking and cycling infrastructure to discuss whether these may be influential to decision-makers. This sought to investigate views on aggregate findings compared to individual case studies, benefit-cost ratios, sub-groups of users (which may impact on inequality or congestion), and relative compared to absolute changes in users.

6.2.4.2 Selection of case study examples

I chose six schemes from the Connect2 programme for each local authority area to be used as discussion prompts in the second stage of the interviews. These each had some similarities with the study areas, such as the type of rural/urban area; level of deprivation (similar Index of Multiple Deprivation quintiles for the local authority [308]); level of cycling (using data from the Propensity to Cycle Tool (PCT) [309]); and topography (particularly hilliness). The examples each had benefit-cost ratios of at least 2 ('high' value for money as defined by the UK's Department for Transport [137]), and most were much higher. Schemes which saw decreases in cyclists or total users were excluded. Schemes which had unusual settings or aspects were excluded, for example if the majority of a new route was composed of a disused railway line or a coastal path because these are quite specific contexts which may not have been relevant for the focal local authority areas. Schemes in Scotland and Northern Ireland were excluded because there was no PCT data available. This resulted in shortlists of 11 Connect2 schemes for each area from which six were chosen, covering a variety of contexts. Table 6.6 shows the schemes used in the interviews for each of the two local authority areas. After piloting the interview guide in Area 1, I decided to also include one of the selected case studies for that area as an additional example in Area 2, because it appeared to be a potentially useful example of a new housing development connecting to an existing town. Therefore I used six

Connect2 case study examples with interviewees from Area 1 and seven examples with interviewees from Area 2, although in some interviews our discussions focussed on only a handful of these.

Table 6.6: Case study examples used in interviews with participants from each local authority area

Scheme	Local authority	Topography	Estimated baseline cycling*	% change cycling*	Estimated baseline walking*	% change walking*	Cost (£)	Length	IMD quintile (1=most deprived)	Area % cycling	Area % potential for cycling	Benefit-cost ratios
Area 1 (semi-rural)		**Flat**	**-**	**-**	**-**	**-**	**-**	**-**	**5**	**>5†**	**19‡**	-
Carlton-Le-Moorland – Bassingham link	North Kesteven	Mixed	10,019	136.2	35,910	53.8	502,000	2.1	5	4.3	19.0	5.4
Kenilworth – Burton Green greenway and link to the University of Warwick	Warwick	Mixed	8,159	767.1	62,475	195.5	1,153,000	9.9	5	3.5	20.3	10.9
Leicestershire: Watermead Park links	Charnwood	Mixed	67,285	42.4	363,671	40.6	1,691,000	7.8	4	4.1	20.8	8.1
Nantwich – Crewe link	Cheshire East	Mixed	42,626	43.5	67,396	60.1	1,560,000	6.3	5	2.9	17.8	4.0
Sleaford – Leasingham link	East Hampshire	Mixed	34,597	55.7	306,832	76.0	871,000	2.6	5	1.9	11.6	3.7
Worcester links and canal towpath	Worcester	Mixed	168,629	23.6	1,926,199	62.9	4,427,000	17.1	3	4.6	22.5	30.8
Area 2 (urban with regeneration)		**Mixed**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**<3†**	**16‡**	-
Bethnal Green local link	Tower Hamlets	Flat	32,917	49.7	234,513	128.1	2,244,000	2.9	1	7.0	30.6	9.0
Blyth network	Northumberland	Hilly	51,224	68.1	609,925	11.9	2,503,000	14.5	3	1.6	14.6	3.5
Croydon parks links, crossing duel carriageways	Croydon	Mixed	15,140	95.0	315,421	273.5	1,868,000	2.3	2	1.3	16.3	16.1
Dover greenway to city centre and seafront	Dover	Mixed	11,368	95.9	543,678	45.5	757,000	2.8	2	2.3	13.4	22.3
Nantwich – Crewe link	Cheshire East	Mixed	42,626	43.5	67,396	60.1	1,560,000	6.3	5	2.9	17.8	4.0
Plymouth network	Plymouth	Hilly	110,247	23.1	672,637	62.9	2,090,000	10.9	2	2.8	13.2	9.2
Tyne Dock safety improvements	South Tyneside	Mixed	68,441	45.6	61,002	-0.1	586,000	1.6	1	2.3	22.0	7.6

* Estimated baseline levels of walking and cycling, and percentage change, for each scheme were found by Sustrans using the methods described in Chapter 5.

† An indication of percentage cycling for the study local authority areas are shown, to reduce likelihood of area identification.

‡ Percentage potential for cycling is rounded for the study local authority areas to reduce likelihood of area identification.

6.2.4.3 Interview prompts: summaries and infographics

The participant questionnaire feedback demonstrated preference for short summaries and infographics (see Section 6.2.1.3), therefore I used these formats to present data for discussion during the semi-structured interviews. This was to engage participants to encourage dialogue during the interviews as well as to increase the likelihood of interviewees reading the material prior to the interviews. I produced summary sheets and infographics with Canva[8], a free design website, to use as interview prompts. These included:

1. A summary sheet for each local authority area entitled 'Background information', which included local authority information that could be compared with the individual case study examples, such as level of commuter cycling from the 2011 census and potential for cycling from the PCT. It also outlined the methods used in evaluating the Connect2 programme. An (unidentified) example is included in Appendix 6.D.
2. A sheet for each of the case study examples. These included a summary of the scheme, a map of the route, changes in pedestrians, cyclists and sub-groups of users, and some local authority information. An example is shown in Figure 6.3.
3. A summary of my Connect2 analysis results (described in full in Chapter 5) showing associations between contextual/ scheme characteristics and doubling, or increasing users by at least 50%, or very high benefit-cost ratios ($\geq$4). See Figure 6.4.

[8] Canva.com

NANTWICH

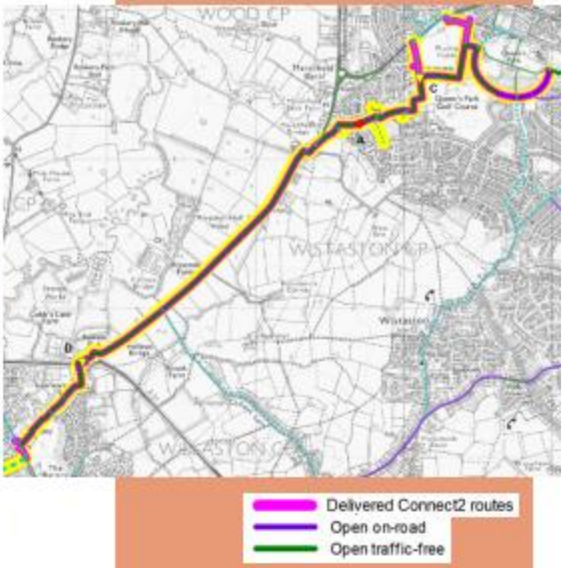
Traffic-free route connecting two Cheshire towns

Length 6.3km

Cost: £1,559,614

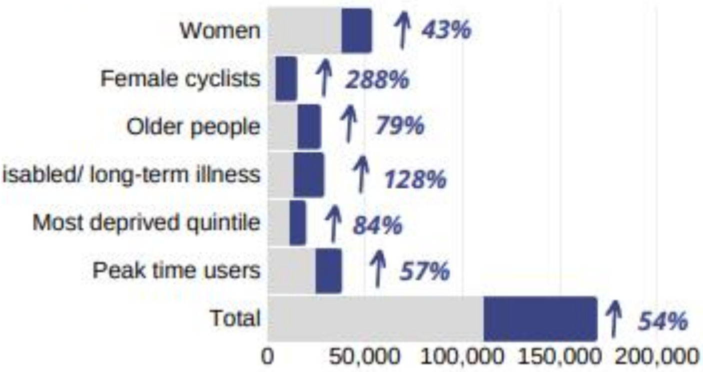
Population within 0.5 miles: 21,598

There are four miles between Nantwich, with substantial new residential development, and Crewe, a significant employment centre. However, the most direct route between the two towns was by a busy and dangerous main road therefore most people drove between the two.
A rural traffic-free route was built, set back from the road. It passes through residential areas, parks and open countryside and connects the two towns, including access to Crewe's railway station, schools, other amenities and greenspaces.
The work is enhanced by a series of small, town centre improvments in Crewe.

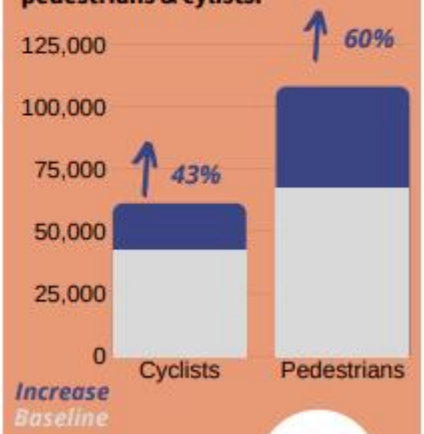


Local authority information:
Car ownership: 84%
Percentage cycling commuters: 3.0%
Potential for cycling: 17.8%
Least deprived quintile (Index of Multiple Deprivation)

Change in type of route user:



Change in estimated annual pedestrians & cylists:



Benefit cost ratio **4.0**

Figure 6.3: Case study example interview prompt sheet

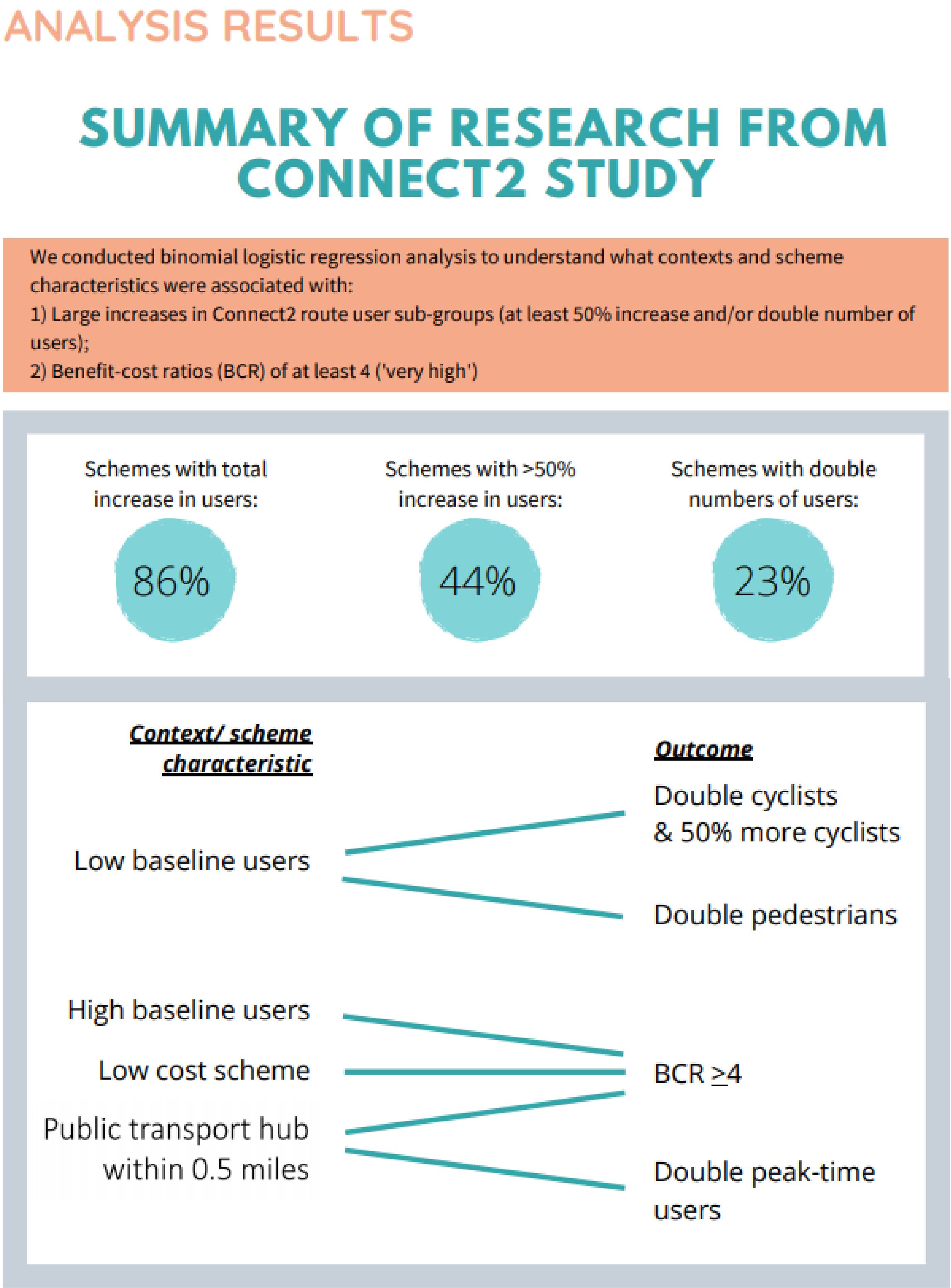


Figure 6.4: Connect2 results infographic interview prompt

6.2.5 Data collection

Qualitative semi-structured interviews were conducted, to allow for in-depth discussions about perceptions of context by stakeholders involved in decision-making for new walking and cycling infrastructure.

I firstly conducted a pilot interview (not recorded) with Oliver Mytton, a colleague familiar with the local authority context, in order to test the interview guide and case study example information sheets before I conducted the first interview. This helped to highlight where clarifications may be needed in explaining the information sheets. I also tested out the format of the interview using the interview prompts.

Where I had conducted a previous interview with a participant, I re-read the transcript of that in advance of the interview. This helped me to identify relevant issues that were previously discussed and could be elaborated on. Before each interview I also reviewed questionnaire feedback from the study development phase, where available, to identify how interested the participant was likely to be about the presented information.

I conducted each interview, either face to face, or via Zoom in March 2020. These took an average of 63 minutes each (range 55 – 75 minutes). The interview prompt sheets were sent to participants in advance and hard copies were also available for discussion in the face to face interviews. For interviews conducted via Zoom I screen-shared the prompt sheets with the participants. All interviews involved obtaining informed consent and were audio-recorded (for both face to face and Zoom interviews), then transcribed verbatim by a third-party transcription company which I then checked and anonymised. I also took notes during and after each interview to record any non-verbal issues which could inform my analysis. The interview guide is included in Appendix 6.E.

6.2.6 Analysis

I conducted thematic analysis [170], supported by qualitative analysis software NVivo 12 [172]. This involved line-by-line coding of all interview transcripts. Throughout the coding I kept a log of ideas and re-categorised the codes as I went to group them into a logical order, as well as merging or adding codes when necessary. Coding was based around the research questions but was also developed inductively to allow for emerging issues and concepts to be captured. A list of my codes is included in Appendix 6.F.

Following the initial coding and categorising stage I produced domain summaries for particular topics. This was initiated by producing an extensive Word document (about 18,000 words) outlining the issues raised in the data, including relevant quotes. I then produced mind maps of the issues identified in the data, grouping them around four core topics related to the research questions: Why good examples are lacking; Important contextual factors; Showing impact; and Impact on sub-groups (a copy of my mind maps are included in Appendix 6.G). From the mind maps I was able to produce more concise domain summaries, outlining basic findings, which Cornelia Guell read, alongside two anonymised interviews, to support discussion of higher order themes. After reviewing the data further, I developed my ideas for the themes as an iterative process involving discussion with Cornelia Guell and Louise Foley. This went beyond summarizing what was said in the interviews to gain deeper understanding about how context is considered, valued and used. Throughout the analysis stages I kept an ideas log to support the development of themes.

6.3 Results

I identified three main themes from the data in this study: using examples to provide believable stories; issues about politicised stories; and the challenges of demonstrating believable outcomes.

6.3.1 Believable stories

Case study examples could be used to provide stories to frame evidence that appeared 'believable' to decision-makers, as well as to the public, who might be sceptical of the need to build new walking and cycling infrastructure. These stories needed to be practical, preferably local, or with similar physical and socio-economic attributes and legal frameworks.

There was reportedly a general lack of monitoring of new walking and cycling routes which resulted in difficulty finding examples of routes in different contexts. This tended to result in famous locations being used to demonstrate new walking and cycling infrastructure, including international examples, such as Freiburg in Germany for pedestrian areas, and the Netherlands for cycling infrastructure. But whilst some interviewees talked about looking at examples from mainland Europe (the Netherlands, Denmark, Sweden and Germany), this was said to be met with scepticism by councillors because "people trust local, they trust what they know" (Private urban planner B07), and the ability to visit examples in person was thought to be useful. There were also concerns about legislative differences and the ability of international designs to pass safety audit requirements, as well as problems around being unable to blend in with existing environments.

> *"…because you've used case studies from the UK they're more likely to be persuasive in influencing the planning environment… Everyone knows about the Dutch and the German schemes but I think that we… know little about the impact of English schemes. So culturally I think they're probably more persuasive than saying, 'Hey look this is what they do in Germany and this is what they do in Holland.'" – Local government urban planner X02*

Furthermore, looking at best practice examples appeared less believable where the gap between best practice and the local situation was so wide that it was difficult to understand how the divide could be bridged. This was also said to be true of using England examples from places known to have an existing cycling culture, such as Cambridge or Bristol.

> *"…people say, "This isn't Cambridge, or this isn't Bristol. You know, we like our cars, we drive." And the amount of time I've sat in public consultations and had that thrown at me." – Private transport planner B10.*

Hilliness, ease of driving and car parking, and level of bus and taxi use were perceived as issues that could influence the relevance of examples because they affected the attractiveness of walking and cycling. Socio-economic demographics were also described as very important because level of affluence or deprivation could influence land values and therefore the amount of money a local authority was able to obtain from developers in Section 106 contributions, which could be used for walking and cycling infrastructure. It also influenced the amount of resources that a local authority may have to improve the quality of place-making.

> *"…so in [local authority area] and in [deprived region] you've got standard housebuilders, you're not getting world winning architects submitting schemes… For the most part you're getting an architectural technician doing it. [local authority area] doesn't have any on-site urban design advice... [Affluent local authority area] has a team of urban designers, landscape architects, conservation officers. They have the professional expertise... in the Council, to be able to push back against developers. [local authority area] doesn't have that." – Local government urban planner C04*

Deprived communities were also likely to have a stigma around cycling, reducing demand for cycling infrastructure. One councillor thought that manual workers might cycle for transport, but it would not be practical for other employees who "have to look nice" for work (Councillor C08). It also appeared that some decision-makers focused more on individual agency as barriers for walking and cycling, rather than the quality of the environment.

> *"So what do you do to make them move from that sort of fairly lazy lifestyle… It's difficult isn't it?... Because a bike to them's seen as well 'you're probably not very cool', you know, 'you're not, you're probably pretty poor'. Whereas if you're in [more affluent village]… cyclists are someone who's okay… It's a stigma, yeah, because people think you're poor, you know. You haven't got a car. You can't afford a car. In [more affluent village] it's a choice… And I suppose as politicians what do you gain from… giving people a multi-million pound cycle route when they don't want it?" – Councillor C08*

Pragmatic solutions, rather than best practice, may be favoured. For example, a developer talked about one of the case study examples which involved a path that was narrower than the minimum usually asked for by a local authority - they thought such an example could be useful in discussing specifications where the minimum standards appeared infeasible. Learning from poor local examples was also discussed, including developments built decades previously, as well as using recent examples to learn about delivery challenges, such as avoiding disjointed provision of cycling routes between parcels of land being developed by different housebuilders on a large site. However, it was pointed out that developers may choose not to look at examples, for instance if they were reluctant to change their housing model which included car-oriented developments that had historically sold well. Some councillors were also not persuaded that walking and cycling infrastructure was needed, such as in places where existing routes were not well used, or where it risked antagonising the car driving public who vote for them.

> *"…I'm thinking from a member perspective, that the push-back that you get for things around, you know, "Ah, well, that's alright there, isn't it, but it's not what people like in [local authority area]…" …They see their local population and then they're trying to think about, okay, well, actually, what's this going to equate to me in votes [laughs]? Does this then save my political seat going forwards? – Local government urban planner C04*

Clarity of purpose for case studies was said to be very important, so that it was clear why a route had been built, such as to tackle perceived safety issues, to improve connectivity, or for leisure. This could help to explain why walking and cycling infrastructure was being asked for, which was pointed out as potentially important for developers who might see it as "one of those nice-to-haves… not an essential" (Local government transport planner B08). One councillor thought that simpler, linear routes were easier to understand than more complicated networks.

> *"…just from my own impression, the simpler the better, so the ones that are basically straight lines… To me I think that, you know, without more information they would appeal more to me if I was trying to make the case, than the sort of bifurcated ones and indeed the network one…" – Councillor B04*

Although one urban planner thought that examples themselves were less important than good design principles because they would always be adapted to a local situation, others said that the overall research "tells a very powerful story", and an individual case study "brings it more alive" (Local government urban planner X02). These were thought to be very useful to show to sceptical members of the public who may not think that new walking and cycling infrastructure was necessary.

> *"Seeing the data will definitely help [people] to understand the impact and the benefits. Sell it as a benefit, which is what people want, it's like 'what's in it for me?' Yeah, that is the question. If you can answer that for people you will get them on board." – Councillor X05.*

Although there were features that appeared to increase the likelihood that stories were considered believable, ultimately these seemed dependent on individual judgement, rather than particular objective attributes.

6.3.2 Politicised stories

Apparently believable examples, which had similar physical or social contexts, could be explicitly politicised, therefore it appeared that judgements about believability were influenced by political ideology: local and national party politics, as well as international political issues, such as the withdrawal of the UK from the European Union ('Brexit').

Many of the interviewees discussed how political issues would influence whether an example was likely to be considered by councillors, who were described as 'tribal' (Local government transport planner B08). This was because they were reportedly less likely to consider an example from a local authority controlled by a different political party. Some interviewees said that this was particularly true of more controversial projects, which could include cycling infrastructure, but it was also discussed in relation to other transport programmes, such as congestion charging. This hostility between local authorities run by different political parties was also described as a problem between tiers of government which could influence infrastructure spending decisions - one councillor (B04) talked about a higher level of government "making life difficult" for the lower level local authority, which was run by another political party.

> *"…members are ultimately the ones that we have to try and convince of things... And sometimes, if they're seeing schemes that are, if you're in a Conservative-led council, and all the examples we're showing them are Labour councils, they will say no just on the principle of the fact that they're Labour councils." – Local government urban planner C04*

One councillor talked about Brexit as one reason why people were reluctant to look at examples from other European countries. They said that England examples would be more positively received because they avoided Eurosceptic concerns.

> *"…it's interesting that your examples are from England, because obviously we're regularly told, 'Oh well Copenhagen you know, look what they're doing in the Netherlands, and the proportion of people cycling is 40% or something, and so on', and now that tends not to work, but partly because of course Europe is a big no-no [with Brexit]…" – Councillor B04*

Interviewees said that generally there was not a lack of support for walking and cycling infrastructure, but that the funding was limited, and money was spent on other things, suggesting it was a political decision. Many of the interviewees asked about the sources of funds for the examples presented (e.g. from local authority funds, Section 106 developer contributions, or external funding bids) to pay for both the capital and on-going maintenance costs, as funding was often challenging to obtain.

> *"People do want to invest, they just haven't got the money and they have to prioritise other things… it's just central Government funding, local authorities have got so much pressure on them now to do so much more with less, that cycling and walking kind of fall off the radar because the people that are shouting the loudest*

> *are the people that have got the giant potholes outside their road, or, there's the adult and social funding budgets come from the same pot and there's always an overspend. So all those like nice projects that the Councils really want to do, they haven't then got funding for." – Local government urban planner C04*

6.3.3 Believable outcomes

When demonstrating the impact of stories, the presented outcomes needed to be believable. Different types of stakeholder were likely to be interested in different types of outcome and the method for measuring these outcomes needed to be widely accepted for them to be believable.

Transport decision-making that focussed on congestion and historic traffic count data struggled to include less tangible health impacts associated with new walking and cycling routes. There was a disparity between demand for 'watertight' evidence of impact from the development sector, that traditional transport modelling approaches claimed to provide, and the uncertainty of health impacts and benefit-cost ratios.

Some interviewees thought that benefit-cost ratios were useful for local authority decision-making (although not for developer contributions), and possibly that additional elements could also be included, such as economic benefits associated with improved connectivity.

> *"The [benefit-] cost ratio is really handy specifically where you're looking at trying to talk to members about them investing in terms of their capital programme. That is really good." – Local government urban planner C04*

However, there was also scepticism voiced by a councillor who did not think that benefit-cost ratios were believable "because they are difficult to prove" (Councillor C08).

Some interviewees said that the case studies and research summaries presented as interview prompts were useful as evidence to be used to influence local transport policies, to request developer contributions and to use in public consultations to demonstrate impact.

> *"[Local authority transport planner] has to fight, you know, tooth and nail to get money for the cycle and footpath infrastructure... By gathering this kind of data we're actually giving them the evidence to say that we're, you know, we're making our residents or our population healthier by creating environments that promote that, we're reducing car usage, you know, we're freeing up the roads, we're addressing air quality issues as well as, you know, obesity and other chronic lifestyle illnesses related to inactivity." – Local government urban planner X02*

However, interviewees were concerned about the ability of using this type information in planning applications. Transport assessments were instead based on travel data from the 2011 census, generally involving places that were designed to prioritise car driving over walking and cycling. This reportedly made it very difficult to model new developments that aimed for high levels of active travel, challenging the status quo of car-dominant environments to providing cycling share greater than 2011 levels (these were often around 2.5%). Where car traffic was predicted to rise a developer would be required to mitigate this impact by constructing new roads, which could facilitate the growth in car use. Number of vehicles, travel times and air quality were described by a private sector transport planner as "traditional metrics" but that health and wellbeing were issues that they were "wrestling with" because methods needed to be "transparent" and "watertight" to be able to stand up in court if a planning application went to appeal (Private transport planner B10).

> *"…if we're promoting the 3,000 houses and we have cited this [points to Connect2 example], which looks, on the face of it, as a really good proxy, there will be clever QCs who will be picking over all the evidence we're using and saying, "Well, you've cited the Nantwich example, which is fine, but actually we've dug into that and we feel there's, you know, flaws in the data," or whatever they might say. Suddenly the case kind of collapses. …we're in development planning and that's quite sort of antagonistic… So anything we put into a technical document that is citing evidence, you know, in theory, we need to be entirely comfortable that we can defend that." – Private transport planner B10*

Although health impacts associated with some user sub-groups were of interest to some interviewees, others questioned the likely health impacts of new routes, including a public health interviewee who was not confident that use would continue over time, particularly if maintenance was not done. An urban planning interviewee questioned whether the least active were likely to be gaining through use of the new routes. Potential impacts of other concurrent interventions, such as behaviour change interventions, were also queried by one interviewee, which they thought could affect user numbers.

For development planning decision-makers the type of user was not important, rather it was mode share that was valued as this could influence levels of traffic congestion which could be a planning constraint.

> *"…it's more about peak time users and it's ways of trying to get traffic off the road to facilitate your growth in houses and potentially your growth in jobs. And so therefore, it kind of matters less, you know, who is actually migrating off the road. It's more there is one less car on the road because we put this cycle link in and, therefore, it gives us some head room in which to grow into." – Private transport planner B10*

Data on relative changes appeared to be attractive to some local authority interviewees - some said that they wanted to increase use where baselines were low, particularly in rural areas; others that it provided a benchmark to demonstrate expected use levels since relative change could be used to translate findings from different locations. However, absolute numbers of users were discussed as influential for planning decisions which involved mitigating traffic impacts of new developments.

6.4 Discussion

6.4.1 Main findings of this study

I found that case study examples could be used as stories to frame evidence to influence people, but only if they appeared believable. What makes a story believable may depend on personal judgement of the audience.

The perceived relevance of a story's setting could be important - physical and socio-economic similarities may be necessary but not sufficient conditions, whilst local politics could be highly influential. Therefore, although examples from England were preferred to international settings, the local political make-up of councils may affect acceptability of examples from other local authority areas.

A believable plotline was needed, involving relevance of the problem being addressed and believability of the stated outcomes. This may be helped by using simple stories. Cautionary tales could also be used whereby lessons are learned from poor quality examples.

Transport assessment methods for new developments, based on historic traffic data, were widely accepted as believable outcomes or 'evidence', despite their biases and uncertainties. This made step changes in mode share challenging and it was difficult to incorporate health and wellbeing metrics which used calculations that were less likely to be believed by transport and urban planning audiences.

6.4.2 Discussion of findings

Contextual information about public health interventions is often limited or treated rather superficially [87,304]. This study has demonstrated its value to stakeholders, particularly in relation to the applicability of an intervention [303]. However, contextual features that appear relevant can be subjective, depending on the judgement of the audience [304].

In this study I have explored different elements of context, describing these within a storytelling analogy as the *setting* of a story, which can include physical, cultural, social, economic, historical, and political factors [87]. Whilst each element can influence whether a case study's setting is believable enough for it to appear relevant, the issues about political context identified in this study were particularly insightful. The importance of political support to enable creation of healthy environments is not a new concept [87,105,108,114,157,310], but I found that acceptable case study settings should be considered through party political lenses because political control of a local authority could be important when considering case study examples from other places, as well as being relevant for other political issues, such as about Brexit. This politicised context was therefore highlighted in relation to whether an intervention was likely to be conducted, because it could affect whether a positive story from elsewhere was believed, rather than necessarily affecting the transferability of interventions and their outcomes.

Using stories as tools for influence has been described in policy studies literature – Cairney and Oliver have described how policy-makers are likely to be influenced by emotions and it is important to recognise that decisions are value-driven [153]. This was also apparent in this study for decision-making for new walking and cycling infrastructure; however, Cairney and Oliver also say that policy-makers tend to base judgments on existing beliefs [153], whereas in this study it appeared that demonstrating the impact of new ALI on particular groups may help to tackle existing assumptions about the value of new walking and cycling routes.

It appeared that simpler stories could be preferred by some stakeholders, such as demonstrating impact from a linear walking and cycling route, rather than from a network of routes. Although the value of simple stories has previously been highlighted [153,311,312], evidence suggests that more connected walking and cycling networks may increase active travel [67,313–315], therefore there could be a tension between simple, believable stories and impactful outcomes.

Cycling infrastructure in particular European countries, such as the Netherlands, is often lauded as means to achieve high levels of cycling, but this study has demonstrated some reluctance to use examples from other countries where differences are very great, making examples appear unrealistic. Cycling proponents appeared more likely to believe positive stories across different contexts, whereas sceptics needed more similarities in terms of setting and plot for a believable story. This is important since international guidance, such as from the World Health Organization [33], tends to highlight best practice examples, whereas in fact it may be more appropriate for individual countries to depict their own pragmatic examples, to avoid legislative and ideological differences that restrict believability. The political ideological differences, which contributed to the limited acceptability of looking to examples from other countries, may have been particularly prominent in this study because stakeholders were from England, a country that has only recently left the European Union, and this reluctance to look to other European countries may be different in other places.

In complex, interdisciplinary interventions, such as the creation of new walking and cycling infrastructure, there appears to be a tension between traditional metrics that are short-term and easy to measure, such as traffic counts and air quality, and less tangible, long-term outcomes, such as population physical activity and prevalence of non-communicable diseases. The latter appears as less believable outcomes to actors in the urban development sector because they require methods that are not widely accepted. However, transport assessment methods that rely on potentially out-dated census data can result in self-fulfilling prophecies for road requirements (a criticism that has also been expressed within transport planning in other countries [316]).

The tension between short- and long-term outcomes can reduce political prioritisation of funding for interventions affecting the environmental determinants of health [34]. This suggests a need to emphasise the short-term outcomes of these multi-disciplinary interventions, such as congestion, mode share, and safety, but could also involve emphasis of impacts on particular target groups, such as older people. This could help to build emotional connections to a story for particular audiences, aligning with other research which has highlighted that policy-makers can make decisions based on emotions, rather than scientific evidence [153,227,311]. This could also help tackle a focus on individual agency as barriers to walking and cycling, and associated 'victim blaming' [317], whereby unhealthy behaviours are viewed as a choice, rather than associated with environmental factors. Connecting people through emotive issues associated with widely held values, such as fairness, is also recommended within 'health in all policies' guidance for local government [107]. However, I highlight that the transport sector is unlikely to consider the type of people who walk and cycle on new routes, which could inadvertently increase inequalities, for example if new walking and cycling routes are only provided in more affluent areas as commuter routes. Rather, to achieve greater public health benefits, convenient, safe and attractive routes for multiple purposes should be provided [97] to attract wider segments of society, including older people and those living in the most deprived areas.

In this study I found that aggregated data from multiple case studies were perceived as useful by stakeholders to demonstrate overall value of new walking and cycling interventions. This points to the value of conducting studies across multiple locations that can then be synthesised, as conducted in my quantitative study described in Chapter 5. Greater monitoring and evaluation could provide more examples from locations that are perceived to be physically, socio-economically, and politically acceptable. In the storytelling analogy greater access to case study examples across contexts can be considered as more books available in a library so that relevant stories can be found for a particular audience. Cautionary tales could also be included to learn from, although examples with negative outcomes could also be used to justify not investing in new ALI.

6.4.3 Strengths and limitations

This was a small study, following-on from my qualitative study described in Chapter 2. I tried to include a range of participants across different locations and from different disciplines, although I was unable to conduct repeat interviews with all participants due to resource constraints and loss of contact. As in the qualitative research methods of Chapters 2 and 3, I did not seek to identify generalisable findings, nor attempt to collect data for a notion of saturation, but rather to gain understanding of the topic under investigation, which is possible with a small sample [146].

This study was conducted in England with the specific context of Brexit. Although that is a unique situation, populism and divisive politics is a feature of many different settings at the present time. Conducting a similar study in other countries would be useful in understanding whether the reluctance to look to other countries for case study examples would be found elsewhere, including whether countries without a dominant two-party political system had similar 'tribal' tendencies when it came to local government decision-making. It could also be interesting to investigate whether political party representation impacts on quality of ALI and associated outcomes. This is discussed further in Section 7.4.5.

I produced the discussion aids from my evaluation of the Connect2 programme. This provided real examples for participants to engage with, to draw on their experiences and perceptions, which have been found to be useful in other studies [246]. However, had I used different examples then the findings may have differed. Whilst I did not emphasise my role in the Connect2 analysis to participants, it may be that people responded positively to them because they were familiar with me and therefore acted courteously, which may have influenced their responses. Having published the previous research which most of the participants were involved with (described in Chapter 2) [189], they may also have come with particular assumptions about what the research was about, which may have influenced discussions. As in the earlier qualitative studies described in Chapters 2 and 3, the active role of the researcher should be acknowledged[146]. Therefore I recognise that had this study been conducted by other researchers they may have developed different findings.

6.5 Chapter summary

This chapter describes my qualitative study of perceptions of contextual relevance for examples of walking and cycling infrastructure in England, using Connect2 case study examples and a summary of my analysis of the Connect2 programme (described in Chapter 5) in semi-structured interviews.

I used thematic analysis to identify three main themes: believable stories; politicised stories; and believable outcomes.

Case study examples could be used as believable stories to increase acceptability of building new walking and cycling routes by local people and decision-makers, although what makes a story believable can differ depending on the audience. Examples from England were generally preferred to those from abroad, particularly because of Eurosceptic attitudes which restricted emotional connections to international stories. Physical and socio-economic similarities could be necessary, but not sufficient, conditions for story settings to appear believable, whereas local party politics could affect acceptability of using examples from other local government areas. Clarity of purpose of individual examples was also important to define the plotline of a story. The need for 'watertight' calculations in transport assessments made it difficult to design for high levels of active travel in new developments or to incorporate health and wellbeing metrics, as these outcomes were less believable to some audiences.

Greater monitoring and evaluation of new walking and cycling infrastructure in similar physical, socio-economic and political contexts appeared necessary to demonstrate value, including impacts on less active groups such as older people and those living in deprived areas. This could increase the library of available stories and strengthen emotional engagement with believable stories for relevant audiences to facilitate investment in new walking and cycling infrastructure.

6.6 Contributions

My idea to conduct the study described in this chapter arose following my qualitative study described in Chapter 2, and my quantitative study described in Chapter 5, with support from Cornelia Guell and Louise Foley. I developed the interview prompt sheets, and wrote the ethics application, with assistance from Cornelia Guell, Louise Foley and Jennifer Furman. I conducted a pilot interview with Oliver Mytton to test the interview guide and prompt sheets. I recruited participants and conducted the interviews. Data transcription was done by a third-party transcription company, with data management support provided by Inge Loudon. I checked and anonymised the transcripts and conducted line by line coding, followed by thematic analysis, with critical feedback from Cornelia Guell and Louise Foley. I wrote the original paper of this study, which is closely aligned to this chapter, and at the time of writing is under review at Health & Place. This received critical feedback from Cornelia Guell, Louise Foley, David Ogilvie, Jenna Panter and James Woodcock. I presented some results from this research in an oral presentation at the Healthy City Design conference (online) in December 2020.

7. Discussion

7.1 Introduction

This final chapter describes the overall findings of my thesis, amalgamating learning described in the earlier project chapters as a mixed methods investigation of factors influencing decision-making for new active living infrastructure (ALI) in different contexts.

7.1.1 Chapter outline

In this chapter I summarise the key findings of the studies included in the earlier chapters (Chapters 2-6). I then discuss the overall findings of my thesis through interpretive integration of the data [140], focusing on three main themes that I identified: bridging the policy-practice gap; inequalities; and synthesising evaluations. I discuss future directions for public health and physical activity research and end the chapter with my own personal reflections and a final conclusion.

7.2 Summary of key findings

Below I summarise the key findings from each of my studies. These build on one another sequentially to develop the ideas in this thesis. An overall summary of key findings from each chapter is shown at the end of this section in Figure 7.1.

7.2.1 Decision-making for active living infrastructure in new communities: A qualitative study in England (Chapter 2)

In this qualitative study I aimed to understand the local level facilitators and challenges to creating ALI in England, including how evidence and data associated with the impacts of new walking and cycling infrastructure are valued by stakeholders. I found that public health practitioners in local government could act as knowledge brokers and leaders to motivate non-health stakeholders such as urban and transport planners to consider health when designing and building new communities. They needed to engage at the earliest stages and be adequately resourced to build relationships across sectors, supporting non-health outcomes such as tackling congestion, which often had greater political traction. I found that ‘evidence’ for decision-making may identify problems (going beyond health), inform solutions, and also be used to justify decisions post hoc, although case study examples, which may be used to demonstrate potential impacts of new walking and cycling infrastructure, were not always convincing if not considered contextually relevant. I developed a conceptual model with three factors needed to bridge the gap between evidence and ALI being built: influential public health practitioners; supportive policies in non-health sectors; and adequate resources.

The following key findings from this qualitative study were used to inform my quantitative study in Chapter 5 and final qualitative study in Chapter 6: more contextually relevant examples are needed; economic evaluations of new ALI may be useful in some situations, particularly to inform public sector investment in ALI, rather than private sector development; there can be a reluctance to invest in cycling infrastructure in areas with low perceived demand; mutually beneficial outcomes from ALI may be possible (assuming that increased use is associated with increased physical activity).

7.2.2 Challenges for creating active living infrastructure in a middle-income country: A qualitative study in Jamaica (Chapter 3)

In this qualitative study I aimed to understand facilitators and challenges to creating ALI in Jamaica. I found that new ALI was challenging to provide because it did not fit with widely held views of ‘development’ which focused on road construction, driving and economics, not walking, cycling or nature. Public open spaces were lacking, and the few high quality examples were expensive to maintain, deterring additional investment. Pedestrian infrastructure was poor quality and cycling infrastructure non-existent, making it dangerous for people to walk or cycle which particularly adversely affected people from deprived communities who may lack political voice. Silos in government limited collaboration and knowledge sharing between government departments - public health and urban planning missed opportunities as natural allies and public health practitioners did not actively engage in influencing environmental determinants of health, instead they prioritised individual behaviour change strategies to tackle physical inactivity. The problems and solutions related to ALI could be re-framed to emphasise economic impacts of new active living infrastructure, particularly new walking and cycling infrastructure, that go beyond tackling physical inactivity.

7.2.3 Understanding decision-making in different contexts for active living infrastructure: A synthesis of two case studies (Chapter 4)

I re-analysed my data from my England and Jamaica studies of Chapters 2 and 3 to obtain additional insights into decision-making for ALI, including how different types and sources of evidence and data associated with the impacts of new walking and cycling infrastructure may be valued by stakeholders. I was able to critique my conceptual model described in Chapter 2 and I identified the importance of both formal roles and informal networks in effectively influencing decision-making for ALI. This included identifying that public sector urban planners, not only public health practitioners, could act as ‘influential individuals’; however, both were only advisory which could limit impact. This synthesis also highlighted that short-term economic issues were prioritised over long-term health issues and ALI could be under-valued where quantity and quality were low. I therefore suggest that public support for ALI is also necessary to bridge the ‘evidence-output implementation gap’, described in Chapter 2, which could be aided by wider recognition of possible economic impacts associated with ALI.

7.2.4 A natural experimental study of new walking and cycling infrastructure across the UK: The Connect2 programme (Chapter 5)

In this quantitative study I aimed to understand how contextual features were associated with use and users of new walking and cycling infrastructure, using different methods (routine monitoring data and academic evaluations), and also the association between use and meeting guideline levels of physical activity, following on from my earlier qualitative studies’ findings. I found that new walking and cycling routes were associated with increased use and large relative increases in users were associated with low baseline levels of use. However, high baseline levels of users were associated with very high benefit-cost ratios. I also found that a public transport interchange within 0.5 miles of the new routes was associated with doubling peak time users and very high benefit-cost ratios. Some contextual features and route characteristics may influence use by certain sub-groups of users.

Use was associated with meeting physical activity guidelines in both repeat cross-sectional and longitudinal analyses. By using both repeat cross-sectional and longitudinal data sets I was able to show how these different methods could be valuable in understanding impacts of new walking and cycling infrastructure.

Results from this study and selected case study examples from the Connect2 programme, which demonstrated impacts on sub-groups of users for particular routes, were used in my final qualitative study of Chapter 6 as discussion prompts.

7.2.5 Understanding context for new walking and cycling routes (Chapter 6)

In this final qualitative study I used data from my Connect2 study in Chapter 5 to explore issues about perceptions of contextual relevance for stakeholders in England relating to decision-making for new walking and cycling route, including how different methods may be valued by stakeholders to demonstrate their impact. I found that data about the impacts of new walking and cycling infrastructure could be useful to demonstrate potential outcomes to sceptical audiences, including through increasing emotional engagement; however, this was only possible if the impacts were perceived as believable. There could be tensions from using traditional transport metrics involving historic traffic counts, and health and wellbeing metrics which are less widely accepted within transport evaluations.

Individual case study examples could be used as believable stories if physical and socio-economic conditions were similar, but alignment with partisan politics could also be important. England examples were preferred to international ones, particularly for Eurosceptic audiences; however, examples from places with high levels of cycling in the UK, such as Cambridge or Bristol, may not be believable in places with much lower levels of cycling. This suggests that good practice examples, rather than ‘best practice’, may be more usable.

The results from my five project chapters provide insights into the value of evidence, alongside other influential factors, such as the role of influential individuals, to share credible narratives and frame evidence to support the creation of new ALI. This is discussed further in the following sections.

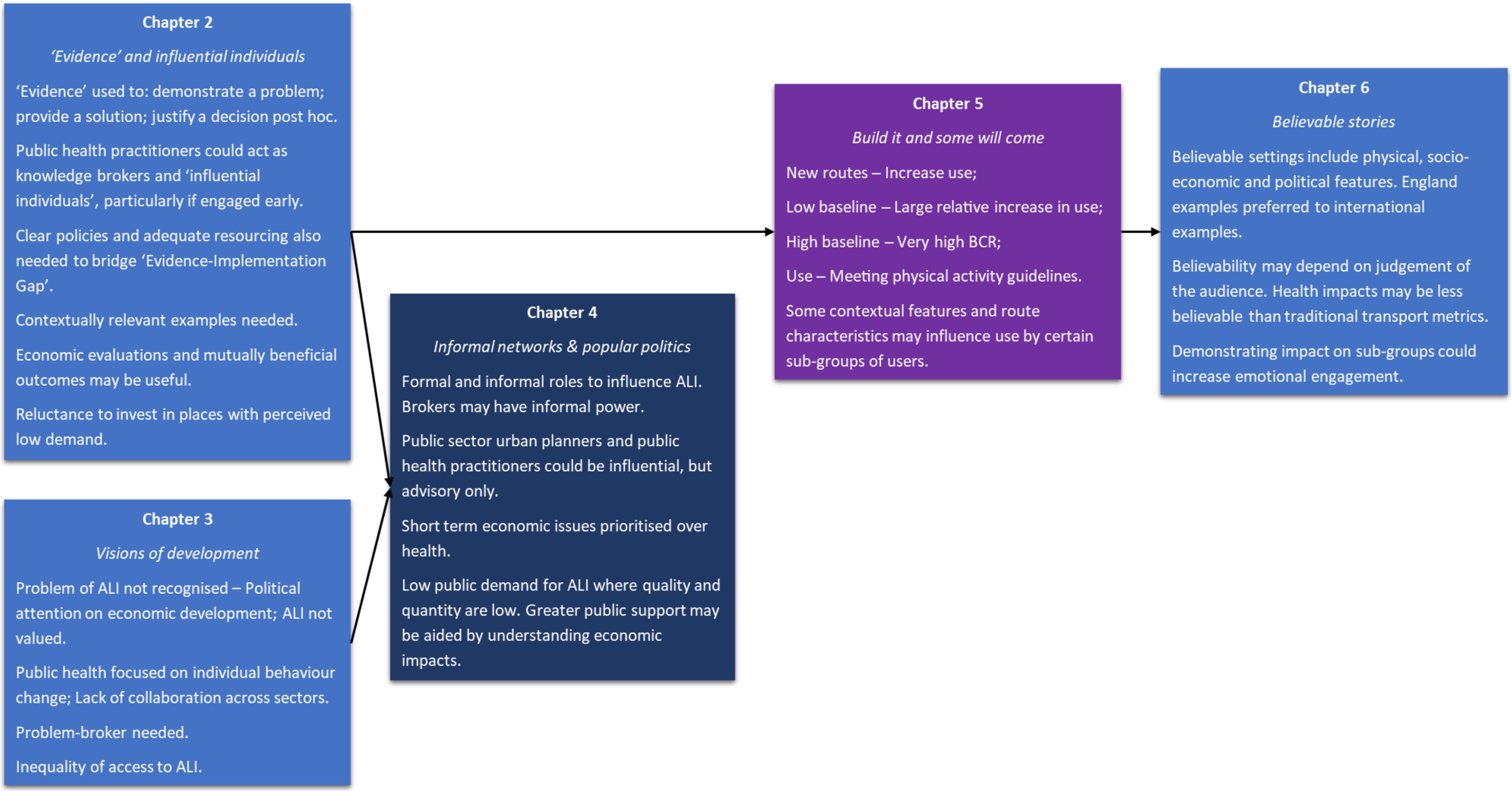


Figure 7.1: Summary of key findings

ALI: Active living infrastructure
BCR: Benefit-cost ratio

7.3 Discussion of findings

There are three main themes that I have identified that run through this mixed methods thesis. The first reflects on the practical public health issue of how to bridge the gap between policy and practice (‘The policy-practice gap’); the second considers the large and enduring public health challenge of inequality (‘Inequalities’); and the third discusses conducting and interpreting research about ALI (‘Synthesising evaluations’).

7.3.1 The policy-practice gap

Despite policies generally being supportive of ALI, in practice ALI is often not built, or of a low quality. This points to a mismatch between vision and action.

In Chapter 2 I discussed the ‘evidence-output implementation gap’, suggesting that a supportive policy environment was one of the elements necessary to bridge the implementation gap. ‘Top-down’ policy theorists Sabatier and Mazmanian outlined six necessary and sufficient conditions for effective policy implementation [179,185], that follow a largely linear, rational perspective, whilst Hogwood and Gunn defined ten pre-conditions to explain why ‘perfect implementation’ does not occur [179,186]. As shown in Table 7.1 and Table 7.2, many of these conditions were not normally met with ALI in the studies included in this thesis, which goes some way to explain the gap between policy and practice. This aligns with policy theory that recognises the limitations of a ‘top-down’ approach to policy implementation [179] which may assume that high-level published policies can be implemented as intended. It appeared that policies associated with ALI tended to be vague with inconsistent objectives.

The ‘top-down’ perspective inadequately recognises the importance of individual actors, which was identified within my qualitative studies, although limited resources and lack of formal positions to influence ALI were also issues. Stakeholders’ lack of belief in the causal theory was also identified as a factor that limited construction of ALI – although the association between physical activity and health was undisputed, some stakeholders in my qualitative studies did not prioritise ALI as a means of increasing levels of physical activity.

A lack of evaluations across different contexts may make it more challenging to demonstrate impact to decision-makers, although my quantitative study in Chapter 5 tackled this issue, demonstrating associations between construction of walking and cycling routes and physical activity. The planning systems in the study areas of this thesis were discretionary, with policies that were often vague, allowing interpretation and a ‘bottom-up’ approach to policy development. I described public sector urban planners as ‘street-level bureaucrats’ because of their potential to interpret policy and influence practice. However, lack of resources, siloed working between disciplines and the advisory nature of public sector urban planners and public health practitioners appear to limit opportunities to ensure active, healthy environments are created.

Table 7.1: Summary of evaluation of ALI relating to conditions for 'perfect implementation' of policy using Sabatier and Mazmanian's conditions [185]

Sabatier and Mazmanian's condition [185]	**Thesis findings that explain the gap between policy and practice**	**Cross-reference to relevant results section**
Clear and logically consistent objectives	Some inconsistency between policies supporting ALI, promotion of housebuilding (quantity over quality) and transport assessment prioritising roads. Policies relating to ALI tend to be vague.	2.3.3.1 Limited by policies 3.3.1.1 Political focus on economic growth: jobs and housing 3.3.3.2 Explicit policies and enforcement 6.3.3 Believable outcomes
Adequate causal theory	Although there is evidence of associations between ALI and physical activity and health benefits, these may not be prioritised by decision-makers.	2.3.1.1 Evidence of a problem – needs assessment beyond health 2.3.2.1 Limitations of evidence 3.3.2.1 Behaviour change focus of public health 3.3.3.1 Evidence and influence 5.3.4 Use and meeting physical activity guidelines 6.3.1 Believable stories 6.3.3 Believable outcomes
Implementation process structured to enhance compliance by implementers	Lack of enforcement of policies. Discretionary planning system allows negotiations that may compromise quantity and quality of ALI.	2.3.1.1 Evidence of a problem – needs assessment beyond health 2.3.3.2 Watering down good designs 3.3.3.2 Explicit policies and enforcement 4.3.1.2 Not walking the talk
Committed, skilful implementing officials	Public health practitioners dedicated to urban development and informed public sector urban planners may influence designs if provided with adequate resources (combination of formal and informal roles). However, these roles are likely advisory only.	2.3.2.2 Influential individuals 3.3.2.2 Visionary urban planners 4.3.1.1 Advising versus designing 4.3.1.3 Reliance on informal networks
Support from interest groups and legislature	Cycling groups likely to support improved cycling infrastructure, but areas with low existing demand may not have these. Low income areas may stigmatise walking and cycling. Economic issues may garner greater public and political support than health-related issues (e.g. housebuilding and job creation). The national policy environment prioritises quantity of housebuilding over quality of place.	2.3.3.1 Limited by policies 3.3.1.1 Political focus on economic growth: jobs and housing 3.3.1.4 Lack of public voice and inequality of access to quality ALI 4.3.2 Values and popular politics 6.3.1 Believable stories 6.3.2 Politicised stories

No changes to socioeconomic conditions	Largely constant during period of research.	N/A

Table 7.2: Summary of evaluation of ALI relating to conditions for 'perfect implementation' of policy using Hogwood and Gunn's conditions [186]

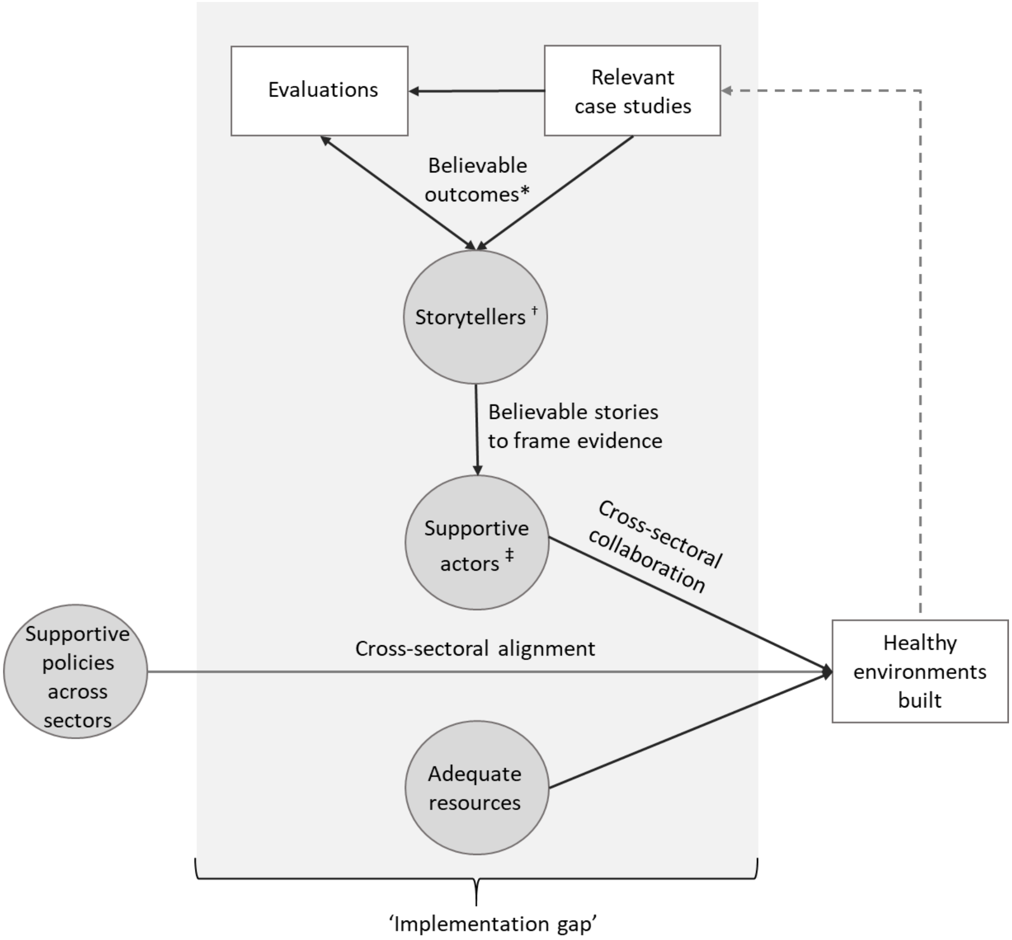
<table>
<tr><th>Hogwood and Gunn's condition [186]</th><th>Thesis findings that explain the gap between policy and practice</th><th>Cross-reference to relevant results section</th></tr>
<tr><td>External circumstances do not impose crippling constraints</td><td>Some conflicting pressures between ALI, housebuilding and roads.</td><td>2.3.3.1 Limited by policies
3.3.1.1 Political focus on economic growth: jobs and housing
3.3.3.2 Explicit policies and enforcement
6.3.3 Believable outcomes</td></tr>
<tr><td>Adequate time and sufficient resources available</td><td rowspan="2">Limited time and resources in the public sector to influence developers' designs.
Lack of resources for maintenance.
Lack of time for collaboration and learning between sectors.</td><td rowspan="2">2.3.3.3 Not enough resources
3.3.1.2 Green spaces under-valued
4.3.1.3 Reliance on informal networks
4.3.2.3 Low value and high price for open spaces</td></tr>
<tr><td>Required combination of resources available</td></tr>
<tr><td>Policy based on valid theory of cause and effect</td><td>Although there is some evidence of associations between ALI and physical activity and health benefits, these may not be prioritised by decision-makers.</td><td rowspan="2">2.3.1.1 Evidence of a problem – needs assessment beyond health
2.3.2.1 Limitations of evidence
3.3.2.1 Behaviour change focus of public health
3.3.3.1 Evidence and influence
5.3.4 Use and meeting physical activity guidelines
6.3.1 Believable stories
6.3.3 Believable outcomes</td></tr>
<tr><td>Relationship between cause and effect is direct</td><td>Health benefits of ALI are only seen in the long-term and therefore a direct link may not be apparent to decision-makers.</td></tr>
<tr><td>Dependency relationships are minimal (policy-makers are not reliant on groups or organisations which are themselves inter-dependent)</td><td>Multiple stakeholders from different sectors are involved in decision-making for ALI.</td><td>2.3.2.3 The value of early involvement
2.3.3.2 Watering down good designs
3.3.3.1 Evidence and influence
3.3.3.3 International influence
4.3.1.3 Reliance on informal networks</td></tr>
<tr><td>Understanding of, and agreement on, objectives</td><td>There is a lack of clarity over ALI specifications and no national minimum standards.
Quantity may be prioritised over quality.
The need for building ALI may not be recognised.</td><td>2.3.3.1 Limited by policies
2.3.3.2 Watering down good designs
3.3.3.2 Explicit policies and enforcement
4.3.2 Values and popular politics</td></tr>
</table>

Tasks are fully specified and in the correct sequence	Whilst there are formal protocols to follow for planning applications, informal processes can be influential, such as early engagement during pre-planning application stage, which is less clearly defined.	2.3.2.3 The value of early involvement 2.3.2.2 Influential individuals 4.3.1.3 Reliance on informal networks
Communication and coordination are perfect	Communication and coordination between sectors may be challenging, although this may be supported by influential individuals.	2.3.2.2 Influential individuals 3.3.3.1 Evidence and influence 4.3.1.3 Reliance on informal networks
Those in authority can demand and obtain perfect compliance	Local policies can outline requirements; however, discretionary planning systems allow negotiation between local authorities and developers. Informal networks can be important.	2.3.2.2 Influential individuals 3.3.3.1 Evidence and influence 4.3.1.3 Reliance on informal networks

As explained above, there are multiple obstacles to bridging the policy-practice gap to create ALI. Whilst supportive policies may be necessary, they are far from sufficient. Alongside clear national and local policies and adequate resourcing, the 'evidence-output implementation gap' that I described in Chapter 2 also highlights the importance of influential individuals. In Chapter2 I suggest that this could be public health practitioners with a dedicated urban planning role, but I expand on this in Chapter 4 and suggest that others can also have formal and informal power for influencing ALI design and construction.

Combining my findings from across my studies I now present a potential conceptual model in Figure 7.2 of the 'policy-practice implementation gap' where the elements in the grey box are identified as necessary (although not always sufficient) to enable policy to be implemented in practice - without the items in the grey box I suggest that there would be an implementation gap between policy and practice. This builds on my conceptual model of Figure 2.2 in Chapter 2, re-framing it to focus on the gap between policy and practice to help explain the challenges of creating ALI where supportive policies are generally in place and yet ALI is often not built. The conceptual model is a simplification of what is undoubtedly a complex problem, but I have chosen to describe it in this way to help explain the main findings of this thesis.

The following sections examine elements of this model in more detail, expanding on issues about contextual relevance for case study examples and believable stories that I discussed in Chapter 6, to suggest ways to build support for ALI that could help to create it in practice.



* 'Believable outcomes' are data or evidence that are valued by particular stakeholders, or audiences, that demonstrate certain impacts of ALI. See section 7.3.1.1.
† 'Storytellers' are influential brokers who can identify appropriate evidence to demonstrate impact of ALI to particular audiences. They provide a credible narrative to frame evidence and explain a believable story. See section 7.3.1.2.
‡ 'Supportive actors' are stakeholders who use the evidence, or stories, to support the development of ALI. See section 7.3.1.3.

Figure 7.2: Policy-practice implementation gap

7.3.1.1 Believable outcomes

In Chapter 2 I discussed how evidence, information and data could be used to identify problems, provide solutions to problems and justify problems post hoc. Through this thesis I have found that use of evidence has further complexities, in that it must be believable for particular audiences to be usable, and therefore I included the need for 'believable outcomes' within my conceptual model shown in Figure 7.2.

Research often refers to internal validity, as the trustworthiness of cause and effect relationships, and external validity, as results being meaningful to other contexts. Whilst both may be useful to inform decision-making for investment in ALI, the limited number of high quality evaluations of ALI, which typically require natural experimental designs, can make it challenging to demonstrate cause and effect across contexts and therefore provide believable outcomes to decision-makers. Figure 7.2 includes a dotted line from ‘Active living infrastructure built’ to 'Relevant case studies’ to point to the need for more monitoring and evaluation. I earlier discussed this issue of providing believable outcomes in terms of transferability of findings (being able to show benefits for other contexts) and applicability of findings (being able to implement an intervention in other places) [303]. These are intrinsically linked, since demonstrating believable outcomes may influence the willingness of decision-makers to implement ALI in other contexts.

In my study described in Chapter 6, I found that it was difficult to incorporate health and wellbeing metrics into evaluations of transport appraisals because people unfamiliar with population health intervention evaluations may under-value these broader impacts for society and instead emphasise easy to measure, short-term impacts such as journey time travelled [274]. Whilst the greatest health gains (and associated health economic gains) are likely where increases in physical activity are achieved by limited mobility populations [1,52], this is difficult to capture in evaluations, particularly in basic traffic monitoring techniques, such as counts of users (and often not even this is achieved), reducing believability of evaluated health impacts. Concerns about inadequate controlling for confounders in natural experiments of ALI have also been raised in the literature [318].

Benefit-cost ratios may demonstrate benefits of ALI, but my qualitative studies identified a lack of believability of the monetisation of health and wellbeing benefits used within benefit-cost ratio calculations. If they are not understood, or do not appear relevant, to decision-makers (which seems particularly true for new developments where the total cost is more relevant in negotiations with developers, and long-term benefits to health services are far removed from short-term infrastructure budgets) then the benefit-cost ratios involving these are unlikely to hold much weight. Furthermore, a lack of consideration of maintenance costs within such calculations [129], which is likely to be a concern for local governments with limited funds, make them even more challenging to be used.

Evaluations need to be accepted as robust enough to compete with other commonly used metrics. Highlighting the multiple positive outcomes associated with ALI, which go beyond physical activity, could support this. These include impacts on safety, air quality, congestion, wellbeing, noise, biodiversity, climate change, heat islands, house prices, and local businesses. Economic evaluations for these issues are currently limited, with some economic evaluations of ALI focusing only on single dimensions of benefit, such as health or environmental outcomes, which may lead to an under-estimation of the economic impacts of ALI [131]. Improved methods incorporating multiple measures could help to demonstrate impacts across different sectors by turning impacts into monetary values which allow comparison across sectors. This could tackle the narrow range of benefits traditionally included in transport appraisals, which can over-value time savings, without adequate inclusion of health and wellbeing impacts. An example of a broader economic evaluation was recently conducted by Hunter et al. for an urban greenway [294]. By evaluating the social return on investment with multiple externalities (land and property values, flood alleviation, tourism, labour employment and productivity, quality of place, climate change and health), they found benefit-cost ratio estimates ranged from 2.9 to 5.8.

7.3.1.2 Believable stories

As discussed in my qualitative studies, different types of evidence, information and data are used by different types of stakeholder [106,108,111,319,320], and the different perspectives on what constitutes 'evidence' may limit collaboration between sectors [109]. However, in this thesis I demonstrate the value that local level decision-makers appear to place on case study examples of new ALI to demonstrate impact, if they appear relevant and believable. This could be particularly useful in areas where ambitious plans differ greatly from the status quo and change is not believed to be possible. For example, in low cycling areas there appeared to be a lot of scepticism that it was worth investing in cycling infrastructure because there was no perceived demand for cycling. However, my analysis of new walking and cycling routes in the Connect2 programme demonstrated that large relative increases in users were associated with low baseline levels of walking and cycling. The use of contextually relevant case study examples could help to combat the myth that ALI is not needed and facilitate political bravery to act in the face of vocal public resistance. Examples perceived as relevant, particularly local ones, could also be used to directly target members of the public to increase level of support for ALI, such as during public consultations for new schemes. I also found that showing people the impact on particular sub-groups of users, such as older people, may help to sell the benefits to a sceptical public, thereby breaking the vicious cycle of apparent low demand and low supply. This could increase emotional connection to a story, which has been identified as important in policy-making [153], and may also influence the wider public, which appeared necessary to induce political support for ALI.

Use of evidence to justify decisions post hoc was discussed in Chapter 2, with some stakeholders selectively using positive messaging about ALI to support justification for it. This includes acknowledgement of health benefits from walking and cycling by transport planners within a business case to support a pedestrian or cycling scheme, even though the primary aim may be to tackle congestion. Developers could also use health evidence to justify not spending money on expensive road building schemes which could impact on profits. My first qualitative study also suggested that some master developers on very large development sites justified spending on greenspaces to investors by using research about potential impact on house prices [175].

I focused on case study examples for new walking and cycling infrastructure in this thesis, which were more commonly sought and used than examples for open space design, perhaps because open spaces are less controversial and are often defined by quantity specifications. In contrast, cycling infrastructure was often viewed as difficult to achieve (particularly in places with low levels of cycling) and there were groups who tried to use examples from other countries with higher quality cycling infrastructure to demonstrate possibilities for change. However, it appeared that this approach may not be successful as people needed believable stories from places that they could relate to. Although local examples were valued, proximity was not the sole characteristic of relevance – as discussed in Chapter 6, physical and social features were also important, including the level of affluence/deprivation, but it was whether local political ideology aligned with the case under examination that was also a key influence for whether it was seen as contextually relevant to local politicians. Research into perceptions of applicability and transferability for public health interventions in Ghana found that proximity was discussed in abstract terms, but when specific case study examples were examined in a ranking exercise proximity did not appear influential [246]. This aligns with my findings that ideology is likely to influence perceptions of relevance, with political challenges of creating healthy environments having been raised in other research [105]. But once decisions have been made to create new ALI, the proximity of case study examples used to inform tangible design issues may be less relevant.

7.3.1.3 Building support

Reasons for the gap between policy and practice appeared to relate to power differences between stakeholders who had differing priorities, and whether roles were either advisory or involved actual infrastructure design. Influencing attitudes of practitioners, politicians and the general public all appeared necessary to increase support for ALI and I have discussed the involvement of brokers for this.

Whilst in Chapter 2 I discussed the value of public health practitioners engaging with urban planners, having dedicated roles for this is far from ubiquitous and it appears that public health departments in many places should engage more with tackling the environmental determinants of health. Clearer understanding of the cost effectiveness of environmental interventions, compared to individual behaviour change programmes, could help to influence public health strategies for increasing population levels of physical activity. Systematic reviews have found that individual behaviour change programmes are less cost effective than environmental-level interventions, such as provision of ALI, making them unscalable at a population level [25,321] (although few environmental physical activity interventions are included in these types of review, and there is little explicit consideration of context). Behaviour change strategies also do not tackle structural issues that are likely to influence long-term behaviours [322]. Therefore, there appears to be scope for increased focus on demonstrating the cost effectiveness of environmental interventions to shift the focus within public health departments. This could combine multiple health-related issues including air quality, safety and physical activity.

Re-framing the problem of lack of ALI appears necessary to influence wider societal perceptions about the value of ALI. Often physical inactivity is described as a 'lifestyle' disease, which tends to shift responsibility away from environments and onto individuals. It can also lead to 'victim blaming' [317] whereby unhealthy lifestyles are viewed as a choice, despite factors being present that are beyond the control of individuals, such as the environment in which one lives and works. This concept has also been described as 'healthism' [323]. This perspective justifies a focus on behaviour change interventions such as health education campaigns, or individual behaviour change programmes. Problem-brokers could help to re-frame responsibility for population health to highlight the need to tackle the environmental determinants of health [34], and this could be done to influence the general public, not only health and non-health sector professionals. This change of policy direction was followed by Sport England in 2016 with a focus on tackling inactivity through active environments, not just through sporting activities [324].

Decision-making for ALI is led by non-health sector actors, therefore greater cross-sectional working with emphasis on multi-sectoral benefits of ALI, including economic impacts, could help to encourage non-health sector professionals to value ALI. My evaluation in Chapter 5 demonstrated that new walking and cycling routes were associated with large increases in people walking and cycling during peak hours, particularly when near to a public transport interchange. This type of information could be used to build and support collaborations between sectors. Policies across sectors also need to be more aligned to avoid undermining aspirations for healthy environments. Bringing together actors from across sectors to support one another aligns with concepts from the advocacy coalition framework [183] whereby groups with shared sets of beliefs can aid one another. However, I acknowledge that disparate groups may follow different approaches to the use of evidence, and have different access to resources, which can influence their ability to work together – they may be more likely to hold shared sets of interests rather than beliefs, as discussed in Chapter 3, which could limit their ability to collaborate.

In my conceptual model shown in Figure 2.2 in Chapter 2, I highlighted the importance of the 'influential individual', suggesting this role could be taken by a public health practitioner with a dedicated urban planning role to inspire non-health colleagues to support creation of ALI. In my conceptual model in Figure 7.2 I propose an expanded role, divided into two parts: storytellers and supportive actors. The storyteller is a type of broker - a combination of Knaggard's problem-broker role [227] to highlight and promote problems associated with a lack of ALI, Kingdon's knowledge broker role [148] to share solutions, and as a storyteller to share believable stories, understanding applicable and transferable examples for particular audiences. Creating powerful narratives to appeal to decision-makers' emotions and values has been advocated since purely rational, evidence-based decision-making is unlikely to occur [153,325,326]. This is said to be particularly necessary where stakeholders need persuading of the need for change, to overcome scepticism and reluctance for reform [327], as is often apparent for active travel interventions such as transfer of road space from cars to cycling infrastructure. It has previously been identified that urban development policy in the UK has been influenced by both evidence and ideological factors [328].

The use of narratives has been identified in the 'grey' literature as important to activists and advocates within social movements[326]. The use of audience segmentation for targeted messaging has been used in different sectors, such as in climate change advocacy [329], and there appears to be similarities with 'story-telling' described by Hajer in relation to environmental policy [330]. The importance of 'narratives' has also been described by Stevens in an ethnographic study of policy-making [320]. This storytelling role can be formal as well as informal to frame problems associated with a lack of ALI and provide believable solutions to influence public and political views about ALI. It may be taken by a public health practitioner but could also be achieved by public sector urban planners, or by stakeholders from other sectors – as discussed in Chapter 3 gaining allies from civil society may also be beneficial to influence attitudes towards ALI. Therefore it appears that providing believable stories for supportive actors could help to tackle the power of hostile actors. However, I recognise that this can be challenging, for example to tackle vocal opposition to low traffic neighbourhoods [331,332]. It is also acknowledged that individuals are unlikely to advocate for change that their colleagues may find unacceptable as it can impact on career progression [320], making dramatic change less likely.

A broker can also act as a link to academia to support co-production of research in this area to improve relevance and impact [87,114], so that believable outcomes are developed for appropriate audiences. This follows recommendations from policy researchers, such as Cairney and Kwiatkowski, who discuss the need for “suppliers of evidence to see the world from the perspective of their audience” [311].

Weiss’ enlightenment concept also appears relevant, particularly where informal networks may play a role in influencing attitudes where change can be slow as it can require changes to strongly held norms and values [118]. This can also relate to Lukes’ concept of ‘power as thought control’ [258] which can point to informal power to shift societal norms and values about ALI over time. A storyteller could help to speed up this process by sharing believable stories to influence these norms and values. However, ‘insiders’ [179] may be needed to gain access to certain audiences. Multiple types of storyteller or broker may therefore be required to influence different audiences to demonstrate the value of ALI to public and private sector practitioners, politicians and the public.

Relying on informal networks to influence decision-making for ALI can be challenging if they are contingent on individual attitudes and personalities. The sociologist Weber discussed different types of authority for leadership: rational-bureaucratic, traditional and charismatic authority [184]. Rational-bureaucratic authority may be easier to create through the adoption of formal roles and processes, whereas there are difficulties in creating routinisation of charisma. Charismatic leadership may also be seen in celebrities, supported by the media, as was the case with Jamie Oliver when he tackled food environments in schools – as described by one GP writing in The British Medical Journal, “Jamie Oliver has done more for the public health of our children than a corduroy army of health promotion workers or a £100m Saatchi & Saatchi campaign” [333]. When considering a celebrity to advocate for ALI it may be assumed that someone from the sporting world is a natural choice, and cyclists such as Chris Boardman have been vocal in campaigns to improve cycling infrastructure. However, there is also a risk of alienating audiences by turning everyday transport and leisure choices into sports issues.

7.3.1.4 Resources

Limited resources for ALI can be perceived as a political issue, particularly for walking and cycling routes as transport budgets that focus on road construction may not include safe walking and cycling infrastructure. This was particularly prominent in my Jamaica study in Chapter 3 where I discussed a lack of value for ALI compared to perceptions of economic development associated with road construction.

Although it is possible to make streets more walkable or cyclable through low-cost interventions, such as filtered permeability by installing barriers, often new ALI requires large sums of money – it can cost millions of pounds to provide a new bridge to connect communities, for example, as seen in the Connect2 programme in Chapter 5. This type of infrastructure provision requires much larger sums of money than other place-based public health interventions, such as tackling the number and location of hot food takeaways to impact on obesity levels. It may be that for some of the Connect2 routes the costs were justified on political grounds, with symbolic meaning of new landmark bridges connecting otherwise divided communities, such as the scheme in Derry, Northern Ireland.

A lack of funds for monitoring can add to the problem of a lack of available contextually relevant case study examples to demonstrate impact. Lack of resources can also be a problem for maintenance [149,334], particularly for open spaces which could lead to a spiral of decline and ultimate loss. There is no simple solution to the maintenance liability of creating new ALI, although I suggest that increasing its perceived value through building support could make it more politically possible to allocate budgets for maintenance, and support a virtuous spiral of quality and use.

In my qualitative study in Chapter 2 I found criticism of policies that had reduced funding for monitoring of ALI, such as public rights of way. Lack of resources made it much more difficult to demonstrate investment needs, potentially leading to reduced maintenance budgets and deterioration of quality. Without political commitment to *quality* ALI, not just *quantity*, low quality or disjointed sections of infrastructure could be available that may not be fit for purpose, being unattractive or inconvenient for users [97], and therefore less likely to be used. This could result in loss of ALI, as space- and resource-intensive ALI, such as open spaces, could be built on. A lack of enforcement of regulations may also be a problem, such as where developers do not provide adequate open spaces and in both England and Jamaica I witnessed accusations of corruption, which may be unsurprising where high profits can be achieved in the urban development sector. Other problems for public sector urban planners in England include difficulties in recruitment, high workloads and inequality of resources across regions to ensure high quality place-making [104].

7.3.1.5 Facades of 'evidence'

In sections 7.3.1.1 – 7.3.1.4 I suggest ways to build support for ALI that could help to create it in practice through ensuring impacts are believable to relevant audiences in the form of believable stories. In this section I outline challenges to this relating to selective use of data or 'evidence' that may impact on provision of quality ALI.

The metrics used to evaluate interventions can affect the political messaging associated with them. For example, only measuring quantity of cycling infrastructure may not consider its quality, actual use, or types of users, which could affect inequality, as discussed earlier. This has been seen with other public health issues too. For example, the introduction of regulations limiting advertising of unhealthy food to children claimed to be successful in 2010 [335]. However, independent evaluation found that it actually led to an increase in unhealthy food advertising overall [336].

In Chapter 6, I discussed how transport assessments for new developments often utilise traffic numbers from the 2011 census, which could limit opportunity to design infrastructure for higher proportions of active travel than that which occurred in 2011. Reliance on these widely accepted metrics, despite apparent lack of reliability, whilst dismissing health and wellbeing metrics as appearing unreliable, is an example of a facade of rigorous evaluation which in fact only considers limited elements of potential impact. Believability of evaluations could explain why certain types of data are chosen that support the dominant view, which could go some way to explaining why transport appraisals focus on traffic flows in a society that prioritises private car travel, whereas health and wellbeing metrics are rarely included.

The mechanisms for appealing against urban planning decisions, involving the National Planning Inspectorate, could also be questionable in their use of evidence. This was found in a recent study by O'Malley et al. whereby planning inspectors appeared to use minimal evidence to support associations between food environments and health outcomes, with the authors stating that "there is no robust evidence to support the assertions made by the inspectors" [337]. Therefore, although the appeals system is meant to be based on evidence as a quasi-legal procedure, decisions are based on professional judgement which may result in evidence that supports existing world views of individual planning inspectors being more influential [115,338]. This is likely to reflect a lack of understanding about health evidence in the urban planning sector, which differs from the type of 'evidence' typically used in decision-making [106,337]. This is demonstrated in a recent recruitment advertisement for planning inspectors that did not specify any requirement for knowledge or experience about the health impacts of developments [339].

Individual case study examples were valued by stakeholders in my qualitative studies. Although these are unlikely to be described as scientific evidence within academic public health spheres, they are likely to be perceived as 'evidence' by other stakeholders involved in decision-making for ALI. This use of examples can provide simple stories to justify complex interventions. If academia plays a role in knowledge brokering, either through direct communication with policy-makers and practitioners or via intermediaries, as is often promoted [111,126,180], then sharing these types of examples could be of value. However, promoting individual case study examples as 'evidence' by advocates of ALI risks accusations of cherry-picking, and opponents could just as easily select unsuccessful schemes to refute arguments to invest in ALI.

7.3.2 Inequalities

Tackling the upstream determinants of health through changing the built environment may have more equitable outcomes than behaviour change interventions that depend on individual agency [128,340,341]. However, unequal access to ALI may impact on health inequalities and this was an issue discussed in my qualitative studies and investigated in my quantitative analysis. Policy-makers in low-income areas appeared more likely to rely on individual agency rather than promoting environmental change; and a reliance on market forces to create new ALI appeared likely to lead to creation of more ALI in high-income areas where house prices were greater. This may help to explain the existing inequality of access to green spaces associated with deprivation [342].

7.3.2.1 Agency

Health evidence associating physical inactivity and risk of disease is widely accepted [1,9,12], and stakeholders in my studies tended to broadly understand this, but there was no consensus about how population physical activity levels should be increased. In more deprived areas, where ALI was more limited, decision-makers appeared more inclined to focus on individual agency as barriers for walking and cycling, whereas in more affluent areas, where stigma of walking and cycling was not apparent, the quality of the environment was more highly valued. This appears to risk perpetuating, or even widening, inequalities if decision-makers in more affluent areas are more likely to invest in ALI compared to those in more deprived areas.

In highly individualistic cultures, such as in the UK [343], there may be a reluctance by government to intervene in issues widely believed to be the responsibility of the individual (as demonstrated in the UK government's vision document on prevention and individual responsibility [344]) and therefore this 'healthism' approach limits investment in infrastructure change [323]. I discussed the need for a problem broker [227] to highlight problems associated with lack of ALI, which supports ideas to 'reframe the debate' around chronic diseases [345].

There is greater acceptability of restricting unhealthy choices for children compared to adults, as seen in the UK government's Childhood Obesity Plan [346,347] and the new obesity strategy [348], with calls to restrict unhealthy food advertising to children [349]. Local planning policies in many parts of the UK are restricting the opening of hot food takeaways near to schools [350], but there is less use of regulatory mechanisms to support healthy travel behaviours for children. This may be because without appropriate environments to walk and cycle, car travel may be perceived to be safer. Problem framing by brokers, or story-tellers, could help to demonstrate the benefits of ALI to particular groups, including children, which could help to garner public support for investment in ALI [128].

7.3.2.2 Market failure

I found that ALI may impact on house prices in some situations, which may encourage private sector developers to invest in it, but this appeared more likely in affluent areas, where house prices were high, so it could exacerbate inequality of availability of ALI. It appears that reliance on the private sector to provide ALI risks market failure for this quasi-public good, as profit-maximising companies try to reduce open space for greater housebuilding and may view walking and cycling infrastructure as a luxury, rather than a necessity. This market failure suggests a need for state intervention.

Risk aversion by developers may reduce high quality walking and cycling infrastructure – some of my study participants accused safety auditors in England of being over-cautious in their assessments of designs and private sector developers did not want to risk a road not being adopted by a local authority since this would result in long-term maintenance liabilities. The perceived risk of walking and cycling in unsafe environments can reduce the attractiveness of doing so [97], which in turn can reduce demand for safe infrastructure. A lack of facilities at destinations can also be a deterrent, particularly for cyclists who seek secure bike parking and changing facilities. Failure of workplaces to provide these services, whilst also providing free car parking, can restrict demand for wider active travel infrastructure [351].

Intervention by the state where the market leads to sub-optimal health outcomes has been used in other sectors, such as minimum pricing of alcohol and high taxation of cigarettes. Price increases such as these are thought to help tackle inequalities as higher prices are more likely to affect the purchasing decisions of deprived groups, therefore reducing consumption of unhealthy products [340]. However, the situation within the housing market is very different and disparity in prices associated with quality can result in poor quality housing and environments for those on low-incomes, and higher quality only for those who can afford it [342]. Restrictions on house prices, such as through 'affordable housing' schemes have been criticised for their lack of actual affordability, being priced at 80% of market rates [352]. Around half of 'affordable houses' are funded through Section 106 developer contributions [353] and their numbers may be reduced during planning negotiations. There can also be trade-offs that may influence quality of place as open spaces may be sacrificed if they are deemed unaffordable.

7.3.2.3 Targeting deprived groups, older people and women

ALI can provide everyday opportunities for physical activity by reducing time and resource barriers. This is likely to be particularly beneficial for groups with less resources and free time, such as people on low incomes, and also for women who tend to earn less and have less free time than men because they undertake more unpaid caring work [277]. The reluctance to invest in ALI could therefore be perceived as not only an income and health inequality issue, but also an issue about gender inequality, as women can reap more benefits from safe pedestrian and cycle routes than men. Brokers could help to re-frame ALI as a feminist issue, engaging additional groups as part of an advocacy coalition [183].

Tackling inequalities through creation of ALI is complicated because where it is built may propagate inequality in some dimensions while simultaneously reducing it in others – my analysis described in Chapter 5 suggested that new walking and cycling routes built in less deprived local authority areas may result in greater relative increases in use by women and people with disabilities or long-term illnesses; however, this could exacerbate inequality if investment is preferred in more affluent areas because it may be less accessible for people living in the most deprived communities. Relative increases in users of new walking and cycling routes from deprived areas appeared to be more likely where a new bridge or tunnel was built, or if routes were built in more highly populated places. It is possible to initiate low-cost measures to make high-density, urban areas more attractive for walking and cycling, such as using filtered permeability, although this can face challenges from car drivers. New bridges are inevitably going to be much more expensive, and connecting deprived communities to more affluent areas will be a political decision that may face challenges if there is stigma against people from poorer areas and greater political engagement by wealthier groups.

Many of the Connect2 route users included in my evaluation in Chapter 5 chose to use the routes for reasons unrelated to physical activity, including convenience, safety and attractiveness of surroundings (see Table 5.D.3). These are important issues for public health and transport stakeholders to consider when influencing creation of new walking and cycling infrastructure, particularly to facilitate use by less active and vulnerable groups.

I have discussed possible benefits of using economic evaluation to demonstrate the impacts of new ALI to different types of audiences from different sectors. The economic impacts associated with changes to physical activity, such as using the Health Economic Assessment Tool (HEAT) [134], will likely be higher with large absolute increases in users. But in my Connect2 analysis in Chapter 5, I demonstrate that very high benefit-cost ratios are associated with high baseline users. This suggests that inequalities in access to ALI could increase if greater investment in ALI is provided in places that are already walkable and cyclable. Wider economic impacts, accounting for additional socio-economic impacts could also be factored in, as achieved by Hunter et al. [294]. In places with low baseline levels of users, demonstrating relative change in particular groups, such as older people and people living in deprived areas, may be useful. This could provide believable stories to audiences, including public health departments and the general public, to demonstrate the value of ALI.

7.3.3 Synthesising evaluations

My sequential mixed methods thesis has involved 'following a thread' [140] to understand factors influencing decision-making for new ALI, taking findings from my earlier studies to inform the development of later ones. I did this using different methods and across different contexts.

Each primary study involved particular settings for each case, but I was able to also combine findings across and within studies: in the qualitative studies this was achieved using thematic analysis for qualitative studies in England which included three local authority areas in the first study and two in the follow-on study, and also through synthesising findings from my original England study with my Jamaica study; and in my quantitative analysis I conducted logistic regression analysis using multiple Connect2 schemes across locations and presented some of these aggregate findings to interview participants alongside some of the Connect2 case study examples. Combining learning from different methods has increased understanding of the impacts of new ALI in different contexts, and how construction of ALI may be facilitated.

7.3.3.1 Learning from different contexts

Combining findings can provide greater understanding across multiple contexts. I chose to include a small study in another country outside of England (which was the focus for the rest of this thesis), to explore issues of decision-making for ALI and valuing of methods to demonstrate impact, in a very different context to England. This enabled me to reflect explicitly about context. By synthesising my qualitative studies from Chapters 2 and 3 (described in Chapter 4) I was also able to highlight issues that were less apparent within the individual studies.

This additional analysis, as a multiple case study [141], enabled me to develop higher-order themes, going beyond my original (rather positivist) approaches of answering specific research questions, to developing deeper insights through a more reflexive approach to thematic analysis [146].

It appears that collaboration across local authorities for monitoring and data collection is currently limited (particularly as monitoring is not a political priority), therefore the Connect2 programme was a good opportunity to evaluate multiple schemes across the UK to explore features of context that could influence use of new walking and cycling routes. Overall, I found that creation of new routes may increase levels of walking and cycling, supporting findings from other research [55,67,73,84]. Using quantitative methods to measure the impact of interventions across contexts, alongside qualitative methods to understand why place-based natural experiments occur where they do, I have helped to understand issues relating to the transferability and applicability of interventions [246,303].

I was interested in understanding whether clearer recommendations could be identified for contextual features that should be considered and reported on for place-based health interventions, to build on more generic available guidance about context in population health interventions [87]. I controlled for potential confounders in my quantitative Connect2 analysis in Chapter 5 and found that baseline levels of users, level of deprivation, population size, whether there was a transport interchange nearby and whether there was a bridge or tunnel built, could influence levels of use, at least for some user sub-groups. My qualitative research identified additional features of context that were perceived as important to stakeholders, notably hilliness as well as safety features such as natural surveillance, which is more difficult to evaluate quantitatively. Neither of these were included in my Connect2 analysis and I suggest that these issues should also be considered as contextual information in future evaluations of ALI interventions.

My analyses in Chapters 5 and 6 suggest that some contextual features may be more important for certain audiences to provide believable stories and make results appear relevant. These contextual features can involve both applicability and transferability issues [246,303]. Context may be associated with political ambition and public acceptability, not only physical and socio-economic conditions - in Jamaica economic aspirations appeared important and Miami was highlighted as a template for development, although not because of its ALI features (despite the fact that Miami is ranked the fifth most walkable city in the United States by walkscore.com, which also describes it as 'somewhat bikeable' [354], and it has almost 150 public parks [355]). In England I found that places with high levels of cycling may not be acceptable to use as examples for new cycling infrastructure in areas with low baseline levels of cycling. I suggest that a broker, or storyteller, is needed to ensure that appropriate contextual features are considered, depending on the purpose of an intervention and values of the audience. Greater understanding of the factors influencing decision-making for new ALI, described in this thesis, helps to shine a light on how messages from research evidence could be tailored to support creation of ALI.

I note that both aggregate results and individual case study examples appeared to be useful, with the former possibly relating to Weiss' enlightenment paradigm [118] whereby research may be seen "less as problem solving than as a process of argument or debate to create concern and set the agenda" [356]. However, the individual case studies were also useful to bring examples to life to tell believable stories to inspire decision-makers and persuade sceptics.

There is criticism of a lack of research about ALI conducted in low- and middle-income countries (LMICs) [357] and my qualitative study adds to the growing literature from such settings. It may be assumed that research from high-income countries is likely to flow to LMICs [246]; however my findings have demonstrated the value of conducting research in a middle-income country to provide insights for a high-income country context. I found that by synthesising my studies in England and Jamaica I could identify similarities between issues in Jamaica and deprived areas of England, and for some issues, such as around stigma of walking and cycling, there appeared to be greater similarities between Jamaica and deprived communities in England than between affluent and deprived areas within England. Therefore issues may be no more disparate between a high-income country and a middle-income country than between two different high-income countries (for example, considering the cyclable Netherlands compared with sprawling, car-dependent American cities). I have therefore demonstrated that qualitative research findings can provide transferable insights across contexts. Research that groups high-income countries together as a homogenous group, quite apart from LMICs [358], may be missing opportunities to learn across these contexts.

7.4 Future research

My thesis has explored decision-making for new ALI, identifying the value of believable stories to build support which requires believable outcomes for different types of audiences. I also suggest that greater consideration of impacts on inequality is necessary. This section discusses opportunities for future research to further develop issues raised in this thesis.

7.4.1 Understanding informal power

My thesis has discussed the use of storytellers, or brokers, to share evidence, information and data across sectors to influence decision-makers involved with creation of ALI. Individuals with informal power, functioning within untransparent processes, are likely to be more difficult to identify than those with formal power associated with their role. However, individuals with charismatic authority [118] may help to shift public opinion about ALI and therefore understanding more about these types of people could be useful. Jamie Oliver is an example of someone who has used informal power and charismatic authority to try to influence public opinion about nutrition [333] and identifying an equivalent in physical activity could be beneficial.

Individuals able to lobby politicians are likely to have informal power and more research about this could be useful to understand who these people are, and therefore help to identify strategies to influence them. As previously discussed, different types of information are likely to appeal to different audiences, therefore understanding more about informal influencers could be helpful. Social network analysis is a way to evaluate power and influence and has been used to identify dominant brokers in nutrition policy-making in Australia, for example [359]. Although this may be challenging to achieve for local level decision-makers, I suggest that a similar exercise could be conducted to help understand ALI influencers at a national level. This could capture key people involved in development of clearer guidance and minimum standards related to ALI, such as those involved with developing the National Planning Policy Framework [162], the new cycling and walking plan [360], and allocating funding allocations for ALI. Identifying these influential individuals could help in developing strategies to influence creation of ALI.

Building on the literature about the value of storytellers in decision-making [153,325,326], I believe that greater understanding about the nuances underlying the storyteller, or broker, role identified in my research would be beneficial to highlight what makes them influential or effective to practice the 'art', not only the science, of public health [187]. Evaluating the storyteller role could be done through the perspective of my 'policy-practice implementation gap' conceptual model in Figure 7.2

to test the validity of the model and develop it in response to additional insights from future research.

7.4.2 Evaluating natural experiments

I have discussed the importance of having believable outcomes to support believable stories, and an important part of this is demonstrating impacts of new ALI. However, there are complexities around demonstrating causation between features of the built environment and health outcomes that may make it challenging for public health stakeholders to advocate for more ALI, particularly as medical epistemology tends to value traditional hierarchies of evidence [76], prioritising randomised controlled trials which are typically inappropriate for complex place-based interventions. These challenges are not unique to ALI and are also apparent in other complex population health challenges, for example creating healthy food environments.

There have been criticisms of natural experimental studies because of their risks of bias, as portrayed by evaluating such studies using traditional systematic review tools that were not designed for evaluating the quality of natural experimental studies [318,361]. It is important to appreciate that evaluations of natural experiments cannot be designed in the same way as clinical trials since the key factors in the design of an intervention will be outside of the control of the researchers [362], and understanding contextual features and their influence on intervention outcomes is important [87]. For environmental changes, natural experiments are often the most suitable means of evaluating impact but these may be under-valued if assessed for quality using the same metrics as for randomised control trials [362], where it may not be feasible or ethical to assign participants randomly into separate exposure and control groups. Increased evaluations of natural experiments could tackle the so-called ‘inverse evidence law’ [177], whereby the least amount is known about interventions that could have the greatest population benefits. Some such evaluations have used complex systems models, which recognise the non-linear and complex nature of the role of ALI in population physical activity [78].

Natural experiments are opportunities to evaluate effects of changes to policy or infrastructure [362]. Greater collaboration between researchers and policy-makers and practitioners could help to understand what outcomes are important to stakeholders so that these can form part of the evaluation. Closer relationships could also help to understand possible future changes so that baseline measurements can be planned for. However, as demonstrated with the soft drinks industry levy in the UK, announcement of policy change can be influential even before policies are implemented [363]. Therefore innovative methods may be required to capture reliable baseline data. In Scarborough et al.’s evaluation of the soft drinks industry levy, the authors used interrupted time series analysis to evaluate impact of the policy. Similar methods may be possible for ALI, such as using routine traffic monitoring data for measuring impact of changes to walking and cycling infrastructure, where long-term measurements are available. These types of routine monitoring tend to only occur on certain routes, but I have demonstrated in Chapter 5 that they could be used in association with other evaluation methods. However, it appears that even simple monitoring is often not conducted, therefore clearer understanding of how data could become more routinely collected and shared would be useful. This may require creativity with data sources, for example using infrared or other traffic cameras or sensors, although automation to identify types of users using cameras is limited and therefore likely to be resource intensive. There is also potential to use Google Street View to estimate types of users in particular environments to evaluate associations between environmental features and physical activity, providing opportunity to monitor change over time using available historical data [364,365]. These methods could be particularly useful to understand displacement associated with new ALI, including understanding biases within data produced using different methods.

Data from GPS smartphone apps, such as 'Strava', could also be used to better understand displacement, as done to map levels of cycling in Glasgow, for example [366]. Although there are limitations with using these methods more broadly across an area - particularly since the types of cyclists captured in apps, such as Strava, are more likely to be middle-aged or younger men [367,368] - combining count data with route choice could be used to estimate percentage of cyclists who re-route compared to new route users. The risk of bias in understanding users of routes using apps such as Strava is demonstrated in an example from Johannesburg, South Africa, where data appeared to show that cyclists were predominantly high-income residents with 80% cycling for recreational purposes [369]. However, low income residents who are unable to afford a smart phone, and therefore unable to access Strava, cannot be captured in this data. Some researchers have attempted to adjust crowdsourced data to reduce bias, such as the study by Dadashova and Griffin in Texas, US which included socio-economic and weather variables to provide more accurate representation of users [370]. However, to date, studies attempting to understand representativeness of using GPS-based smartphone apps tend to include small sample sizes and may be conducted in areas with very low cycling commuter rates, such as the study conducted by Garber et al. in Atlanta, Georgia, US (n=95) [371] - therefore learning from this is currently limited. Use of social media data could also be used to monitor use of open spaces to increase understanding of contextual factors associated with use [372].

Evaluating the impact of ALI in new communities using natural experimental designs also faces challenges around self-selection bias since more active people may be more likely to move to a place with higher levels of ALI. Difficulties in obtaining reliable baselines before people choose to move to a new area, to determine the extent and impact of this bias, can be challenging [66], therefore more research is needed to investigate ways to capture this data.

There are risks of disruption that can affect data collection in natural experiments [66]. Even without delays it can be difficult to evaluate interventions over long time periods due to restricted funding periods, and evaluations of new ALI often involve relatively short follow-up times following completion of the infrastructure. However, as demonstrated in my Connect2 analysis, and that of others within the iConnect evaluation [266], it appears that behaviour change can take years to occur, although other studies, such as Aldred et al.'s evaluation of London's mini-Holland programme found shorter timeframes for behaviour change to be seen [373]. In my qualitative research one of the public health interviewees expressed a concern that use would decrease in the longer term, because maintenance may be lacking that deters use. Therefore, longer follow-up periods should be included within study designs to understand more about the long-term impact of new ALI. For my qualitative research I had originally planned to follow new housing developments from conception (i.e. pre-planning application) through to construction. However, this was not possible because of the length of time that this can take (and because I converted from part-time to full-time mode of study, therefore reducing the timescale of my PhD). Conducting longitudinal qualitative research over the course of development of new communities could provide additional insights. This could include understanding to what extent plans for new residents to engage in physical activity in their local environments are realised in practice, which could provide clearer information to decision-makers about how ALI should be designed.

Finally, greater understanding about behaviour change interventions, such as campaigns, conducted alongside infrastructure changes that may augment the effectiveness of ALI in encouraging physical activity [374] could be useful. These may influence cultural change processes through normalising behaviours, such as cycling [73,97].

7.4.2.1 Opportunities following COVID-19

The introduction of new walking and cycling infrastructure in towns and cities across the UK, funded as part of the UK government's emergency active travel fund in response to the COVID-19 pandemic [375], provides a unique opportunity to conduct qualitative research to better understand how 'extreme events', discussed by Kingdon as a catalyst of change, can create a 'window of opportunity' for action [148].

The new cycling and walking strategy published in July 2020 plans for 'bold' investment in quality infrastructure. Decision-making for designing different types of cycling infrastructure could be investigated in different places: local authorities that implemented ambitious schemes; those with tokenistic measures; areas that did not bid for additional funding; and those places where schemes were implemented and then removed within short timescales due to local political pressure following complaints from a vocal motor lobby [331,332]. This could include investigation into the use of novel tools, such as the Rapid Cycleway Prioritisation Tool that can help identify priorities for pop-up cycleways [376]. This is an example of a tool to inform top-down decision-making that avoids local consultation. Decision-making of this nature could be investigated with consideration of my conceptual model shown in Figure 7.2 involving believable stories, including development of concepts about politicised stories and partisan politics. It could also provide insights into how policy aspirations are, or are not, implemented as intended.

The new cycling and walking strategy also includes creation of an Active Travel Inspectorate. Investigating the formal and informal roles associated with this could be insightful, including in relation to public health practitioners' engagement in urban development.

The impacts of the new infrastructure created in response to COVID-19, much of which was constructed in areas with low levels of active travel, particularly cycling, could also be investigated. This includes evaluation of 12 new 'mini-Hollands' proposed in low cycling areas [360]. Such evaluations could help to provide believable stories to local decision-makers. Although there are complexities around baseline measurements it is likely that routine data collection, such as automatic monitoring, was already being collected in many places before COVID-19, therefore impacts of schemes could be evaluated using interrupted time series analysis, possibly alongside mobile phone app data to help understand displacement. Additionally, conducting qualitative research about the impact of these facilities on the perceived ability of different types of people to walk and cycle could personify experiences and provide additional believable stories to support creation of new ALI, or help to make temporary measures permanent to support long-term modal shift. It could be particularly useful to capture perspectives of those new to cycling, as well as people who have not changed their mode of travel. Existing cohort studies could be used to engage with people, or alternative recruitment methods used, such as via large employers near to new walking and cycling infrastructure to understand the views of commuters, or via schools to understand travel behaviours of children and parents.

Much of the initial new walking and cycling infrastructure installed in response to COVID-19 was designed to be temporary. My research described in Chapter 2 found a reluctance to pilot infrastructure change due to concerns about being perceived to waste resources. Therefore this is an ideal opportunity to understand the role of piloting and whether it leads to longer-term infrastructure change - whether people return to pre-lockdown travel behaviours, or whether, with the provision of new walking and cycling infrastructure, levels of walking and cycling are able to be increased in the long-term.

7.4.3 Understanding users of ALI

I have discussed the need for quality ALI, not simply quantity, to attract users, particularly from certain groups of people. As discussed in Chapter 5, certain features of the built environment may influence physical activity, including safety, aesthetics, destinations and functional features and there is population variation towards what may be considered 'quality' ALI (i.e. what may be considered safe to a young man may not be viewed as such by an older woman). There are tools available to provide standardised measures associated with quality, for example the Method for Observing pHysical Activity and Wellbeing (MOHAWk) tool that takes account of 'incivilities' including litter, graffiti, evidence of alcohol use or drug taking and noise [377], but there are a lack of qualitative studies about people's experiences of changes to the environment and physical activity over time [378]. Qualitative insights of this type could help to better understand causal pathways, and increase understanding about the value of quality over quantity, including for open spaces [32,62,63]. Clearer understanding of the factors that attract people to use ALI from particular socio-economic or demographic groups could help in designing more inclusive spaces, for example understanding how people from more deprived communities can obtain health and wellbeing benefits from local green spaces [112], as well as identifying unintended consequences that could influence inequality.

In Chapter 5 I discussed the difficulties in evaluating the impact of new ALI on certain groups of people, such as cycling commuters, due to low response rates in cohort studies. Therefore improved recruitment strategies that target certain demographics may be valuable. Working with employers may be one way to increase participation by employees, particularly low wage employees who may be underrepresented in evaluation studies [340] compared to retired people who are likely to have more free time available to take part in research studies. Branion-Calles et al. analysed differences in responses between cross-sectional data collection asking about 'typical' cycling behaviour compared to longitudinal data collection involving repeat 7-day recall, involving participants from seven European cities [118]. They obtained larger sample size with better representation of sociodemographic groups for the single cross-sectional study design, concluding that the longitudinal approach resulted in participation bias, particularly due to loss of frequent cyclists in the sample.

This bias due to loss to follow-up is recognised as a problem within cohort studies [119–121]. Although shorter questionnaire designs and personalisation can improve response rates, these can also involve trade-offs about quality and cost [122]. Investigation of the use of technology to improve follow-up rates should be sought, such as the use of apps that send push notifications to remind participants to complete follow-up self-reports.

GPS-based smartphone apps, such as Strava, may be used to inform decision-making for new cycling routes [379]. As discussed earlier, there are limitations in understanding risk of bias in using this type of technology, which tend to be used by younger, male leisure cyclists [367,368]. Although app technology could be used to better understand displacement associated with new active travel routes I argue that this type of data should not be used for planning and investment purposes – as demonstrated in Chapter 5, large increases in users could occur in places with low baseline levels. Therefore basing infrastructure decisions on existing cyclists could miss opportunities to connect places for active travel and increase cycling rates, particularly for less represented groups. However, there may be potential to use such technologies to highlight problems of poor air quality for existing cyclists, which could be a driver to construct segregated infrastructure [114]. Greater clarity about the limitations and value of tools such as Strava Metro [379], particularly in relation to attracting new users and tackling inequality, would be useful.

The Propensity to Cycle Tool is an alternative way to demonstrate where cycling infrastructure should be increased by using commuter patterns and school journeys from census data to highlight where car drivers may switch modes to cycling, if appropriate infrastructure was available [115]. This seems a more appropriate tool to inform planning decision-making, although there are some limitations, such as using potentially outdated data (being based on 2011 census data) and focusing on commuting and school journey patterns which may miss opportunities for utility and leisure cycling for other groups in society. If similar data is captured in the next UK census in 2021 it should support greater understanding about ALI and journey modes.

7.4.4 Multiple benefits of ALI

Throughout this thesis I have discussed the need for greater collaboration across disciplines in the creation of new ALI. This is also necessary to support evaluation of ALI and to demonstrate cross-sectoral outcomes. This goes beyond health and transport metrics. For example, working with climate change researchers and activists could strengthen the case for investing in ALI to reduce emissions by reducing demand for roads for private cars, alongside promoting active travel for public health benefits. ALI could also support climate change mitigation and adaptation through associated tree planting and other vegetation. These can act as carbon sinks, help to alleviate rising temperatures and reduce risk of urban flooding, whilst also making places to walk and cycle more attractive.

Greater collaboration across health sectors could also be beneficial, covering physical activity, air quality and injury prevention. However, there may be perceived tension between health outcomes – as seen in my qualitative study described in Chapter 2, perceptions of safety could be used as a reason to reduce the quality of walking and cycling infrastructure. Air quality has been found to be associated with physical activity [380], despite evidence to show that only in the world's most polluted cities do risks associated with pollution outweigh health benefits associated with physical activity [381]. Greater coordinated evaluations across health measures could be useful to challenge these types of perceived conflicts. Systems mapping could be used to identify interconnected elements and increase visibility of relevant issues which could help to simplify the complex nature of decision-making for ALI [382]. For example, a pragmatic systems mapping exercise conducted by Cavill et al. with stakeholders in a city-wide physical activity programme in Derby, UK, found that the process of systems mapping was useful to highlight the multi-sectoral nature of environmental determinants of physical activity, going beyond individual behaviour change interventions [383]. Understanding the impact of using systems mapping approaches more widely to influence decision-making for ALI could be further investigated.

The Health Economic Assessment Tool is simple to use and widely available to calculate economic impacts associated with changes to ALI. Its appeal may be related to the limited data necessary to be inputted to calculate economic impacts of new walking and cycling routes, but clearly it is also limited as it only includes mortality impacts. Greater evaluation of economic impacts associated with morbidity, as well as other non-health outcomes, could be useful. This type of broader economic evaluation of ALI is in its infancy and should be researched further to influence non-health sectors associated with environmental determinants of health.

My research did not focus on impacts on children from the presence of ALI. Other upstream public health interventions, such as those related to fast food takeaways or tobacco control, have framed these interventions as ways to protect children [128], so it seems that investigating perspectives about impacts on children's health by different stakeholders could be useful to understand how relevant this could be to enable ALI.

7.4.5 Research in different contexts

The majority of research about ALI has been conducted in high-income countries [80,384], but LMICs face their own set of strengths and challenges that are likely to differ. Although learning may be transferable across these contexts, and my research has demonstrated that learning from middle-income country examples may be pertinent in certain settings within high income countries, it is likely that studies conducted in LMICs are viewed as more relevant, and therefore believable, to decision-makers in LMICs. For example problems of high fences built around homes that reduce natural surveillance and road safety issues for people conducting active travel are more likely to be issues in middle-income, compared to high-income, country settings. To support the availability of relevant case study examples, greater understanding of the types of places that decision-makers in different areas of the world look to for good examples would be useful. This may relate to aspirational locations with shared sets of values, rather than geographic proximity or exemplar schemes [239,246]. Qualitative research can help to understand issues of transferability and applicability when considering how case studies may be influential. This goes beyond the rather generic concepts of external validity and could encourage research that is appropriate to relevant audiences [246,304]. Within the UK context, greater availability of case study examples from less traditionally cyclable places could help to meet demand for local examples and combat the scepticism of the relevance of examples from other European countries or well-known UK cycling cities such as Cambridge, Oxford and Bristol. Combining quantitative and qualitative research about ALI in different contexts could also help to understand causal mechanisms, and whether these differ in different places and for different types of people [97,100,302].

In this thesis I have focussed on places with discretionary planning systems, where public sector urban planners are able to negotiate planning requirements with developers. Many countries have zonal systems that may be much more rigid in their planning requirements and conducting research in these places could provide additional insights into the role of ‘storytellers’ and brokers. Evaluating proposed planning regulation changes in England, if implemented, also appears necessary to understand its impact on healthy place-making [385]. I also suggest that replicating my studies described in Chapters 2 and 3 in other contexts could be useful, in particular in low-income countries where far fewer people can afford private cars, yet where there is high potential to influence the design of new communities, such as during slum upgrading programmes. Qualitative synthesis techniques, such as meta-ethnography [244], could be used to create higher-order themes using reflexive thematic analysis [146] from studies across additional contexts. Framework analysis may be appropriate to analyse and compare different cases, using a matrix to structure qualitative data to investigate specific research questions about transferability of ALI across contexts [173].

Qualitative synthesis could also be used more to combine insights from across qualitative studies in different places to help develop more insightful findings across different public health issues. For example, this could entail synthesis of studies investigating the commercial determinants of health to understand more about this complex issue, evaluating studies related to nutrition, alcohol and tobacco, alongside those involving private sector developers and the built environment.

7.5 Personal reflections

When I started my PhD journey I held a relatively positivist perspective and wanted to focus on identifying practical solutions to support more and better ALI for everyday physical activity across the population. This came from having a background in the pragmatic fields of civil engineering and water, sanitation and hygiene in low- and middle-income countries (LMIC) where understanding ways to provide practical solutions was crucial to lead to high quality infrastructure provision.

Although I still value pragmatic research that can influence change, as reflected in the specific research questions used in each of my studies, my PhD has also encouraged me to appreciate the value of more conceptual undertakings that can shed light across multiple issues. This change in perspective arose from me gaining a greater understanding about qualitative research over the course of my PhD, learning from authors such as Braun and Clarke, as well from working with Cornelia Guell who provided invaluable support and insights about qualitative research across my PhD projects. This led to me developing a greater appreciation of the potential value in taking a more reflexive, interpretivist approach to thematic analysis, rather than being limited by a more restrictive, positivist stance. I believe that my thesis findings can provide insights into other public health issues, particularly around the issues of creating believable stories, using appropriate storytellers as problem-brokers for particular audiences, and demonstrating contextually relevant examples to inspire decision-makers.

My previous work with LMIC, which included understanding ways to support sustainability of rural water services through improved governance structures, encouraged me to pursue research in a middle-income context. I am pleased that it was possible to demonstrate that research in LMIC can also provide insights for high-income settings, which may support additional research in these settings and help to tackle assumptions about direction of research flows between countries.

7.6 Conclusions

Despite policies and generic guidance generally supporting the creation of ALI, often it is not built in practice. This thesis provides new insights to explain the gap between policy and practice. I found that believable stories (credible narratives to frame evidence and explain its value) may help to build support for ALI across sectors, with politicians and the general public. This can help to counter-act the power of hostile actors who may impede creation of ALI.

I identified influential individuals with formal and informal roles who can support creation of quality ALI, which may involve a combination of rational-bureaucratic and charismatic authority [184]. This thesis advances understanding about the broker role, which may be used to share believable stories with relevant audiences. I found that these stories can involve case studies from places that are perceived as physically, socio-economically and/or politically similar. Greater monitoring and evaluation of new ALI in different contexts could help increase the supply of case study examples, or stories, for a broker or storyteller to choose from. I suggest that this may increase the likelihood that such stories are believable and influential to audiences who may otherwise be reluctant to support ALI, particularly for cycling infrastructure which can be controversial in car-dominant communities.

My research suggests that problems of physical inactivity may require re-framing to emphasise the importance of tackling the environmental determinants of health, which may not be adequately recognised by public health departments, councillors or the general public, who may perceive physical inactivity as an individual agency problem. I have identified potential inequality issues related to creation of new ALI (and associated levels of physical activity and health outcomes), such as a reluctance to investment in walking and cycling infrastructure in more deprived communities because of stigma associated with active modes. So whilst I have demonstrated that places with low baseline levels of walking and cycling may achieve the greatest relative increases in number of users with the provision of new walking and cycling routes, already walkable and cycleable places may be more likely to benefit from additional investment. I suggest that demonstrating the impact of new walking and cycling routes on vulnerable and disadvantaged groups may help to build emotional support which could tackle scepticism about their value. I also found that market forces should not be relied upon to create equitable ALI and government intervention appears necessary to increase the quality and quantity of ALI.

New ALI may impact on cross-sectoral outcomes and greater collaboration between health and non-health actors could help to build advocacy coalition networks [183] to support investment in ALI. In particular I have emphasised how public health and urban planning sectors could work together more closely. In this thesis I identified how different types of 'evidence' may be used by different stakeholders to identify a problem, identify a solution, or justify a solution post hoc. I suggest that collaborations could be supported by demonstrating wider economic impacts of ALI that go beyond health.

Different methods were necessary to explore the issues within this thesis and I have demonstrated that combining methods, within and between qualitative and quantitative analyses, can help with creating and sharing believable stories, providing efficient insights through re-examination of data (in the cases of the qualitative synthesis and the iConnect study) and exploring issues in greater depth (through the sequential 'follow a thread' study design) to understand the factors that influence decision-making for new active living infrastructure. By demonstrating how different methods are valued by different audiences I have contributed to a greater understanding of how research evidence, and more routine monitoring methods, can be used to support creation of healthier environments.

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Appendices

Appendix 2.A: England 1 - semi-structured interview guide

#	Main Questions	Possible follow-up/prompts
	Interview guide	
#	**Main Questions**	**Possible follow-up/prompts**
Background to involvement and personal attitude to healthy infrastructure:		
1	Can you outline **your role**?	Can you describe how and when you are involved with planning or developing walking and cycling infrastructure and open spaces? What type of developments are you normally involved with?
2	What is your view on the walking and cycling infrastructure, and open spaces, in this areas?	How **walkable** or **cyclable** are developments/ this development? How do you feel about the amount and quality of **open space**? Why are there **differences** between different areas?
Knowledge exchange and evidence influencing the decision-making process:		
3	Can you tell me about the **sources of information, knowledge or data** that you use to help you make or influence decisions?	Where do you go for **information**? What are the key **guidance documents?** How useful is evidence from **other settings**? Is **National guidance** useful? What other **evidence** is used to inform **decision-making**?
4	What is your view of **economic analysis** for healthy infrastructure?	Is **cost effectiveness** useful? Do you think savings to the **NHS** can influence infrastructure decisions? Do you assess **value for money**? *Developer*: How can **viability** impact on levels of open space? Could it affect walking and cycling routes?
5	Do you do or use **monitoring** or **effectiveness** data for walking or cycling?	How **useful** is monitoring data?
6	What **other information** or **evidence** would be useful to you?	Are there times where your argument would have been strengthened by better information or evidence?
7	Can you tell me about your view of **HIAs**?	What are the **benefits or problems** with HIA? Can planning be **refused** on health grounds?
Key stakeholders and their relationships		
8	Who are the main **supporters and opponents** to planning healthy infrastructure?	Can you describe the type of working **relationship** between stakeholders (e.g. planners, public health, developers, councillors etc.). Are they **collaborative**? **Silos**?

9	What do you think is the **main driver** for building active infrastructure?	Congestion, cost, health, etc.?
10	What do you think is needed to help **you** to enable more healthy infrastructure to be built?	What **limits** your influence e.g. time, budget, silos, politics, interest, relevance etc.?
11	What do you think **motivates others** to support walkable and cycling developments?	e.g. Traffic, the economy, politics, congestion, safety, carbon footprint, air pollution, community cohesion, local economy, economic benefits etc.?
12	Do you feel encouraged to be **innovative** and try new approaches?	What **supports** or **inhibits** innovation and trying new things? Can you comment on the level of influence by **central government**?
Drivers for change during the planning process		
13	Can you explain to me **how and when changes can occur** in development plans, particularly related to active living infrastructure?	Do you have a recent **example**? **What happened and why?** **Who** was involved?
Changes in healthy planning over time		
14	Have you seen any **changes** to how planning decisions account for health over the last few years, since public health moved into local authorities in 2013?	What other things have **influenced** how public health issues are considered in the last few years?
Thank you very much for answering my questions. Is there anything else that you would like to say on this topic? **Comments**? **Feedback**?		

Appendix 2.B: England 1 - participant information sheet and consent form for interviews

<u>Interview Participant Information Sheet</u>

Study Title: Evidence and Active Urban Environments Research Project

Researcher: Anna Le Gouais (PhD student)
Supervised by: Dr David Ogilvie and Dr Cornelia Guell
University sponsorship reference number: RG71157

Please read this information carefully before deciding to take part in this research.

What is the research about?

The urban environment can influence levels of physical activity and population health. I want to find out more about how decisions are made to build 'active living' infrastructure, such as that for walking, cycling and open space. I am particularly interested in understanding how evidence, data and other information is used by different groups to influence planning decisions. This will be done through interviews with key stakeholders and observing meetings and workshops.

I am a part time PhD student, originally a civil engineer, and now doing public health research which is funded by the Medical Research Council and based at the MRC Epidemiology Unit and The Centre for Diet and Physical Activity Research (CEDAR) at the University of Cambridge. This research project will focus on three local authority areas in the UK between 2017 and 2020.

Why have I been chosen?

You have been identified as a key stakeholder in the process of urban planning. In total I plan to interview around 30 people in my research.

What will happen to me if I take part?

You will be invited to arrange a time for an interview on your views about planning for 'active living' infrastructure and how you use evidence in decision-making. This may be done face to face in your offices, or by phone or Skype. If you agree, the interview will be recorded so that it may be transcribed to assist with the research. It is expected that each interview will take an hour or less. Some participants will also be asked to be re-interviewed approximately a year later.

Taking part is completely voluntary and you may refuse to take part or withdraw at any point without giving a reason and without penalty or loss of benefits which you may otherwise be entitled.

Are there any benefits in my taking part?

The information collected during this study will help to better understand the drivers for and barriers to providing healthy urban infrastructure. By taking part you are helping to identify what could be done to improve the use of information and evidence which could lead to more healthy planning decisions and facilitate healthier communities.

Are there any risks involved?

There are no risks involved in taking part.

Will my participation be confidential?

Your participation will be treated as confidential and the information you provide will be held and used in accordance with the Data Protection Act 1998 and stored securely at the MRC Epidemiology Unit in Cambridge. All interviewees will be identified by an ID number which relates to your professional role and any information about you will have your name and place of work removed so that you cannot be recognised from it.

What will happen to information about me collected during the study?

Any information we hold and share about you will have your name and address removed so that you cannot be recognised from it and it will not be used or made available for any purpose other than for research.

Identifying details (such as your name, email or other details you may have given us to get in touch with you) will be kept separately from the transcript of your interview, and linked only by an ID number. The database containing personal information is on a secured, password-protected drive on computers in the MRC Epidemiology Unit, University of Cambridge. Once your interviews have been analysed and you have been sent a summary of our findings (if you want one), we will delete your name and address, keeping only your anonymised interview transcripts.

Extracts from your anonymised interviews may be included in reports or talks presenting the findings from this study.

With your permission, the full anonymised transcripts of your interviews will be stored by the MRC Epidemiology Unit so other researchers may be able to use your valuable interviews for future research.

Occasionally our studies may be monitored by our Sponsor (University of Cambridge). This is to ensure our research is conducted soundly. This procedure is routine and carried out by fully qualified personnel. Data confidentiality will be adhered to at all times.

What happens if I change my mind?

You are free to withdraw from the study at any time and without giving a reason. If you do decide to withdraw, or if you are no longer able to take part in the study, we will use the data collected up to the time of your withdrawal.

What if there is a problem?

If you have a concern about any aspect of this study, you should contact Anna Le Gouais on [number/email] . She will do her best to answer your questions. If you remain unhappy and wish to complain formally, the normal University of Cambridge complaints process is available to you through the University of Cambridge Clinical School Secretary: telephone: [number/email].

What will happen to the results of the study?

When the study is completed, reports and papers will be published and talks given to share the findings with researchers and other stakeholders. Your identity and personal details will be kept confidential. No information that could identify you, like your name, will be published in any report about this study. We will also prepare a summary of the findings for all interview participants, which we will send to you if you are interested in what your interviews have shown!

Who has reviewed the study?

This study has been reviewed by an independent group of people, called the Research Ethics Committee, to protect your safety, rights, wellbeing and dignity. The study has been given a favourable opinion by the University of Cambridge School of the Humanities and Social Sciences Ethics committee.

Where can I get more information?

If you would like more information or have any questions, please contact Anna Le Gouais on [number] or by email at [email]

Participant Consent Form

Study Title: Evidence and Active Urban Environments Research Project

Ethics reference number:

Name of Principal Investigator: Dr David Ogilvie

Study ID:…………………………………………..

Please **initial** to confirm the statements below:

[ ] I confirm that I have read and understood the Interview Participant Information Sheet version 1.1, dated 01 Aug 2017 for the above study. I have had the opportunity to consider the information and ask questions. The questions I have asked have been answered satisfactorily.

[ ] I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my legal rights being affected.

[ ] I agree that the information gathered about me will be looked after and stored securely by the MRC Epidemiology Unit, University of Cambridge and its collaborators, and may be used anonymously in future projects.

[ ] I agree that the interview will be audio-recorded and that quotations can be used which contain no identifiable information.

[ ] I agree to be contacted about further research related to this project in the future.

[ ] I agree to take part in the above study.

-- ------------------------

PLEASE SIGN DATE

PRINT YOUR NAME (BLOCK CAPITALS)

-- ---------------- -------------------------

NAME OF PERSON TAKING CONSENT *DATE* *SIGNATURE*

1 copy for participant and 1 copy for researcher

Evidence+AUE consent form v1.1 01 Aug 2017

Appendix 2.C: England 1 - participant information sheet for meeting observations

Participant Information Sheet 1

Study Title: Evidence and Active Urban Environments Research Project

Researcher: Anna Le Gouais (PhD student)
Supervised by: Dr David Ogilvie and Dr Cornelia Guell
University sponsorship reference number: RG71157

Please read this information carefully before deciding to take part in this research.

What is the research about?

The urban environment can influence levels of physical activity and population health. I want to find out more about how decisions are made to build 'active living' infrastructure, such as that for walking, cycling and open space. I am particularly interested in understanding how evidence, data and other information is used by different groups to influence planning decisions. This will be done through interviews with key stakeholders and observing meetings and workshops.

I am a part time PhD student, originally a civil engineer, and now doing public health research which is funded by the Medical Research Council and based at the MRC Epidemiology Unit and The Centre for Diet and Physical Activity Research (CEDAR) at the University of Cambridge. This research project will focus on three local authority areas in the UK between 2017 and 2020.

Why am I included?

You are attending a meeting or workshop related to the process of urban planning. It is being observed by the researcher to help understand the context for urban planning related to 'active living' infrastructure.

What will happen to me if I take part?

You will be observed during the meeting and general, un-attributable field notes will be made. No audio recording equipment will be used. Any notes that are taken will be kept fully anonymised and confidential under MRC and University of Cambridge data management processes.

Please make it clear if you do not want a researcher to be present for any part of the meeting - you can ask that I leave at any time. Lack of verbal objection will be taken to imply consent.

Taking part is completely voluntary and you may refuse to take part or withdraw at any point without giving a reason and without penalty or loss of benefits which you may otherwise be entitled.

Are there any benefits in my taking part?

The information collected during this study will help to better understand the drivers for and barriers to providing healthy urban infrastructure. By taking part you are helping to identify what could be done to improve the use of information and evidence which could lead to more healthy planning decisions and facilitate healthier communities.

Are there any risks involved?

There are no risks involved in taking part.

Will my participation be confidential?

Your participation to be treated as confidential and the information you provide will be held and used in accordance with the Data Protection Act 1998 and stored securely at the MRC Epidemiology Unit in Cambridge. No identifiable data will be attributable to you.

What happens if I change my mind?

You are free to withdraw from the study at any time and without giving a reason. If you do decide to withdraw, or if you are no longer able to take part in the study, we will use the data collected up to the time of your withdrawal.

What if there is a problem?

If you have a concern about any aspect of this study, you should contact Anna Le Gouais by telephone or email as shown below. She will do her best to answer your questions. If you remain unhappy and wish to complain formally, the normal University of Cambridge complaints process is available to you through the University of Cambridge Clinical School Secretary: telephone: [number/email].

What will happen to the results of the study?

When the study is completed, reports and papers will be published and talks given to share the findings with researchers and other stakeholders. Extracts from anonymised field notes may be included in reports or talks presenting the findings from this study, but any identifiable information will be kept confidential. No information that could identify you, like your name, will be published in any report about this study.

Who has reviewed the study?

This study has been reviewed by an independent group of people, called the Research Ethics Committee, to protect your safety, rights, wellbeing and dignity. The study has been given a favourable opinion by the University of Cambridge School of the Humanities and Social Sciences Ethics committee.

Where can I get more information?

If you would like more information or have any questions, please contact Anna Le Gouais on [number] or by email at [email]

Appendix 2.D: England 1 - list of codes

Name	Files	References
01. General level of walkability and bikeability	16	21
01.1 Doing the 'right thing'	9	29
Aspirational design and starting with ambition	11	17
Good design	20	48
Gut feeling or common sense	16	32
02. Infrastructure	0	0
Car parking	23	51
Car-oriented design	14	26
Congestion and air quality	24	83
Connectivity	21	55
House prices	6	8
Housing density or size	11	21
Open space	29	180
Play areas	12	30
Public transport	19	56
Size of developments	3	4
Town centres and shops	4	11
Walking & cycling infrastructure	36	267
03. Communities	1	1
2nd car	1	2
Cars - rights and status	6	11
Consultation	16	40
Crime & ASB	14	47
Cycling & walking culture and behaviour change	26	120
Difficulties in increasing cycling	15	27
Engaging with communities	24	79
Media and public perceptions	2	7
National awareness in Physical Activity and health	4	6
Selling a lifestyle	7	10
Villages and existing communities	15	24
04. Policies and plans	0	0
Changes to plans	25	81
Housebuilding targets	10	13
Local Plan	23	66
Masterplans	21	46
Planning Policies & specifications	24	104
Planning process	25	85
Policy change - Central government focus on Physical Activity	10	11
Policy change – Local Authority focus on Physical Activity & health	7	17
Policy change - PHE and NGO focus on Physical Activity	2	2
Policy influence	10	19
Sustainability agenda & carbon	6	15
Transfer of PH into councils	20	24
05. Short-term or long-term	0	0
Allow or restrict access from the start	2	4
Business as usual - playing it safe	16	26

Innovation & trying new things	26	44
Long term vision	12	28
Technological change (Autonomous vehicles, home working, apps etc)	10	15
06. Resources	1	1
Financial needs or pressures	34	181
Resource barriers	22	61
Viability	13	19
07. Evidence	1	1
_Need for more evidence	28	84
Biased use of evidence	2	2
Census data	4	5
Community Survey	5	6
Economic evaluation	23	54
Effectiveness and success	16	38
Evidence - Bespoke or new data	13	19
Evidence - health impacts	25	67
Evidence - local or existing Local Authority specific data	29	87
Evidence - Other places or case studies	29	106
HIA	13	21
Influence	22	80
Monitoring	14	25
National or Generic guidance	24	92
Propensity to cycle tool	5	7
Sourcing evidence	7	9
Traffic and travel monitoring	13	29
08. Stakeholders	0	0
Individual opinion differences	2	4
Opponents	13	17
Role - Community Development	2	2
Role - Councillor	8	18
Role - Cycling team (Council)	4	6
Role - Developer	4	5
Housebuilders	0	0
Master developer	7	12
Transport planner	3	7
Urban design	3	7
Role - Landscape architecture	1	4
Role - New Communities Coordinator (Council)	1	1
Role - NGO or industry	2	8
Role - Parks	2	4
Role - Planning Policy (Council)	4	5
Role - Police	1	3
Role - PROW	1	3
Role - Public Health (Council)	5	8
Role - Public sector developer	1	1
Role - Regeneration	1	1
Role - Tariff Manager	1	3
Role - Transport Planner (Council)	5	6
Role - Urban Planner (Council)	4	6
Working with Academics	5	8

Working with Business Intelligence	1	2
Working with Community Development	4	5
Working with Councillors	22	69
Working with Developers and their consultants	31	134
Working with Education	7	10
Working with Environment	4	7
Working with Health bodies (CCG, NHS, social care, GPs, PHE etc)	11	27
Working with Housebuilders	9	25
Working with Investors	1	1
Working with Land Owners	1	1
Working with Mayor's office	4	4
Working with National Government	9	15
Working with New Communities	2	5
Working with NGO or Industry	19	45
Working with Planning	26	92
Working with Planning Policy	4	10
Working with Police	2	4
Working with Public Health	25	59
Working with Residents	3	3
Working with Safety Auditors	4	6
Working with Transport or Highways (Council)	24	46
Working with Walking group (Council)	1	1
9. Inter-organisational working	0	0
Competing or multiple interests	26	81
Consistency over time	8	12
Corruption	1	1
Leadership	17	33
Partnerships & knowledge sharing	30	173
Power inequality	6	9
Silos	4	6
Great quotes	29	139
Support for research project	7	9

Appendix 3.A: Jamaica participant information sheet and consent form

Participant Information Sheet and Consent Form for Evidence and Active Urban Environments Research Project in Jamaica

Researcher: Anna Le Gouais (PhD student)
Supervised by: Dr Ishtar Govia, Dr Louise Foley and Dr Cornelia Guell

What is the research about?
The urban environment can influence levels of physical activity and population health. We want to find out more about how decisions are made to build 'active living' infrastructure, such as that for walking, cycling and open spaces. We are particularly interested in understanding how evidence, data and other information is used by different groups to influence planning decisions. This will be done through interviews with key stakeholders and observing meetings and workshops.

Anna Le Gouais is an international PhD student based at the MRC Epidemiology Unit and The Centre for Diet and Physical Activity Research (CEDAR) at the University of Cambridge, United Kingdom. She was originally a civil engineer, and is now doing public health research which is funded by the UK Medical Research Council.

This research project will focus on two parishes in Jamaica.

Why have I been chosen?
You have been identified as a key stakeholder in the process of urban planning. In total we plan to interview around 10-12 people for this research.

What will happen to me if I take part?
You will be invited to arrange a time for an interview on your views about planning for 'active living' infrastructure and how you use evidence in decision-making. This may be done face to face in your offices, or by phone or Skype. If you agree, the interview will be recorded so that it may be transcribed to assist with the research. It is expected that each interview will take an hour or less.

Taking part is completely voluntary and you may refuse to take part or withdraw at any point without giving a reason and without penalty or loss of benefits which you may otherwise be entitled.

Are there any benefits in my taking part?
The information collected during this study will help to better understand the drivers for and barriers to providing healthy urban infrastructure. By taking part you are helping to identify what could be done to improve the use of information and evidence which could lead to more healthy planning decisions and facilitate healthier communities.

Are there any risks involved?
There is minimal risk involved in taking part.

Will my participation be confidential?
Your participation will be treated as confidential and the information you provide will be held and used in accordance with the Caribbean Institute of Health data protection regulations and stored securely at CAIHR. All interviewees will be identified by an ID number which relates to your professional role and any information about you will have your name and place of work removed so that you cannot be recognised from it.

What will happen to information about me collected during the study?
The University of the West Indies will act as the data controller for this and will keep identifiable information about you for 15 years after the study has finished. Any information we hold and share about you will have your name and address removed so that you cannot be recognised from it and it will not be used or made available for any purpose other than for research. Identifying details (such as your name, email or other details you may have given us to get in touch with you) will be kept separately from the transcript of your interview, and linked only by an ID number.

Extracts from your anonymised interviews may be included in reports or talks presenting the findings from this study. With your permission, the full anonymised transcripts of your interviews will be stored by CAIHR so other researchers may be able to use your valuable interviews for future research.

Occasionally our studies may be monitored by overseeing institutions. This is to ensure our research is conducted soundly. This procedure is routine and carried out by fully qualified personnel. Data confidentiality will be adhered to at all times.

What happens if I change my mind?
You are free to withdraw from the study at any time and without giving a reason. Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible.

What if there is a problem?
If you have a concern about any aspect of this study, you should contact Dr Ishtar Govia at [email]. She will do her best to answer your questions. If you remain unhappy and wish to complain formally, the normal University of the West Indies complaints process is available to you through the Chair of the University of the West Indies Ethics Committee: Dean Dr Tomlin Paul telephone: [number] or email: [email]

What will happen to the results of the study?

When the study is completed, reports and papers will be published and talks given to share the findings with researchers and other stakeholders. Your identity and personal details will be kept confidential. No information that could identify you, like your name, will be published in any report about this study. We will also prepare a summary of the findings for all interview participants, which we will send to you if you are interested in what your interviews have shown!

Who has reviewed the study?
This study has been reviewed and given a favourable opinion by an independent group of people, called the Ethics Committee of the University of the West Indies, to protect your safety, rights, wellbeing and dignity.

Where can I get more information?
If you would like more information or have any questions, please contact Dr Ishtar Govia by [email].

Part II: Consent Form

Evidence and Active Urban Environments Research Project in Jamaica

Participant ID: ……………………

DECLARATION

Please **initial** to confirm the statements below:

[ ] I confirm that I have read and understood the Participant Information Sheet. I have had the opportunity to consider the information and ask questions. The questions I have asked have been answered satisfactorily.

[ ] I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my legal rights being affected.

[ ] I agree that the information gathered about me will be looked after and stored securely by CAIHR, University of West Indies and its collaborators, and may be used anonymously in future projects.

[ ] I agree that the interview will be audio-recorded and that quotations can be used which contain no identifiable information.

[ ] I agree to be contacted about further research related to this project in the future.

[ ] I agree to take part in the above study.

Print Name of Participant__________________

Signature of Participant __________________

Date ___________________________
Day/month/year

Statement by the researcher/person taking consent
I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

A copy of this consent form has been provided to the participant.

Print Name of Researcher/person taking the consent________________________

Signature of Researcher /person taking the consent_________________________

Date ___________________________
Day/month/year

Appendix 3.B: Jamaica semi-structured interview guide

No	Main Questions	Possible follow-up/prompts	Comment
Background to involvement and personal attitude to healthy infrastructure:			
1	Can you outline **your role**?	Can you describe how and when you are involved with planning or developing walking and cycling infrastructure and open spaces? What developments are you involved with? Do you see **health** as an influencing factor in your role?	
2	What is your view on the walking and cycling infrastructure, and open spaces, in this area?	How **walkable** or **cyclable** is this area, or will this development be? How do you feel about the amount and quality of **open space**? Why are there **differences** between different areas?	
Key stakeholders and their relationships			
3	Who are the main **supporters and opponents** to planning healthy infrastructure?	Can you describe the type of working **relationship** between stakeholders (e.g. planners, public health, developers, councillors etc.). Are they **collaborative**? **Silos**?	
4	What do you think is the **main motivation** for building active infrastructure?	e.g. Congestion, cost, health, politics, safety, carbon footprint, air pollution, community cohesion, economic benefits etc.?	
5	What do you think is **needed** to enable more active infrastructure to be built?	What **limits** your influence e.g. time, budget, silos, politics, interest, relevance etc.?	
6	Do you feel encouraged to be **innovative** and **try new approaches**?	What **supports** or **inhibits** innovation and trying new things? Can you comment on the level of influence by **central government**?	
Knowledge exchange and evidence influencing the decision-making process:			
7	Can you tell me about the **sources of information, knowledge or data** that you use to help you make or influence decisions?	Where do you go for **information**? What are the key **guidance documents?** How useful is evidence from **other settings**? Is **National guidance** useful?	

8	What **other information** or **evidence** would be useful to you?	Are there times where your argument would have been strengthened by better information or evidence?	
9	What is your view of **economic analysis** for healthy infrastructure?	Is **cost effectiveness** useful? Do you think savings to health can influence infrastructure decisions? Do you assess **value for money**? *Developer*: How can **profit** impact on levels of open space? Could it affect walking and cycling routes?	
10	Do you do or use **monitoring** or **effectiveness** data for walking or cycling?	How **useful** is monitoring data?	
11	Can you tell me about your view of **Health Impact Assessments**?	In the UK there is increased interested in HIAs – what is your experience **here**? What are the **benefits or problems** with HIA? Can planning be **refused** on health grounds?	
Drivers for change during the planning process			
12	Can you explain to me **how and when changes can occur** in development plans, particularly related to active living infrastructure?	Do you have a recent **example**? **What happened and why?** **Who** was involved?	
Changes in healthy planning over time			
13	Have you seen any **changes** to how planning decisions account for health over the last few years?	What other things have **influenced** how public health issues are considered in the last few years?	
Cross-cultural comparison			
14	How do you think your experiences here **differ from in England**?	What affect does **context** have?	
Thank you very much for answering my questions. Is there anything else that you would like to say on this topic? **Comments**? **Feedback**?			

Appendix 3.C: Jamaica list of codes

Name	Files	References
_Ecological model	0	0
Age, sex and hereditary factors	1	2
Cultural conditions	9	32
Environmental conditions	8	25
Individual lifestyle factors	4	8
Social and community networks	4	13
Socio-economic conditions	6	17
1. Demand-supply cycle	0	0
Demand	0	0
Air quality concerns	3	5
Expectation of being able to drive - Going against the tide of public opinion	5	12
Lack of advocacy for health	2	3
Miami skyline and 1st world aspirations	3	5
Political judgement on condition of roads	1	2
Promoting active lifestyle	8	18
Tourism or leisure demanding access to nature	3	8
Demand- supply vicious or virtuous cycle	5	9
Supply	0	0
Car-oriented design	8	19
Exclusivity by income	2	7
Good examples of ALI built	5	12
Not building new ALI	9	21
2. Poor quality ALI	0	0
Active travel or public transport barriers	2	3
Inequality of ALI by income	5	8
Lack of resources	7	12
Making do	6	13
Not pedestrian friendly	6	15
Safety for cycling	6	12
Security concerns & natural surveillance	7	15
Evidence	0	0
Belief in the data	3	6
Health evidence	3	8
Healthcare savings from Physical Activity (economics)	6	12
International examples	8	33
Local data	6	29
Monitoring	2	3
Need for more evidence	5	11
New or emerging knowledge - Learning	4	15
Greenspaces not valued	0	0
Community responsibility for open space	6	15
Community walking or running trails	2	8
Maintenance or landscaping (budget or lack of)	8	41
Multi-purpose spaces	5	18
No one fights for Green Infrastructure	4	13

Parks run by councils	1	1
Private open space (not public)	2	3
Public-private partnership	6	19
Scruffy' open spaces +squatting	5	7
Useless space	5	7
Influential individuals	0	0
Believing in the value of ALI	8	25
Connection and influence - ear to power	3	12
Knowledge broker	5	6
Leadership	6	18
Valuing good placemaking	3	4
Lack of government sovereignty	0	0
(Unsolicited) foreign investment	3	4
IFI loan (or grant) (inc. requirements)	3	10
International agencies	6	14
International consultancies not understanding real Jamaica	1	2
Private profit	0	0
Corruption	3	7
Housing demand and densification	6	19
Quality is hard to measure	0	0
Lack of skills (inc. brain drain + training)	3	5
Tick box - easy to measure	3	6
Reaching out or keeping to silos	0	0
Broad policies	2	5
Central government focus on physical activity	5	11
Cross-sectoral working	6	14
Environment health and safety priority over non-communicable diseases	7	12
Lack of ambition from Health influencing planning	5	12
No one's responsible	4	6
Silos in government	5	15
Top-down planning	0	0
Changes to plans	6	15
Complicated legislative framework	3	7
Consultation	6	17
Don't criticise the government	1	1
Focus on supporting economic growth	2	4
Minister has the final say	1	1
Opposition by local people	2	5
Outdated plan before it's signed off	2	2
Plans not followed	6	24
Trying to change the law	1	1
Vague policies or unenforceable guidance	9	36
Visionary planners	4	26
Y_Comparison with England	4	4
Z_Great quotes	9	51
Z_Support for research project	3	7

Appendix 4.A: Comparison of England and Jamaica study findings

Issue	England	Jamaica	Similar or different
Setting/ contextual issues			
Housing demand	Housebuilding was prioritised over quality place-making to achieve government housing targets. This increased the power of housebuilders	Housebuilding was prioritised over quality place-making.	Similar
Flexible local policies	Yes	Yes	Similar
Policies vs. practice	Policies generally supported good ALI design, but practice may differ	Policies generally supported good ALI design, but practice likely to differ	Similar
Resource constraints	Yes – on-going austerity with restricted local government budgets	Yes – middle-income country with limited government resources	Similar
Land values	High land values where development was expected – resulting in the need to increase densities	High land values where development was expected – resulting in the need to increase densities	Similar
Walking and cycling safety	Walking normally safe; cycling safety depended on the area. Risk of crime usually low	Walking and cycling unsafe. Poor pedestrian infrastructure common. No cycling infrastructure. Risk of crime high	Different
Public transport	Public transport generally available	Public transport limited	Different
Public open spaces	Parks available. Maintained by local government or, in some new developments, by private-sector management companies	Public parks few and far between. Promotion of public-private-partnerships for maintenance funding; Community open spaces usually managed by the community (believed to be unsustainable)	Different
Value of the environment	Environments were valued	Low value placed on open spaces and landscaping	Different
Political priority	Pedestrian infrastructure assumed and supported; Central government aspirations to increase cycling infrastructure but mixed local support; Support for open spaces but potentially acceptable for some development	Pedestrian and cycling infrastructure not prioritised and often not provided; Open spaces not valued and acceptable for development	Different
Short-term/ long-term focus	Mix of short and long term	Short-term focus, often firefighting	Different
Crime	Generally low	Generally high	Different

Public health, urban planning and transport planning			
Case study examples	Examples used but contextual relevance highly valued	Examples used but contextual relevance highly valued	Similar
Economic analysis of environment and health	Difficult to use economic analysis in the planning system since developer contributions focus on total amounts, not cost benefit ratios. Local government budgets not linked to funding for NHS.	Difficult to use economic analysis because of the short-term focus. Health costs were often borne by the individual, not the health sector. It was unclear how costs could relate between health and infrastructure.	Similar
Urban planners' use of evidence	Local data and precedence plus learning from other places, case studies and guidance etc.	Local data and precedence plus learning from other places, case studies and guidance etc.	Similar
Public health's focus on the environment	Public health practitioners in local government were interested in creating more healthy environments. Some areas had public health practitioners focussed on urban planning	Focus on individual behaviour change and infectious disease by public health. Only encouraging community open spaces with community walking trails, not walking and cycling for transport	Different
Public health's ability to influence other sectors	Public health practitioners in local government were found to able to act as knowledge brokers and inspirational leaders to non-health colleagues	Minimal cross-sectoral working therefore there was limited opportunity for influential individuals to inspire other sectors.	Different
Tackling congestion	Transport planners may support active travel as a way to reduce congestion	Road widening seen as the best way to reduce congestion	Different
Monitoring	Limited monitoring of new walking and cycling routes. Accident data collected	(Assuming none?)	Different
Other influential issues			
Demand-supply relationship	Yes – in areas with low levels of cycling there is low perceived need for cycling therefore it is not support. Vicious cycle	Yes – cycling in rarely done and there appears to be little support to provide cycle paths	Similar
Consultation for ALI-related plans	Important to engage early to influence designs before they reach formal consultation stage. This can be done by public health having a seat at the table	No formal consultation appeared to be done	Different
Changes to designs	Safety auditors can reduce the quality of ALI; Impractical designs need checking before getting on site;	Lack of funds could restrict designs; Plans not followed and enforcement not done.	Different
International organisations	N/A	International agencies could shape the agenda, making sure their regulations were followed, although possibly in a 'tick-box' fashion; Unsolicited foreign investment	Different

Appendix 5.A: Sustrans' survey of users questionnaire

Version 1 - 2011 **Sustrans Route User Survey**

sustrans JOIN THE MOVEMENT

Survey Site Number:

Interview Number:

Location:

Date (DD/MM/YY)

Time interviewed started:

Interviewer initials:

Day Type? (Select one choice only)

Weekday .... ☐ *Weekend* .... ☐ *Bank Holiday* .... ☐

School holiday or term time? (Select one choice only)

School Holidays .... ☐ *Term Time* .... ☐

Q1 Activity undertaken? (Select one choice only)

Walking .... ☐ *Wheelchair Use* .... ☐
Cycling .... ☐ *Roller Skating* .... ☐
Running/Jogging .... ☐ *Horse Riding* .... ☐
Dog Walking .... ☐ *Other* .... ☐

Q2 If you are in a group how many of you are there? (Please write)

Adults ....

Children ....

ABOUT YOUR CURRENT JOURNEY

Q3 What is the purpose of your current journey?

	Tick One From	*Tick One To*
Home	☐	☐
Home - Recreation	☐	☐
Work	☐	☐
In course of work	☐	☐
Education (school/college etc)	☐	☐
Shopping	☐	☐
Personal business	☐	☐
Visiting friends/ family	☐	☐
Social/Entertainment	☐	☐
Holiday base	☐	☐
Escort to school	☐	☐
Other escort	☐	☐
Other	☐	☐

Q4a Where did you start your journey today? Postcode, location or street name

Q4b Where will you finish your journey today? Postcode, location or street name

Q4c If you are travelling to a particular destination on your journey please state:

Q5 Approximately how long do you estimate your journey today will take? (Please write)

Hours ....

Minutes ....

Q6 Approximately how far do you estimate you will travel today (Please only insert in one box)

Miles ....

Kilometres ....

Q7 Did you or will you use any other mode of transport for part of this journey today? (Select one choice only - main type)

- *Car / Van* ☐
- *Train* ☐
- *Bus* ☐
- *Taxi* ☐
- *Jogging* ☐
- *Horse riding* ☐
- *None JUST the bike or walking* ☐

Q8 If you did use another mode of transport how far have you travelled by this mode to enable you to make this journey? Please include outward and return distances. (Select one choice only)

- *Under 1 mile* ☐
- *1 - 2 miles* ☐
- *3 - 5 miles* ☐
- *6 - 10 miles* ☐
- *11 - 15 miles* ☐
- *16 - 20 miles* ☐
- *20+ miles* ☐

Q9 How often do you make this journey? (Select one choice only)

- *Daily* ☐
- *2 - 5 times per week* ☐
- *Weekly* ☐
- *Fortnightly* ☐
- *Monthly* ☐
- *Yearly* ☐
- *Less frequently* ☐
- *Other (Write in)* ☐

Q10 If you had been unable to access this route would you still have needed to make this journey to your given destination/ wanted to make a journey for this particular purpose? (For example by another/ alternative route?)

- *Yes* ☐
- *No* ☐
- *Don't Know* ☐

Q11 Which other modes of transport could you have used to make today's journey? (Tick all that apply if not on this route) **See notes for wheelchair users**

- *Car / Van* ☐
- *Taxi* ☐
- *Bus* ☐
- *Rail* ☐
- *Don't know* ☐
- *Wouldn't have made the journey* ☐
- *Other (Write in)* ☐

Q12 Have you heard of Sustrans' routes, programmes, projects or schemes?

- *Yes* ☐
- *No* ☐

Q13 To what extent have the following factors influenced your decision to walk, cycle or use wheelchair today? (Tick the appropriate boxes)

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I can go straight to my destination	☐	☐	☐	☐	☐
It's the best transport option	☐	☐	☐	☐	☐
This is the most convenient route	☐	☐	☐	☐	☐
I save money by using this route	☐	☐	☐	☐	☐
I like the surroundings on this route	☐	☐	☐	☐	☐
This route feels safe	☐	☐	☐	☐	☐
This is the only exercise I get and/or this adds to the exercise I get from other parts of my life	☐	☐	☐	☐	☐
I have environmental concerns	☐	☐	☐	☐	☐

Q14 Do you have any long-term illness, health problem or disability which limits your daily activities or the work you can do? (Include problems due to old age)

- *Yes* ☐
- *No* ☐
- *Prefer not to say* ☐

Q15 Overall how would you rate your general health over the last four weeks? (Select one choice only)

- *Excellent* ☐
- *Very Good* ☐
- *Good* ☐
- *Fair* ☐
- *Poor* ☐
- *Very Poor* ☐

Q16 In the past week on how many days have you completed 30 minutes or more physical activity that was enough to raise your breathing rate? (This may include sport, exercise and brisk walking or cycling for recreation)

	0	1	2	3	4	5	6	7
Days	☐	☐	☐	☐	☐	☐	☐	☐

Q17 To what extent do you agree or disagree with the following statements? (Tick the appropriate boxes)

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I intend to walk more in the next 12 months	☐	☐	☐	☐	☐
I intend to cycle more in the next 12 months	☐	☐	☐	☐	☐
It is likely I will walk more in the next 12 months	☐	☐	☐	☐	☐
It is likely I will cycle more in the next 12 months	☐	☐	☐	☐	☐

ABOUT YOU

Q18 ASK CYCLISTS ONLY. What sort of cyclist would you say you were? (Select one choice only)

- *New to cycling* ☐
- *Starting to cycle again* ☐
- *Occasional cyclist* ☐
- *Experienced, occasional cyclist* ☐
- *Experienced, regular cyclist* ☐

Q19 Are you?

- *Male* ☐
- *Female* ☐

Q20 Which age group do you fit into? (Select one choice only)

- *16 - 24* ☐
- *25 - 34* ☐
- *35 - 44* ☐
- *45 - 54* ☐
- *55 - 64* ☐
- *65+* ☐

Q21 Which of the following best describes your working status? (Select one choice only)

- *Employed full-time (30+ hours)* ☐
- *Employed part time* ☐
- *Looking after home/family* ☐
- *Unemployed/sick leave* ☐
- *Retired* ☐
- *Studying* ☐
- *Voluntary worker* ☐
- *Other (write in)* ☐

Q22 How many other people live in your household? By this we mean people who have your residence as their only or main residence? (Write in number)

- Children under 5 ☐
- Children 5 - 15 ☐
- Adults 16+ (Please do not include yourself) ☐

Q23 Are you a sole carer for a child/children?

- *Yes* ☐
- *No* ☐

Q24 What is your full postcode? ☐☐☐☐☐☐☐

IF NOT UK WRITE IN THE COUNTRY ☐

Q25 Is there an ethnic group that you feel you belong to? (Select one choice only)

- *White* ☐
- *Mixed* ☐
- *Indian* ☐
- *Pakistani* ☐
- *Bangladeshi* ☐
- *Other Asian* ☐
- *Caribbean* ☐
- *African* ☐
- *Other Black* ☐
- *Chinese* ☐
- *Other Ethnic Origin* ☐
- *Prefer Not To Say* ☐

Q26 Are you a migrant worker? (Select one choice only)

- *No* ☐
- *Yes (EU Country)* ☐
- *Yes (Non EU Country)* ☐
- *Prefer not to say* ☐

Q27 Has the presence of this route helped you to increase the amount of physical activity that you regularly take? (Select one choice only)

- *Yes, by a large amount* ☐
- *Yes, by a small amount* ☐
- *No* ☐

I hereby consent to the information provided on this questionnaire to be processed by Sustrans for the purpose of monitoring the impact of their projects.

Please Tick

I agree with this statement ☐

Appendix 5.B: Additional information about Sustrans' total annual scheme users and benefit-cost ratio calculations

Total annual scheme users

Total annual scheme users were estimated by Sustrans using multiple datasets for each Connect2 scheme [386], including automatic counter data, manual counts of users and user survey data. The method for estimating numbers of users on each Connect2 scheme [386] is outlined below:

1. Map obtained of each scheme showing baseline monitoring points. An example is shown in Figure 5.B.1.
2. Using information from the map and survey of users the scheme details were understood, such as journey purpose, type of scheme, connectedness etc.
3. Average trip length calculated for each scheme based on trip lengths in the National Travel Survey [272] and the types of journey reported in the survey of users.
4. Schematic maps made for each scheme. Mapping software used to determine distances between monitoring sites and schemes divided into segments.
5. Following a series of rules (see below for details), monitoring sites were identified for inclusion or exclusion in the total annual scheme users.
6. Annual estimates of users at each monitoring site was calculated using seasonal distribution curves where less than 6 months data is available, or directly extrapolated where more than 6 months data was available. The seasonal distribution curves were derived from data on automatic cycle counters on similar schemes.
7. Total annual scheme users calculated for baseline and post-implementation: Usage estimates from monitoring sites chosen for inclusion were summed. Where double counting was identified the total annual scheme users was reduced appropriately. Where black-spots were identified the figure was increased as required.

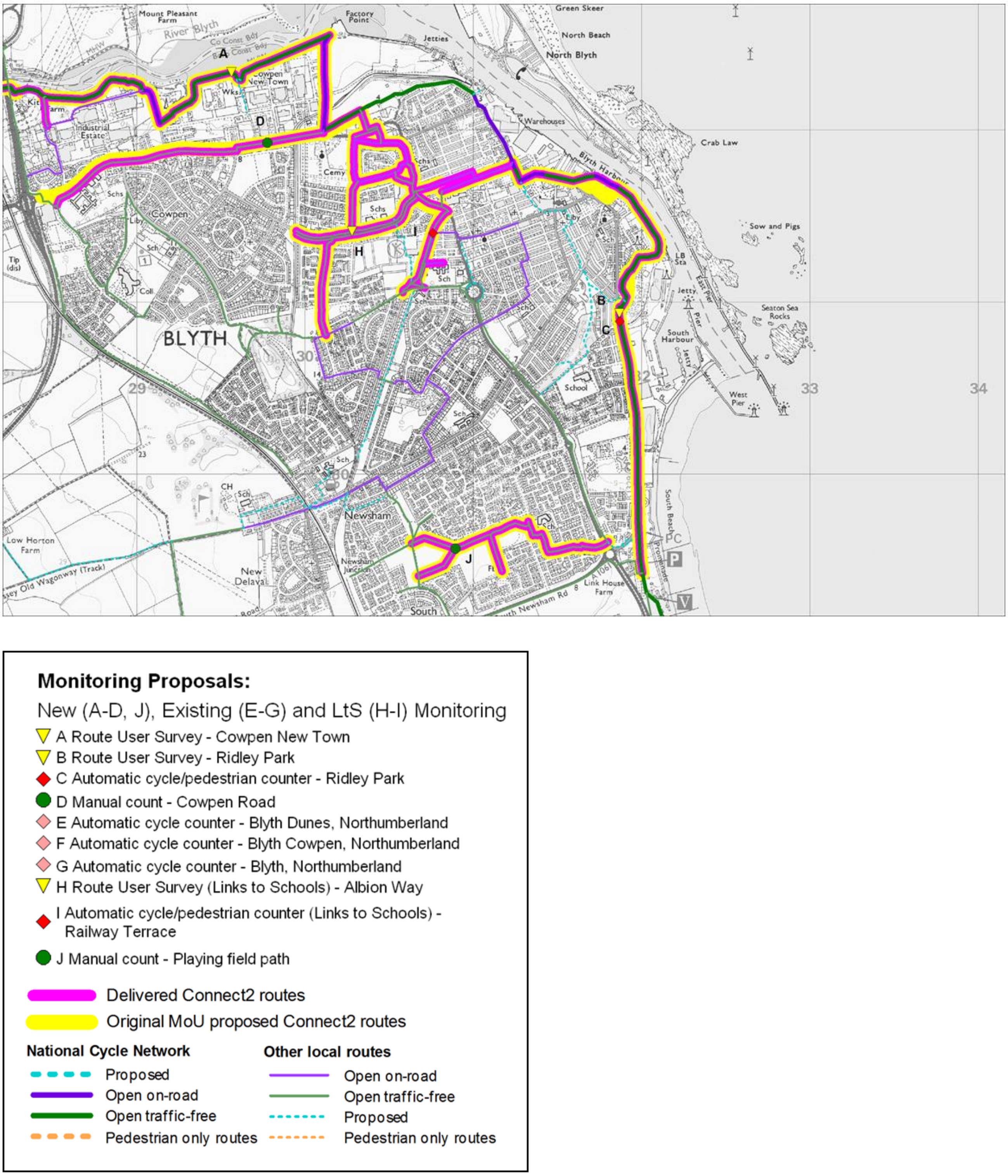

Figure 5.B.1 – Example scheme map and key showing monitoring locations

Average trip lengths

The survey of users included questions about journey origin and destination to allow journey distances to be calculated. However, this often led to unreliable responses as people did not know exact addresses for where they were going to, or in the case of leisure routes, how far they were going if it was a circular route. Therefore, it was decided that average distances for each journey type would be taken from the National Travel Survey (2002-2010) [272]. However, the National Travel Survey only records utility trips, not leisure trips (i.e. only recording journeys to a recreation location to undertake an activity rather than considering the journey itself a form of leisure as would be the case for a recreational walk or bike ride). Therefore, survey data from the National Cycle Network in 2011 was used for leisure trips. Categories 'escort to education', 'other escort', 'holiday base' and 'other' for cycling were all assigned the average trip length for all purposes (2.5 miles). This is shown in Table 5.B.1.

The survey of users was used to identify the purposes of journeys along each route and together an average route trip length was calculated.

Table 5.B.1 – Walking and cycling trip length by purpose used by Sustrans.

Purpose	Walking trip length (miles)	Cycling trip length (miles)
Commute	0.853	2.879
Leisure	2.000	8.000
In course of work	0.701	2.480
Education	0.698	1.638
Shopping	0.611	1.428
Personal business	0.595	1.746
Visit friends/family	0.684	2.016
Social/entertainment	0.792	2.629
Holiday base	0.900	2.500
Escort to school	0.542	
Other escort	0.644	
Other	0.954	

Rules to identify monitoring sites used

Many schemes had multiple monitoring points. To avoid double counting, a series of rules were followed to determine which monitoring points to be used. Two main methods were used:

a) Using route user data: Where survey data was sufficient, journey origin and destination postcodes were used to determine the percentage of trips which passed both monitoring points. This allowed reduction of monitoring figures from particular monitoring points to avoid double counting.
b) Using trip distances: Using the average trip distances by mode (from the National Travel Survey and the survey of users), and the known distance between monitoring sites, an estimation was made of how many trips were likely to be double counted:

Rule 1: Where two monitoring sites were less than half the average trip distance from each other the monitoring point with the larger overall value were used since it was assumed that users counted at one monitoring point would be counted at the other (Figure 5.B.2):

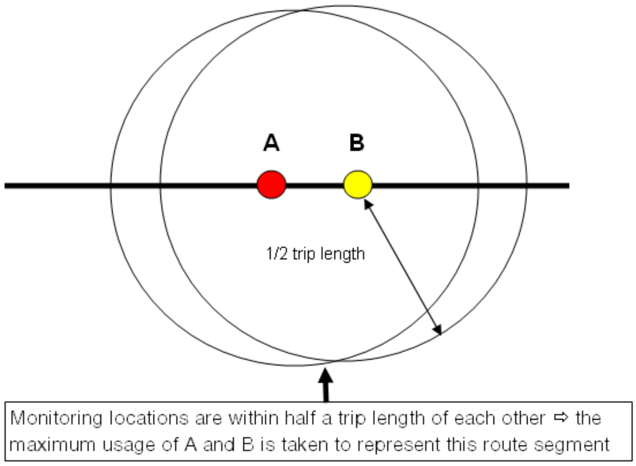

Figure 5.B.2: Rule 1 – Larger value of A or B used

Rule 2: Where the half average trip length from two monitoring points overlapped the usage at each monitoring site was summed and the total reduced by the amount assumed to pass both points based on average trip length (Figure 5.B.3):

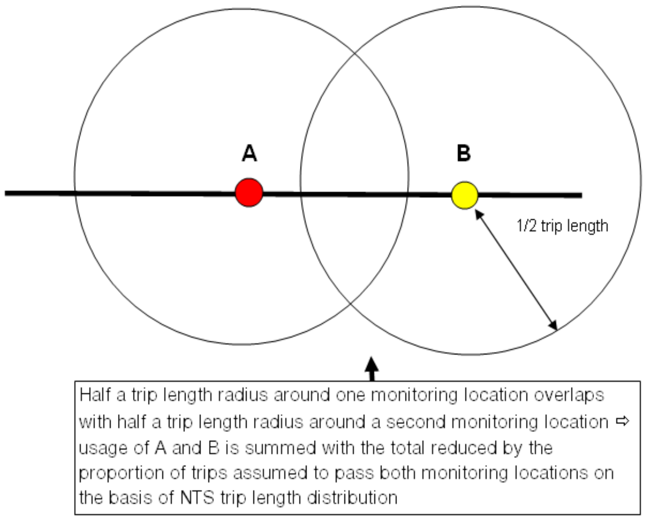

Figure 5.B.3: Rule 2 – Usage at A and B summed, then reduced by amount assumed to pass both points

Rule 3: Where the half average trip lengths from two monitoring points did not overlap then the usage from each monitoring point was summed (Figure 5.B.4):

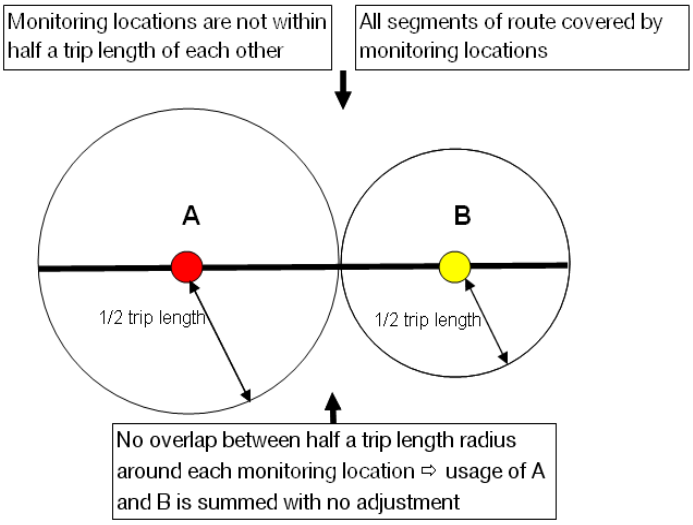

Figure 5.B.4: Rule 3 – Usage at A and B summed

Rule 4: Where segments were not covered by estimated usage from monitoring points ('black-spots') an estimate was calculated from the closest or most representative monitoring point using an estimated 'per km' usage figure (Figure 5.B.5):

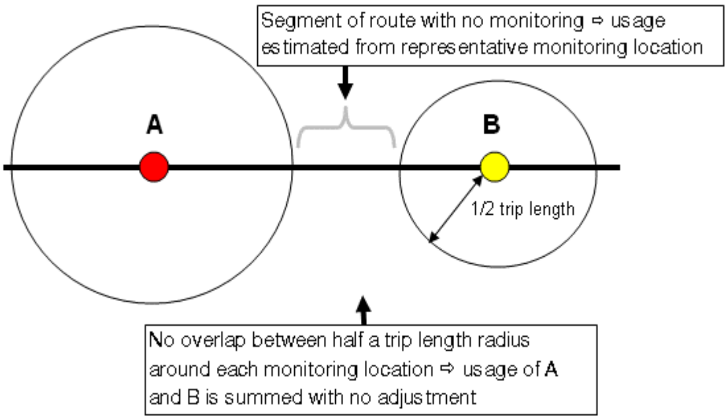

Figure 5.B.5: Rule 4 – 'Block spot' estimated using appropriate monitoring point with a 'per km' usage figure

(Annual usage on monitored route segment / length of monitored route segment) * length of unmonitored route segment = use on unmonitored route segment

The broad rules were assessed on a case-by-case basis for each scheme involving local stakeholders as appropriate. If a scheme consisted of disparate sections completely isolated from each other or not linked by continuous existing network these sections were treated separately and usage summed for each segment.

Is it acknowledged that there may be some uncertainty around users accessing routes in multiple locations and who therefore may not be captured by monitoring points.

Other adjustments

Common to transport assessments, it was assumed that 90% of journeys were return journeys and 10% were one-way journeys on the route.

As outlined above, seasonal distribution curves were used within the calculation of total annual scheme users. Sustrans assessed the reliability of using the seasonal distribution curves, compared to simply extrapolating where more than 6 months data is available. Although the data did not match exactly, it was believed that this method was the most reliable available. Although it may seem that over or under estimates are likely where the majority of data was in one season, for example if collected mostly in winter, it was found that matching count data to distribution curves where more than 6 months was available was less reliable than simply extrapolating and therefore the latter method was followed in such a scenario. Some schemes only had cycle counters. If local stakeholders believed that the nearest survey of users was not representative of pedestrian usage then a modal split using National Cycle Network data was used to estimate pedestrian usage. Whilst this may be representative of the modal split on the National Cycle Network it may not be representative on the scheme. However, it was viewed as more appropriate than using a non-representative monitoring site. Where a proxy monitoring point was used there may have been some differences between that location and the actual Connect2 sites, although they were judged to be appropriately similar by local stakeholders.

Benefit-cost ratios

Sustrans followed the WebTAG [274] (now known as Transport Analysis Guidance, see https://www.gov.uk/guidance/transport-analysis-guidance-webtag) methodology to estimate the economic benefits of the Connect2 schemes. This uses assumptions about benefits to health, car kilometres replaced and time travelled, as outlined below.

Health Economic Assessment Tool

Sustrans used a previous version of the Health Economic Assessment Tool (HEAT) [387] to calculate mortality benefits and BCRs, many of the assumptions used HEAT default values:

Assumptions used in HEAT:

- Value of statistical life: £3,229,114 [388]
- Mean annual all-cause mortality - walking: 0.004341 (HEAT default value)
- Mean annual all-cause mortality – cycling: 0.002490

- Relative risks for walking based on all-cause mortality data: 0.89 [15]
- Relative risks for cycling based on all-cause mortality data: 0.90 [15]
- Build-up for benefits: 5 years
- Build-up of uptake for walking and cycling: 2 years
- Discount rate for future resource savings: 5% (HEAT default)
- Mean annual benefit: 10 years (HEAT default)
- Assumed walking and cycling attributable to Connect2: 50%
- Respondents in pre-specified age categories (walking >20, <74; cycling >20, <64): 100% (adults only)
- Number of days cycling per year: 124 days (HEAT default)
- Discount rate for BCR: 1.5%
- Assessment period: 30 years
- Total cost of the Connect2 project: £170M

HEAT models for walking and cycling assumed that 50% of the walking and cycling was attributable to Connect2. This estimate was based on previous research suggesting that Connect2 is associated with newly induced walking and cycling and a shift from previous walking and cycling trips (Goodman et al., 2014).

An estimate of the number of days spent cycling per year among adult users of Connect2 was based on the HEAT default value of 124 days per year, the observed number of days spent cycling per year in Stockholm (Schantz & Stigell, 2008).

Car kilometres replaced

The estimated number of car kilometres replaced was found from the survey of users: the number of respondents stating that they did not use a car for any part of their journey and the percentage stating that they could have used a car instead of walking or cycling. This was applied to the average trip distance for that scheme and the difference in car kilometres replaced for the pre and post surveys gave the total car kilometres abstracted. This figure was also used to estimate carbon dioxide reduction and accident benefits. Carbon savings as a result of reduced car kilometres were valued using DECC values (£53 per tonne carbon dioxide equivalent).

The values of the marginal benefits associated with the abstraction of car km benefit was calculated using the WebTAG rate for the appropriate road type using the Marginal External Costs spreadsheet[9].

Amenity benefits

The amenity benefit of the schemes was calculated using the distance travelled for pedestrians and the time spent on the route for cyclists:

Pedestrians: Additional distance travelled by new users = (Number of trips x trip distance)$_{\text{post survey}}$ - (Number of trips x trip distance)$_{\text{pre survey}}$

Amenity benefit to new pedestrians was valued at 7.6 p/km (the sum value for amenity benefit to pedestrians from street lighting, kerb level and pavement evenness, directional signage and new benches).

Cyclists: Additional time spent on intervention by new users = ((Trip distance ÷ default speed) x number of trips)$_{\text{post survey}}$ – ((Trip distance ÷ default speed) x number of trips)$_{\text{pre survey}}$

Amenity benefit to existing cyclists was valued at:

4.73 p/min for an off-road segregated cycle path (WebTAG value), or

2.01 p/min for an on-road segregated cycle path (WebTAG value).

Amenity benefit to new users was valued at half that to existing users.

Absenteeism and accident benefits

Absenteeism benefits were valued based on average daily salary for each region. Accident benefits were valued based on the car accident rate and the costs per casualty from WebTAG.

Growth rates

Calculations assumed that the build-up in demand equalled the time between pre and post survey, followed by 5% growth rate for 10 years. This was in line with the annual average levels of growth observed by Sustrans on the National Cycle Network. For appraisal periods of longer than 10 years, no growth was assumed after the initial two years.

Appraisal period and scheme costs

Future impacts, beyond the monitoring period, were captured using a 30-year appraisal period. This differed from the DfT guidance which suggests an appraisal periods of 10 years for footpaths

[9] Updated version available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/625402/TAG_unit_a5.4_marginal_external_costs_jul17-2.pdf)

because it was anticipated that the quality of the schemes would enable them to be used for much longer than 10 years. Large infrastructure elements, such as bridges, were considered to have a functional life of 60 years. Therefore, their costs were amortised to the length of the appraisal period. This does not follow standard WebTAG guidance, for which only road or rail is considered to have a usable life of 60 years, but it was used since it was believed that this gives a fairer valuation of the infrastructure.

Scheme costs were converted to market price at baseline. Following WebTAG guidance, 3.5% discount rate was applied.

A maintenance cost of £500 per km per annum was included for all schemes. This was based on Sustrans' experience.

Appendix 5.C: iConnect questionnaire example [75]

SECTION A

About your local area

1. Firstly, we'd like to ask you about the **neighbourhood where you live**. By *neighbourhood* we mean the area that you could walk to in **10–15 minutes from your home**. How much do you agree with the following statements about your neighbourhood? **(Tick one box per row.)**

	STRONGLY AGREE	SOMEWHAT AGREE	NEITHER AGREE NOR DISAGREE	SOMEWHAT DISAGREE	STRONGLY DISAGREE
a. Walking is unsafe because of the traffic.	☐	☐	☐	☐	☐
b. Cycling is unsafe because of the traffic.	☐	☐	☐	☐	☐
c. There are no convenient routes for walking and cycling.	☐	☐	☐	☐	☐
d. There are not enough safe places to cross roads.	☐	☐	☐	☐	☐
e. The area is unsafe because of the level of crime or anti-social behaviour.	☐	☐	☐	☐	☐
f. The area is generally free from litter or graffiti.	☐	☐	☐	☐	☐
g. There are places to walk or cycle to (e.g. shops, restaurants, leisure facilities).	☐	☐	☐	☐	☐
h. There are open spaces (e.g. parks, sports fields or beaches).	☐	☐	☐	☐	☐
i. There are pavements suitable for walking.	☐	☐	☐	☐	☐
j. There are special lanes, routes or paths for cycling.	☐	☐	☐	☐	☐
k. There are many road junctions.	☐	☐	☐	☐	☐
l. There are many different routes for walking and cycling so I don't have to go the same way every time.	☐	☐	☐	☐	☐
m. The area is pleasant for walking or cycling.	☐	☐	☐	☐	☐

2. Now we would like to ask you about **travelling between Penarth and Cardiff Bay**. To what extent do you agree with the following statements? **(Tick one box per row.)**

	STRONGLY AGREE	SOMEWHAT AGREE	NEITHER AGREE NOR DISAGREE	SOMEWHAT DISAGREE	STRONGLY DISAGREE
a. Walking is unsafe because of the traffic.	☐	☐	☐	☐	☐
b. Cycling is unsafe because of the traffic.	☐	☐	☐	☐	☐
c. The level of crime or anti-social behaviour means walking or cycling is unsafe.	☐	☐	☐	☐	☐
d. There are pavements suitable for walking.	☐	☐	☐	☐	☐
e. There are special lanes, routes or paths for cycling.	☐	☐	☐	☐	☐
f. The routes for walking and cycling are generally well lit at night.	☐	☐	☐	☐	☐
g. The routes are pleasant for walking or cycling.	☐	☐	☐	☐	☐

About your travel

SECTION **B**

We are interested in your views about

walking and cycling to travel from place to place.

By *walking and cycling to travel*, we mean any walking and cycling you do to get to places. For example, going to work, going out to get lunch, coming home from work, going shopping, going to the bus or railway station, visiting friends, or escorting someone else (for example, taking a child to school). ⚠ **We do not** mean any walking or cycling you do for recreation, health or fitness—we will ask you about this later.

PLEASE COMPLETE THESE QUESTIONS EVEN IF YOU DON'T DO MUCH WALKING OR CYCLING.

3. Think about **walking to travel** from place to place.
How much do you agree with the following statements? **(Tick one box per row.)**

	STRONGLY AGREE	SOMEWHAT AGREE	NEITHER AGREE NOR DISAGREE	SOMEWHAT DISAGREE	STRONGLY DISAGREE
a. Walking to travel from place to place is something I do automatically without really thinking about it.	☐	☐	☐	☐	☐
b. It is beneficial for me to walk for travel.	☐	☐	☐	☐	☐
c. Walking for travel is enjoyable.	☐	☐	☐	☐	☐
d. The people in my life whose opinions I value most would approve of me walking for travel.	☐	☐	☐	☐	☐
e. Most people who are important to me walk for travel.	☐	☐	☐	☐	☐
f. It is possible for me to walk for travel.	☐	☐	☐	☐	☐
g. It is mostly up to me whether I walk for travel.	☐	☐	☐	☐	☐
h. I intend to do more walking for travel over the coming months.	☐	☐	☐	☐	☐
i. I see people in my neighbourhood walking for travel.	☐	☐	☐	☐	☐
j. Over the last 12 months I have done more walking for travel.	☐	☐	☐	☐	☐

4. Think about **cycling to travel** from place to place.
How much do you agree with the following statements? **(Tick one box per row.)**

	STRONGLY AGREE	SOMEWHAT AGREE	NEITHER AGREE NOR DISAGREE	SOMEWHAT DISAGREE	STRONGLY DISAGREE
a. Cycling to travel from place to place is something I do automatically without really thinking about it.	☐	☐	☐	☐	☐
b. It is beneficial for me to cycle for travel.	☐	☐	☐	☐	☐
c. Cycling for travel is enjoyable.	☐	☐	☐	☐	☐
d. The people in my life whose opinions I value most would approve of me cycling for travel.	☐	☐	☐	☐	☐
e. Most people who are important to me cycle for travel.	☐	☐	☐	☐	☐
f. It is possible for me to cycle for travel.	☐	☐	☐	☐	☐
g. It is mostly up to me whether I cycle for travel.	☐	☐	☐	☐	☐
h. I intend to do more cycling for travel over the coming months.	☐	☐	☐	☐	☐
i. I see people in my neighbourhood cycling for travel.	☐	☐	☐	☐	☐
j. Over the last 12 months I have done more cycling for travel.	☐	☐	☐	☐	☐

The next set of questions asks about the **vehicles** you have access to and the vehicles you actually use.

5. How many of the following vehicles are kept in your household? (Include all vehicles kept overnight.)

	WRITE IN NUMBER	IF ZERO, TICK HERE		WRITE IN NUMBER	IF ZERO, TICK HERE
Bicycles for adults		☐	Private cars and vans		☐
Bicycles for children		☐	Motorcycles		☐
Company cars and vans		☐			

6. Please tell us about the **cars and vans** you **actually use**. These may be among the cars or vans from the previous question, but they could also include other vehicles owned by friends or family.
If you do not use any cars or vans please tick here ☐ and go to question 8.

VEHICLE NO.	MAKE AND MODEL	FUEL TYPE	ENGINE SIZE	AGE (IN YEARS)	HOW MUCH HAVE YOU SPENT ON FUEL FOR THIS VEHICLE IN THE LAST seven (7) DAYS?
1		☐ PETROL ☐ DIESEL ☐ OTHER (PLEASE SPECIFY): __________	☐ LESS THAN 1.4 LITRES ☐ 1.4–2.0 LITRES ☐ MORE THAN 2.0 LITRES		£ TICK HERE IF £0 ☐
2		☐ PETROL ☐ DIESEL ☐ OTHER (PLEASE SPECIFY): __________	☐ LESS THAN 1.4 LITRES ☐ 1.4–2.0 LITRES ☐ MORE THAN 2.0 LITRES		£ TICK HERE IF £0 ☐
3		☐ PETROL ☐ DIESEL ☐ OTHER (PLEASE SPECIFY): __________	☐ LESS THAN 1.4 LITRES ☐ 1.4–2.0 LITRES ☐ MORE THAN 2.0 LITRES		£ TICK HERE IF £0 ☐
4		☐ PETROL ☐ DIESEL ☐ OTHER (PLEASE SPECIFY): __________	☐ LESS THAN 1.4 LITRES ☐ 1.4–2.0 LITRES ☐ MORE THAN 2.0 LITRES		£ TICK HERE IF £0 ☐

7. Which of these **vehicles did you use most** over the **last seven (7) days**?
(Please refer to question 6 for the **vehicle number**.)

We'd now like to ask about

your journeys in the last seven days

Please include all the journeys you made however long or short, using any method of transport, not just walking and cycling. **Four points to note** ① A return journey counts as one journey. For example, if you travelled to work and back five (5) times, this counts as five (5) journeys. ② Where a return journey involves a number of purposes, please give the **main** purpose. ③ Include all methods of travel you used as part of a journey (e.g. walking to a bus stop and then catching the bus). ④ If you spent time waiting for public transport please include this within the public transport journey time. Here is an example:

FIVE (5) RETURN JOURNEYS TO WORK

10 minutes (each way) x 5 (return journeys) = 100 minutes (1 hour 40 minutes)
0.5 miles (each way) x 5 (return journeys) = 5 miles
20 minutes (each way) x 5 (return journeys) = 200 minutes (3 hours 20 minutes)
25 miles (each way) x 5 (return journeys) = 250 miles

PLEASE COMPLETE THESE QUESTIONS EVEN IF YOU DON'T TRAVEL AROUND VERY MUCH IN GENERAL OR YOU DO NOT DO VERY MUCH WALKING OR CYCLING.

8. Think about your **journeys to and from work**.
(e.g. travel to and from your place of work, accompanying your spouse to and from their work).

a. How often did you make such a journey over the **last seven (7) days**? ☐ TIMES ☐ IF ZERO TIMES, TICK HERE AND GO TO QUESTION 9.

b. How much time in total over the last seven (7) days did you spend travelling **to and from work** by:

	HOURS	MINUTES
Walking		
Cycle		
Bus		
Train		
Car, as a driver		
Car, as a passenger		
Other (please specify): ____________		

c. How far did you travel in total over the last seven (7) days **to and from work** by:

	MILES
Walking	
Cycle	
Bus	
Train	
Car, as a driver	
Car, as a passenger	
Other (please specify): ____________	

9. Think about your **business journeys**, by which we mean any journeys in the course of your work or on employer's business (e.g. travel to and from meetings, making deliveries, etc.)

a. How often did you make such a journey over the **last seven (7) days**? ☐ TIMES ☐ IF ZERO TIMES, TICK HERE AND GO TO QUESTION 10.

b. How much time in total over the last seven (7) days did you spend travelling **on business journeys** by:

	HOURS	MINUTES
Walking		
Cycle		
Bus		
Train		
Car, as a driver		
Car, as a passenger		
Other (please specify): ___________		

c. How far did you travel in total over the last seven (7) days **on business journeys** by:

	MILES
Walking	
Cycle	
Bus	
Train	
Car, as a driver	
Car, as a passenger	
Other (please specify): ___________	

10. Think about your **journeys to and from a place of study** (e.g. travel to and from your university or college) or **to and from school** (e.g. if you accompany a child to and from school).

a. How often did you make such a journey over the **last seven (7) days**? ☐ TIMES ☐ IF ZERO TIMES, TICK HERE AND GO TO QUESTION 11.

b. How much time in total over the last seven (7) days did you spend travelling **to and from a place of study** or **school** by:

	HOURS	MINUTES
Walking		
Cycle		
Bus		
Train		
Car, as a driver		
Car, as a passenger		
Other (please specify): ___________		

c. How far did you travel in total over the last seven (7) days **to and from a place of study** or **school** by:

	MILES
Walking	
Cycle	
Bus	
Train	
Car, as a driver	
Car, as a passenger	
Other (please specify): ___________	

11. Think about your **journeys for shopping and personal business**
(e.g. food shopping, non-food shopping, window-shopping, visiting a doctor, bank, solicitor or estate agents,visiting a relative in hospital, or accompanying someone else to a doctor, hospital etc.).

a. How often did you make such a journey over the **last seven (7) days**? ☐ TIMES ☐ IF ZERO TIMES, TICK HERE AND GO TO QUESTION 12.

b. How much time in total over the last seven (7) days did you spend travelling for **shopping and personal business** by:

	HOURS	MINUTES
Walking		
Cycle		
Bus		
Train		
Car, as a driver		
Car, as a passenger		
Other (please specify): ___________		

c. How far did yo travel in total over the last seven (7) days for **shopping and personal business** by:

	MILES
Walking	
Cycle	
Bus	
Train	
Car, as a driver	
Car, as a passenger	
Other (please specify): ___________	

12. Think about your **journeys to visit friends and relatives** and for **other social activities**.
(e.g. a journey to and from the cinema or other entertainment facilities).

a. How often did you make such a journey over the **last seven (7) days**? ☐ TIMES ☐ IF ZERO TIMES, TICK HERE AND GO TO QUESTION 13.

b. How much time in total over the last seven (7) days did you spend travelling to **visit friends or relatives** or for **other social activities** by:

	HOURS	MINUTES
Walking		
Cycle		
Bus		
Train		
Car, as a driver		
Car, as a passenger		
Other (please specify): ___________		

c. How far did you travel in total over the last seven (7) days to **visit friends or relatives** or for **other social activities** by:

	MILES
Walking	
Cycle	
Bus	
Train	
Car, as a driver	
Car, as a passenger	
Other (please specify): ___________	

SECTION C

About your recreation and leisure-time activities

We are interested in your views about

walking and cycling for recreation.

By *walking and cycling for recreation*, we mean any walking and cycling you have done for leisure, health or fitness including, for example, walking or cycling in parks or along trails or walking the dog. ⚠ **We do not** mean walking or cycling you may do for the primary purpose of travel to get from place to place.

PLEASE COMPLETE THESE QUESTIONS EVEN IF YOU DON'T DO MUCH WALKING OR CYCLING.

13. Think about **walking for recreation**. How much do you agree with the following statements? **(Tick one box per row.)**

	STRONGLY AGREE	SOMEWHAT AGREE	NEITHER AGREE NOR DISAGREE	SOMEWHAT DISAGREE	STRONGLY DISAGREE
a. Walking for recreation is something I do automatically without really thinking about it.	☐	☐	☐	☐	☐
b. It is beneficial for me to walk for recreation.	☐	☐	☐	☐	☐
c. Walking for recreation is enjoyable.	☐	☐	☐	☐	☐
d. The people in my life whose opinions I value most would approve of me walking for recreation.	☐	☐	☐	☐	☐
e. Most people who are important to me walk for recreation.	☐	☐	☐	☐	☐
f. It is possible for me to walk for recreation.	☐	☐	☐	☐	☐
g. It is mostly up to me whether I walk for recreation.	☐	☐	☐	☐	☐
h. I intend to do more recreational walking over the coming months.	☐	☐	☐	☐	☐
i. I see people in my neighbourhood walking for recreation.	☐	☐	☐	☐	☐
j. Over the last 12 months I have done more walking for recreation.	☐	☐	☐	☐	☐

14. In the **last seven (7) days**, did you do any **walking** for recreation, health or fitness?

☐ YES
☐ NO (IF NO GO TO Q15.)

a. In the **last seven (7) days**, how many times did you **walk** for recreation, health or fitness (including walking your dog)? ☐ TIMES

b. Please estimate the total time you spent **walking** for recreation, health or fitness in the **last seven (7) days** (e.g. 2 times x 20 minutes = 40 minutes). HOURS ☐ MINUTES ☐

15. Think about **cycling for recreation**. How much do you agree with the following statements? **(Tick one box per row.)**

	STRONGLY AGREE	SOMEWHAT AGREE	NEITHER AGREE NOR DISAGREE	SOMEWHAT DISAGREE	STRONGLY DISAGREE
a. Cycling for recreation is something I do automatically without really thinking about it.	☐	☐	☐	☐	☐
b. It is beneficial for me to cycle for recreation.	☐	☐	☐	☐	☐
c. Cycling for recreation is enjoyable.	☐	☐	☐	☐	☐
d. The people in my life whose opinions I value most would approve of me cycling for recreation.	☐	☐	☐	☐	☐
e. Most people who are important to me cycle for recreation.	☐	☐	☐	☐	☐
f. It is possible for me to cycle for recreation.	☐	☐	☐	☐	☐
g. It is mostly up to me whether I cycle for recreation.	☐	☐	☐	☐	☐
h. I intend to do more recreational cycling over the coming months.	☐	☐	☐	☐	☐
i. I see people in my neighbourhood cycling for recreation.	☐	☐	☐	☐	☐
j. Over the last 12 months I have done more cycling for recreation.	☐	☐	☐	☐	☐

16. In the **last seven (7) days**, did you do any **cycling** for recreation, health or fitness?

☐ YES
☐ NO (IF NO GO TO Q17.)

a. In the **last seven (7) days**, how many times did you **cycle** for recreation, health or fitness? ☐ TIMES

b. Please estimate the total time you spent **cycling** for recreation, health or fitness in the **last seven (7) days**. (e.g. 2 times x 20 minutes = 40 minutes). HOURS ☐ MINUTES ☐

The next set of questions is about **other leisure-time physical activities** that you have done in the **last seven (7) days**, besides what you have already mentioned. ⚠ Please do not include any walking or cycling in answering the questions below.

17. In the **last seven (7) days**, did you do any vigorous-intensity, leisure-time physical activities like jogging, aerobics or competitive tennis? **Do not** include walking or cycling or moderate-intensity physical activities. Vigorous-intensity physical activities make you breathe harder or puff and pant.

☐ YES
☐ NO (IF NO GO TO Q18.)

a. In the **last seven (7) days**, how many times did you do vigorous-intensity, leisure-time physical activities which made you breathe harder or puff and pant? ☐ TIMES

b. Please estimate the total time you spent doing vigorous-intensity, leisure-time physical activities in the **last seven (7) days**. HOURS ☐ MINUTES ☐

18. Apart from what you have already mentioned, in the **last seven (7) days**, have you done any other moderate-intensity, leisure-time physical activities like gentle swimming, social tennis, golf or heavy gardening? Moderate intensity physical activities make you breathe somewhat harder than normal.

☐ YES
☐ NO (IF NO GO TO Q19.)

a. In the **last seven (7) days**, how many times did you do moderate-intensity, leisure-time physical activities which made you breathe somewhat harder than normal? ☐ TIMES

b. Please estimate the total time you spent doing moderate-intensity, leisure-time physical activities in the **last seven (7) days**. HOURS ☐ MINUTES ☐

SECTION

D

About your local pedestrian and cycling routes

You may be aware that in the past year a new bridge for pedestrians and cyclists has been opened over the River Ely in Cardiff Bay. This is known locally as the Pont-y-Werin Bridge "The People's Bridge".

19. Had you heard of the People's Bridge before completing this survey?

☐ YES
☐ NO

20. Do you use the People's Bridge?

☐ YES
☐ NO (IF NO GO TO Q23.)

21. Think about the People's Bridge ...and **walking**. Do you **walk** across the People's Bridge ...?

	YES	NO
a. On your way to or from work.	☐	☐
b. For business-related journeys.	☐	☐
c. On your way to or from a place of study (e.g. college/university).	☐	☐
d. To get to the shops or for personal business (e.g. visiting a doctor, bank, solicitor or estate agents).	☐	☐
e. On your way to visit friends and relatives or to do other social activities.	☐	☐
f. For recreation, health or fitness.	☐	☐

22. Think about the People's Bridge ...and **cycling**. Do you **cycle** across the People's Bridge ...?

	YES	NO
a. On your way to or from work.	☐	☐
b. For business-related journeys.	☐	☐
c. On your way to or from a place of study (e.g. college/university).	☐	☐
d. To get to the shops or for personal business (e.g. visiting a doctor, bank, solicitor or estate agents).	☐	☐
e. On your way to visit friends and relatives or to do other social activities.	☐	☐
f. For recreation, health or fitness.	☐	☐

SECTION E

About your work or place of study

23. Think about the work you do. Which of these best describes your situation at present? **(Tick one only.)**

- Doing paid work full-time ☐
- Doing paid work part-time ☐
- Full-time student ☐

GO TO QUESTION 24A

- Unemployed ☐
- Retired ☐
- Looking after home or family ☐
- Permanently sick or disabled ☐
- Other (please specify) ____________________ ☐

GO TO SECTION F

24a. What is the postcode of your **main** place of work or study? ☐☐☐☐ ☐☐☐

24b. If you do not know the postcode, please give the address of your place of work or study

25. Please **tick** the option that **best** corresponds with your work or study. **(Tick one only.)**

Sedentary occupation
You spend most of your time sitting
(e.g. in an office, driving a vehicle). ☐

Standing occupation
You spend most of your time standing or walking.
However, your work does not require intense physical effort
(e.g. shop assistant, hairdresser, guard). ☐

Manual work
This involves some physical effort including
handling of heavy objects and use of tools
(e.g. plumber, electrician, carpenter). ☐

Heavy manual work
This implies very vigorous physical activity
including handling of very heavy objects
(e.g. dock worker, miner, bricklayer, construction worker). ☐

SECTION F

About you and your household

26. Are you male or female? **(Tick one only.)** ☐ MALE ☐ FEMALE

27. How old are you? ☐ YEARS

28. How much do you weigh in light indoor clothes? ☐ STONES ☐ LBS or ☐ KG

29. How tall are you without shoes on? ☐ FEET ☐ INCHES or ☐ CM

30. Do you have any long-term illness, health problem or disability which limits your daily activities or the work you can do? (Include problems which are due to old age.) ☐ YES ☐ NO

31. Would you say that for someone of your age your own health in general is… **(Tick one only.)**

- Excellent ☐
- Good ☐
- Fair ☐
- Poor ☐

32. Which of the following groups do you consider you belong to? **(Tick one only.)**

- White ☐
- Mixed ethnic group ☐
- Asian or Asian British ☐
- Black or Black British ☐
- Other (Please specify): ________________ ☐

33. What is your highest educational qualification? **(Tick one only.)**

- Degree, NVQ4, NVQ5 (or equivalent) ☐
- BTEC (Higher), BEC (Higher), TEC (Higher), HNC, HND (or equivalent) ☐
- GCE 'A' Level, NVQ3, Scottish Higher (or equivalent) ☐
- BTEC (National), BEC (National), TEC (National), ONC, OND (or equivalent) ☐
- GCSE Grades A to C, GCE 'O' Level, CSE Grade 1, NVQ2 (or equivalent) ☐
- Other qualifications ☐
- No formal qualifications ☐

34. What is the postcode of your home? ☐☐☐☐ ☐☐☐

35. How long have you lived in your current home? ☐ YEARS ☐ MONTHS

36. How many people, other than you, live in your household?
We mean people who have your accommodation as their only or main residence, and who either share at least one meal a day with you or share the living accommodation (living room or sitting room) with you. **(Write in number.)**

Children aged under 5	☐	IF NONE, TICK HERE. ☐
Children aged between 5 and 15	☐	IF NONE, TICK HERE. ☐
Adults aged 16 and over (do not include yourself)	☐	IF NONE, TICK HERE. ☐

37. Does your household own or rent its accommodation? **(Tick one only.)**

- Rents it from the council, a housing association or a charity ☐
- Rents it from a private landlord or letting agency ☐
- Partly owns it and partly rents it (shared ownership) ☐
- Owns it (including buying with a mortgage) ☐
- Other ☐

38. What is your total household income from all sources before tax? **(Tick one only.)**

- Up to £10,000 ☐
- £10,001–£20,000 ☐
- £20,001–£30,000 ☐
- £30,001–£40,000 ☐
- £40,001–£50,000 ☐
- More than £50,000 ☐
- Don't know ☐

39. Are you aware of, or taking part in, any projects in your area relating to walking and cycling? ☐ YES ☐ NO

If yes, please specify: ____________________

____

____

____

40. Please enter the date on which you are completing this survey.

DAY ☐☐ MONTH ☐☐ YEAR ☐☐

41. Are there any other comments you would like to add?

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Appendix 5.D: Additional data tables

Table 5.D.1: Estimated total annual scheme users (from Sustrans)

Scheme	Pre Cycling	Post Cycling	% Change Cycling	Pre Walking	Post Walking	% Change Walking	Pre Total	Post Total	Total Change	% Total Change	BCR
Argoed	5,683	5,583	-2%	9,722	29,462	203%	15,405	35,045	19,640	127%	17.2
Ballymoney	9,716	13,058	34%	83,510	184,112	120%	93,226	197,169	103,944	111%	11.5
Bath	29,238	136,347	366%	85,042	127,851	50%	114,280	264,198	149,918	131%	3.4
Bedlington	34,557	49,297	43%	290,548	502,571	73%	325,105	551,868	226,763	70%	3.3
Bethnal Green	32,917	49,275	50%	234,513	534,883	128%	267,430	584,158	316,728	118%	9.0
Birmingham	20,284	38,460	90%	330,717	398,060	20%	351,000	436,520	85,520	24%	4.0
Blandford	-	44,692	N/A	-	141,226	N/A	-	185,918	185,918	N/A	15.0
Blyth	51,224	86,111	68%	609,925	682,700	12%	606,056	736,403	130,347	22%	3.5
Bradford	2,003	9,608	380%	252,993	393,169	55%	254,996	402,777	147,781	58%	1.4
Bristol	196,292	352,239	79%	284,382	524,998	85%	480,674	877,238	396,563	83%	15.2
Brompton	14,614	9,935	-32%	27,034	10,240	-62%	41,648	20,175	-21,473	-52%	1.0
Bury	37,406	42,955	15%	227,688	281,181	23%	265,094	324,136	59,042	22%	9.4
Cardiff	60,330	129,722	115%	214,904	382,738	78%	275,234	512,460	237,226	86%	3.0
Carlton	10,019	23,667	136%	35,910	55,225	54%	45,929	78,891	32,962	72%	5.4
Cheshunt	2,818	24,637	774%	29,518	234,445	694%	32,336	259,082	226,746	701%	0.8
Chester	30,884	35,591	15%	1,610,512	2,093,566	30%	1,641,396	2,129,157	487,761	30%	21.9
Clydach	29,998	31,610	5%	30,196	73,520	143%	60,194	105,130	44,936	75%	3.5
Conkers	10,811	4,162	-61%	9,259	7,079	-24%	20,070	11,241	-8,829	-44%	0.3
Conwy	15,189	37,461	147%	1,768	6,417	263%	16,957	43,878	26,920	159%	3.2
Croydon	15,140	29,527	95%	315,421	1,178,256	274%	330,561	1,207,783	877,221	265%	16.1
Dartford	19,993	10,870	-46%	143,816	211,186	47%	163,809	222,056	58,248	36%	3.0
Derry	-	-	-	-	-	-	-	-	-	-	-
Dewsbury	11,315	25,705	127%	24,090	79,817	231%	35,405	105,522	70,117	198%	3.2
Dover	11,368	22,269	96%	543,678	791,084	46%	555,046	813,353	258,307	47%	22.3
Dumfries	19,333	37,276	93%	48,191	70,552	46%	67,524	107,828	40,304	60%	5.8
Everton Park	2,040	8,073	296%	285,395	227,302	-20%	287,435	235,375	-52,060	-18%	0.8
Falkirk	7,677	10,809	41%	35,989	34,194	-5%	43,666	45,003	1,338	3%	3.1
Foryd Harbour (Rhyl)	-	49,472	N/A	-	338,494	N/A	-	387,966	N/A	N/A	-
Glasgow	64,524	100,978	56%	616,896	800,629	30%	681,420	901,607	220,187	32%	1.4
Hamilton	19,408	31,030	60%	285,885	336,907	18%	305,294	367,937	62,643	21%	2.1
Haringey	66,314	71,905	8%	707,056	829,869	17%	773,370	901,774	128,404	17%	10.8
Harrogate	11,428	188,421	1549%	154,875	372,402	140%	166,303	560,823	394,519	237%	44.4
Hastings	23,360	85,699	267%	80,273	132,194	65%	103,633	217,893	114,260	110%	17.5
Havering	53,741	58,912	10%	572,838	694,594	21%	626,580	753,506	126,926	20%	3.3
Hereford	56,397	58,456	4%	49,549	50,720	2%	105,946	109,176	3,230	3%	2.6
Huyton	3,198	6,488	103%	60,257	39,400	-35%	63,455	45,888	-17,566	-28%	1.0
Islington	266,410	235,962	-11%	607,834	834,312	37%	874,244	1,070,274	196,029	22%	8.0
Kenilworth	8,159	70,755	767%	62,475	184,606	195%	70,634	255,360	184,726	262%	10.9
Killamarsh	69,715	83,220	19%	69,244	95,586	38%	138,959	178,806	39,847	29%	5.2
Kirkby	26,282	30,877	17%	246,108	213,617	-13%	272,390	244,494	-27,896	-10%	3.4
Leeds	18,083	35,108	94%	148,322	218,482	47%	166,405	253,590	87,185	52%	12.4
Leicestershire	67,285	95,815	42%	363,671	511,205	41%	430,956	607,020	176,064	41%	8.0
Luton	18,902	49,163	160%	44,823	96,788	116%	63,725	145,951	82,226	129%	6.5

Scheme	Pre Cycling	Post Cycling	% Change Cycling	Pre Walking	Post Walking	% Change Walking	Pre Total	Post Total	Total Change	% Total Change	BCR
Merthyr	4,084	4,745	16%	55,742	73,786	32%	59,825	78,531	18,705	31%	4.7
Monmouth	9,904	11,293	14%	196,630	232,649	18%	206,534	243,942	37,408	18%	2.2
Nantwich	42,626	61,162	43%	67,396	107,931	60%	110,022	169,093	59,071	54%	4.0
Newport	20,692	77,745	276%	131,929	327,020	148%	152,622	404,765	252,143	165%	7.9
Newton Abbot	65,893	62,196	-6%	231,929	316,509	36%	297,822	378,705	80,883	27%	3.1
Newtownabbey	38,325	37,090	-3%	43,621	50,193	15%	81,946	87,283	5,337	7%	0.5
Northampton	58,880	85,925	46%	78,437	130,968	67%	137,317	216,893	79,576	58%	2.9
Northwich	14,969	53,696	259%	85,472	254,401	198%	100,441	308,097	207,656	207%	7.9
Norwich	161,772	186,910	16%	209,408	347,101	66%	371,180	534,011	162,832	44%	7.6
Omagh	5,853	8,067	38%	31,671	33,899	7%	37,525	41,966	4,441	12%	0.7
Ottery	14,031	20,766	48%	55,498	82,136	48%	69,529	102,902	33,373	48%	3.7
Padiham	19,967	33,669	69%	311,995	393,587	26%	331,962	427,256	95,294	29%	4.1
Plymouth	110,247	135,701	23%	672,637	1,095,750	63%	782,884	1,231,451	448,567	57%	9.2
Port Talbot	25,426	40,255	58%	82,227	130,035	58%	107,653	170,290	62,637	58%	8.8
Radstock	638	18,836	2852%	18,030	49,704	176%	18,668	68,540	49,872	267%	2.8
Rochdale	55,853	63,989	15%	190,204	227,233	19%	246,056	291,222	45,165	18%	3.1
Royston	8,959	34,128	281%	66,525	79,175	19%	75,484	113,302	37,818	50%	1.0
Rugby	32,968	65,708	99%	272,672	229,452	-16%	305,640	295,160	-10,481	-3%	3.3
Sale	42,821	225,998	428%	144,731	573,289	296%	187,552	799,287	611,735	326%	31.7
Scunthorpe	50,045	59,155	18%	130,674	179,721	38%	180,719	238,876	58,156	32%	0.7
Shoreham	83,865	137,968	65%	673,147	742,128	10%	757,013	880,097	123,084	16%	3.6
Shrewsbury	45,330	43,452	-4%	894,522	514,172	-43%	939,852	557,624	-382,228	-41%	1.4
Sleaford	34,597	53,880	56%	306,832	540,129	76%	341,428	594,008	252,580	74%	3.7
South Bermondsey	-	116,226	N/A	-	1,979,371	N/A	-	2,095,597	N/A	N/A	-
Southampton	87,607	99,048	13%	785,651	552,804	-30%	873,257	651,852	-221,405	-25%	1.7
St Helens	-	10,673	N/A	-	81,447	N/A	-	92,120	N/A	N/A	-
St Neots	48,766	74,024	52%	257,891	287,965	12%	306,657	361,988	55,332	18%	2.1
Stockbridge	-	6,935	N/A	-	30,744	N/A	-	37,679	37,679	N/A	11.6
Stockport (Marple)	6,898	12,479	81%	26,889	18,522	-31%	33,786	31,001	-2,786	-8%	0.6
Swindon	172,865	189,566	10%	95,266	57,792	-39%	268,131	247,358	-20,773	-8%	11.2
Titanic Quarter	74,740	137,614	84%	290,692	310,703	7%	365,432	448,317	82,885	23%	32.5
Topsham	107,719	109,749	2%	27,722	35,781	29%	135,441	145,530	10,089	7%	13.2
Treforest	14,916	15,220	2%	21,738	22,182	2%	36,654	37,402	748	2%	0.6
Tyne Dock	68,441	99,645	46%	61,002	60,955	0%	129,443	160,600	31,157	24%	7.6
Watton	12,361	38,308	210%	84,960	185,717	119%	97,321	224,025	126,704	130%	7.5
Westminster	19,767	43,266	119%	153,030	233,071	52%	172,797	276,336	103,539	60%	14.6
Weymouth	332,506	374,807	13%	2,072,786	2,000,593	-3%	2,405,292	2,375,400	-29,892	-1%	6.8
Whitstable	66,103	140,091	112%	1,132,798	1,119,768	-1%	1,198,901	1,259,859	60,958	5%	17.0
Wicken Fen	2,316	19,157	727%	4,084	22,335	447%	6,400	41,492	35,092	548%	1.1
Worcester	168,629	208,459	24%	1,926,199	3,137,672	63%	2,094,828	3,346,131	1,251,303	60%	30.8
Workington	-	27,151	N/A	-	179,144	N/A	-	206,295	N/A	N/A	-

Table 5.D.2: Change in estimated total annual users across all schemes (Number of schemes = 77, using total annual scheme users)

Mode	Pre		Post		Change			% increase		
	Median	IQR	Median	IQR	Median	IQR	p-value	Median	IQR	p-value
Walking	144,731	235,194	227,302	437,419	51,022	129,634	1.05e-08	**38**	**64.3**	**1.07e-09**
Cycling	26,282	47,452	49,163	61,474	14,829	23,823	7.41e-12	**51.8**	**100.2**	**3.83e-12**
Walking & cycling combined	172,797	270,794	259,082	447,521	62,643	135,912	2.13e-10	**35.6**	**66.2**	**1.11e-10**

Table 5.D.3: Reasons for choosing to use routes and additional travel modes & distances across all schemes (Number of schemes = 84), except where scheme is specified

		Pre										Post									
		Total	Women	Cyclists	Female cyclists	65+	Disabled	Most deprived	Cardiff	Southampton	Kenilworth	Total	Women	Cyclists	Female cyclists	65+	Disabled	Most deprived	Cardiff	Southampton	Kenilworth
To what extent have the following factors influenced your decision to walk, cycle or use wheelchair today? (Agree/strongly agree (%))	I like the surroundings on this route	80	80	84	85	88	86	76	92	79	93	85	86	88	88	89	86	90	90	76	99
	This is the most convenient route	75	76	75	75	77	80	78	54	89	56	82	83	81	80	82	82	80	80	82	98
	This route feels safe	72	71	76	76	78	77	70	79	78	77	81	80	85	85	83	79	92	92	73	91
	I can go straight to my destination	65	67	66	65	61	68	70	45	86	39	67	69	66	66	61	65	67	67	69	33
	It's the best transport option	62	63	71	70	62	67	63	43	86	39	66	66	74	73	64	65	66	66	76	54
	This is the only exercise I get and/or this adds to the exercise I get from other parts of my life	55	58	61	62	63	62	53	57	41	81	61	62	65	66	64	65	62	62	75	92
	I save money by using this route	50	51	58	60	40	51	56	34	62	7	52	52	59	58	40	49	62	62	57	29
	I have environmental concerns	54	56	63	67	56	57	50	43	74	64	51	51	58	60	51	51	61	61	53	22
Belief that new route increases physical activity (%)	Yes (a little/ a lot)											67	69	71	76	65	31	67	67	80	32

Table 5.D.4: Additional modes and distances to reach routes (Number of schemes = 84)

		Pre							Post						
		Total	Women	Cyclists	Female cyclists	65+	Disabled	1st IMD	Total	Women	Cyclists	Female cyclists	65+	Disabled	1st IMD
Did you or will you use any other mode of transport for part of this journey today? (%)	Car/Van	14	15	6	7	18	15	11	13	14	6	7	16	13	8
	Bus/Train	7	7	3	3	7	6	8	8	8	2	2	8	8	10
	Only walking/cycling	71	70	85	83	71	76	75	75	73	85	83	73	76	79
How far did you travel by another mode of transport to enable you to make this journey? (%)	0-2 miles	7	9	2	3	10	9	8	7	9	1	2	10	9	7
	3-5 miles	5	6	2	3	6	5	6	5	6	2	3	6	5	4
	6-15 miles	4	5	2	2	5	4	3	5	5	3	3	5	4	5
	>15 miles	4	3	3	2	4	3	2	3	3	2	2	3	2	2

Table 5.D.5: Multivariable binary logistic regression analysis showing relationship between contextual factors/ scheme characteristics and at least 50% increase and double the number of route users across all schemes (Number of schemes = 77, using total annual scheme users)

Independent variable	**Cyclists odds ratio (95% CI)**				**Pedestrians odds ratio (95% CI)**				**BCR ≥4 odds ratio (95% CI)**	
	At least 50% increase in cyclists		**Double cyclists**		**At least 50% increase in pedestrians**		**Double pedestrians**			
	Unadjusted	**Adjusted***	**Unadjusted**	**Adjusted***	**Unadjusted**	**Adjusted***	**Unadjusted**	**Adjusted***	**Unadjusted**	**Adjusted***
Public transport interchange within 1 mile	1.71 (0.55, 5.64)	2.20 (0.54, 9.48)	1.13 (0.33, 4.48)	1.65 (0.32, 9.81)	1.08 (0.35, 3.58)	1.20 (0.31, 4.91)	0.73 (0.21, 2.97)	1.21 (0.23, 7.21)	2.28 (0.72, 8.03)	**4.64 (1.00, 26.62)**
Population within 0.5 miles (0,000s)	0.90 (0.71, 1.14)	0.88 (0.55, 1.34)	0.87 (0.64, 1.13)	1.11 (0.66, 1.85)	1.00 (0.79, 1.26)	1.18 (0.81, 1.75)	0.88 (0.63, 1.17)	1.24 (0.70, 2.27)	1.20 (0.95, 1.55)	1.24 (0.78, 2.20)
Bridge or tunnel present	1.6 (0.65, 4.01)	1.03 (0.35, 3.00)	2.07 (0.75, 6.15)	1.39 (0.38, 5.38)	1.59 (0.64, 4.09)	1.42 (0.50, 4.12)	2.25 (0.73, 7.78)	1.80 (0.44, 8.77)	0.63 (0.25, 1.54)	0.58 (0.17, 1.86)
Deprivation quintile (1 = most deprived)	1.23 (0.90, 1.73)	1.14 (0.78, 1.67)	1.42 (1.00, 2.05)	1.11 (0.66, 1.85)	1.24 (0.90, 1.73)	1.27 (0.88, 1.86)	1.31 (0.90, 1.95)	1.29 (0.82, 2.09)	0.81 (0.58, 1.11)	0.99 (0.64, 1.52)
Scheme cost (£ million)	1.12 (0.84, 1.55)	1.24 (0.89, 1.84)	0.97 (0.67, 1.31)	1.27 (0.74, 2.02)	1.00 (0.74, 1.34)	1.04 (0.72, 1.44)	0.78 (0.45, 1.15)	0.87 (0.42, 1.65)	**0.59 (0.37, 0.87)**	**0.29 (0.13, 0.57)**
Length (km)	1.03 (0.95, 1.11)	1.10 (0.97, 1.26)	0.97 (0.88, 1.06)	1.03 (0.89, 1.20)	0.99 (0.91, 1.08)	0.98 (0.87, 1.10)	0.96 (0.85, 1.06)	0.95 (0.79, 1.12)	1.01 (0.93, 1.10)	0.95 (0.82, 1.09)
Baseline (0,000s for cyclists; 00,000s for pedestrians)	**0.85 (0.72, 0.95)**	**0.79 (0.63, 0.92)**	**0.63 (0.44, 0.83)**	**0.52 (0.31, 0.77)**	***0.88 (0.73, 1.01)***	***0.86 (0.68, 1.01)***	**0.48 (0.24, 0.79)**	**0.39 (0.14, 0.78)**	**1.12 (1.00, 1.32)**	**1.24 (1.05, 1.57)**
Time from completion to post-monitoring (months)	1.01 (0.95, 1.06)	0.99 (0.92, 1.05)	1.04 (0.98, 1.10)	1.02 (0.95, 1.10)	1.04 (0.99, 1.10)	1.03 (0.97, 1.11)	1.07 (1.01, 1.14)	1.08 (1.00, 1.17)	1.03 (0.90, 1.10)	1.06 (0.99, 1.15)

* Maximally adjusted model adjusted for other independent variables (baseline users, bridge or tunnel present, cost, index of multiple deprivation quintile, length, population within 0.5 miles, public transport interchange with 0.5 miles) and time from completion to post-monitoring.

Table 5.D.6: Multivariable binary logistic regression analysis showing relationship between contextual factors/ scheme characteristics and at least 50% increase and double the number of sub-groups of users (data sets: counts of users, user survey and total annual scheme users)

Independent variable	**Odds ratio of increasing by at least 50% (95% CI) (maximally adjusted)***						**Odds ratio of doubling (95% CI) (maximally adjusted)***					
	Women (N=69)	**Older people (N=69)**	**Disabled/ long-term illness (N=71)**	**1st IMD quintile (N=73)**	**Peak time users (N=69)**	**Women cyclists (N=69)**	**Women (N=69)**	**Older people (N=69)**	**Disabled/ long-term illness (N=71)**	**1st IMD quintile (N=73)**	**Peak time users (N=69)**	**Women cyclists (N=69)**
Transport interchange present	0.72 (0.17, 3.01)	1.17 (0.28, 4.84)	1.60 (0.40, 6.49)	0.92 (0.20, 4.13)	1.05 (0.24, 4.73)	0.45 (0.08, 2.12)	1.00 (0.17, 6.34)	1.32 (0.28, 7.00)	0.85 (0.20, 3.87)	0.79 (0.17, 4.02)	**13.00 (1.47, 340.87)**	1.58 (0.32, 8.54)
Population within 0.5 miles (000's)	1.12 (0.72, 1.75)	1.04 (0.68, 1.60)	0.97 (0.65, 1.43)	**1.93 (1.18, 3.67)**	1.14 (0.73, 1.78)	1.12 (0.73, 1.74)	1.58 (0.82, 3.28)	0.99 (0.62, 1.59)	1.25 (0.82, 1.92)	**1.54 (1.01, 2.52)**	1.11 (0.61, 2.02)	1.08 (0.65, 1.82)
Bridge or tunnel present	0.89 (0.29, 2.69)	1.45 (0.51, 4.19)	1.37 (0.48, 3.89)	**3.51 (1.12, 12.16)**	0.87 (0.27, 2.75)	0.41 (0.12, 1.29)	0.88 (0.20, 4.10)	1.23 (0.39, 4.02)	0.83 (0.26, 2.60)	2.00 (0.60, 7.27)	1.02 (0.22, 4.74)	**0.19 (0.05, 0.64)**
IMD quintile 1 = most deprived	1.32 (0.90, 2.01)	1.03 (0.70, 1.53)	1.17 (0.79, 1.76)	1.01 (0.66, 1.54)	1.66 (1.11, 2.62)	1.22 (0.81, 1.91)	**1.87 (1.14, 3.32)**	0.97 (0.63, 1.49)	**1.56 (1.03, 2.46)**	1.22 (0.81, 1.90)	1.47 (0.92, 2.49)	1.33 (0.87, 2.16)
Scheme cost (£00,000's)	1.12 (0.69, 1.86)	1.20 (0.76, 1.97)	1.25 (0.77, 2.14)	1.04 (0.62, 1.77)	1.16 (0.70, 1.97)	1.29 (0.79, 2.22)	1.31 (0.67, 2.57)	1.09 (0.65, 1.80)	0.80 (0.46, 1.32)	0.79 (0.46, 1.31)	1.15 (0.63, 2.09)	1.30 (0.77, 2.23)
Length (km)	0.91 (0.73, 1.07)	1.04 (0.92, 1.18)	0.98 (0.88, 1.10)	0.96 (0.84, 1.10)	0.90 (0.76, 1.03)	1.00 (0.89, 1.14)	0.86 (0.67, 1.05)	1.04 (0.90, 1.18)	1.01 (0.90, 1.13)	0.94 (0.82, 1.05)	0.91 (0.72, 1.10)	1.05 (0.91, 1.21)
Baseline (00,000 total users or 0,000 cyclists)	0.91 (0.73, 1.07)	0.88 (0.74, 1.01)	0.93 (0.80, 1.06)	**0.79 (0.63, 0.94)**	0.94 (0.78, 1.09)	0.92 (0.83, 1.02)	**0.46 (0.22, 0.80)**	0.92 (0.75, 1.07)	0.91 (0.74, 1.05)	0.92 (0.74, 1.08)	**0.71 (0.42, 0.98**	**0.77 (0.60, 0.92)**
Time from completion to post-monitoring (months)	1.05 (0.99, 1.13)	1.03 (0.97, 1.11)	1.00 (0.94, 1.07)	1.03 (0.95, 1.12)	1.04 (0.97, 1.11)	1.01 (0.94, 1.08)	1.05 (0.96, 1.15)	1.08 (1.01, 1.16)	1.02 (0.96, 1.10)	1.04 (0.97, 1.12)	1.07 (0.99, 1.17)	1.03 (0.96, 1.11)

* Maximally adjusted model adjusted for other independent variables (baseline users, bridge or tunnel present, cost, index of multiple deprivation quintile, length, population within 0.5 miles, public transport interchange with 0.5 miles) and time from completion to post-monitoring.
Note N = Number of schemes.

Table 5.D.7: Sensitivity analysis for people living in most deprived LSOA UK-adjusted IMD quintile and with disability/ long-term illness

Independent variable	Odds ratio of increasing by at least 50% (95% CI) (maximally adjusted)		Odds ratio of doubling (95% CI) (maximally adjusted)	
	Disabled/ long-term illness (N=71)	1st IMD quintile (N=73)	Disabled/ long-term illness* (N=71)	1st IMD quintile (N=73)
Transport interchange present	1.56 (0.39, 6.34)	0.97 (0.19, 5.07)	0.85 (0.20, 3.87)	0.61 (0.11, 3.96)
Population within 0.5 miles (000's)	0.97 (0.65, 1.43)	**1.59 (1.03, 2.69)**	1.25 (0.82, 1.92)	**1.60 (1.02, 2.76)**
Bridge or tunnel present	1.24 (0.44, 3.50)	**4.44 (1.32, 16.72)**	0.83 (0.26, 2.60)	1.53 (0.39, 6.33)
IMD quintile 1 = most deprived	1.17 (0.79, 1.75)	1.07 (0.69, 1.63)	**1.56 (1.03, 2.46)**	1.01 (0.63, 1.61)
Scheme cost (£00,000's)	1.14 (0.71, 1.90)	1.63 (0.93, 3.23)	0.80 (0.46, 1.32)	1.12 (0.65, 1.92)
Length (km)	1.00 (0.90, 1.12)	0.92 (0.80, 1.03)	1.01 (0.90, 1.13)	0.88 (0.75, 1.00)
Baseline (00,000 total users or 0,000 cyclists)	0.92 (0.79, 1.05)	0.89 (0.75, 1.04)	0.91 (0.74, 1.05)	0.97 (0.78, 1.12)
Time from completion to post-monitoring (months)	1.01 (0.94, 1.08)	0.93 (0.85, 1.00	1.02 (0.96, 1.10)	0.96 (0.88, 1.04)

* Sensitivity analysis for doubling disabled/long-term illness resulted in no difference in results.
Note N = Number of schemes.

Table 5.D.8: Sensitivity analysis for 30 minutes physical activity on at least 5 days in the previous week for all types of route users, including runners

Type of route user		Survey of users: at least 5 days of 30 min physical activity in previous week for all types of user, including runners							
		Pre				Post			
		Sample (n)	% of sample achieving 5+ days	Unadjusted	Adjusted*	Sample (n)	% of sample achieving 5+ days	Unadjusted	Adjusted*
Frequency of journey on route	Irregularly (Weekly or less frequently) (reference)	4,562	43.5%	1.00	1.00	6,876	43.3%	1.00	1.00
	Regularly (Daily/ 2-5 times a week)	8,781	57.5%	**1.78 (1.65, 1.91)**	**1.79 (1.67, 1.93)**	12,668	58.6%	**1.87 (1.77, 1.99)**	**1.90 (1.79, 2.02)**
Journey purpose on route	Recreation (reference)	6,605	56.6%	1.00	1.00	10,358	55.0%	1.00	1.00
	Commuting	1,715	56.6%	1.00 (0.90, 1.11)	1.03 (0.92, 1.15)	2,751	56.4%	1.06 (0.97, 1.15)	*1.09 (0.99, 1.19)*
	Non-commuting transport	4,997	46.0%	**0.65 (0.61, 0.70)**	**0.67 (0.62, 0.72)**	6,404	48.8%	**0.78 (0.73, 0.83)**	**0.79 (0.74, 0.84)**
	Recreation and transport	-	-	-	-	-	-	-	-
Mode on route	Walking (reference)	10,441	52.0%	1.00	1.00	14,046	53.6%		
	Cycling	2,485	56.7%	**1.21 (1.11, 1.32)**	**1.12 (1.02, 1.23)**	4,839	53.6%	1.00 (0.94, 1.07)	0.98 (0.92, 1.05)
	Running	324	48.5%	0. 87 (0.70, 1.08)	0.83 (0.66, 1.04)	476	47.3%	**0.78 (0.65, 0.93)**	**0.76 (0.63, 0.92)**
	Other	93	32.3	**0.44 (0.28, 0.67)**	**0.44 (0.28, 0.68)**	183	21.9%	**0.24 (0.17, 0.34)**	**0.27 (0.18, 0.38)**
Journey time on route (hrs)		13,243	52.6%	**1.07 (1.04, 1.11)**	**1.05 (1.02, 1.08)**	19,406	53.1%	1.00 (0.98, 1.03)	1.00 (0.97, 1.02)

* Adjusted for demographic variables: gender (male/female), age (16-24/25-34/35-44/45-54/55-64/65+), employment (employed full time/employed part time/retired/other), ethnicity (white/non-white), general health (excellent/good/fair/poor), disability/long-term illness (yes/no), home IMD quintile, and child under 16 in the household (yes/no).

Appendix 6.A: England 1 - summary report, including links to resources and request for feedback

Evidence and Active Urban Environments Research Project

Interim report for knowledge exchange

Introduction

'Evidence and Active Urban Environments Research Project' involved interviews and observations with a range of stakeholders involved in walking and cycling infrastructure and open spaces (referred to as 'Active Living Infrastructure' (ALI)). This was done by Anna Le Gouais (PhD student at the Centre for Diet and Activity Research (CEDAR), University of Cambridge), between October 2017 and June 2018 and focussed on three areas of England, each of which had at least one large development being planned and/or built.

The study focussed on evidence in decision-making for ALI.

The study found a number of issues about ALI where knowledge was limited and better understanding could be of value. Gaps in knowledge or evidence of participants was collated and reviewed by Anna, then refined into possible topics for which evidence summaries could be produced. These gaps are summarised in this report, together with links to existing documents.

At the end of the document there is the opportunity to give feedback about the proposed evidence summaries.

More general study findings will follow in a separate report.

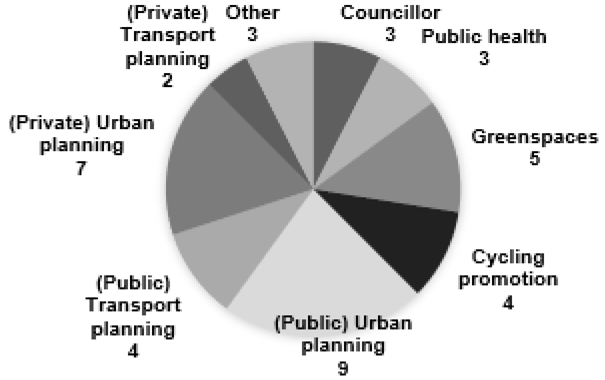


Figure 1 – Number and types of stakeholders included in interviews

1

Evidence+AUE Interim report for knowledge exchange
Oct 2018

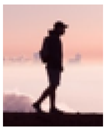
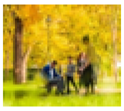
Gaps in knowledge related to ALI which could be addressed with evidence summaries:

The following six topics were identified by at least three interview participants in the study:

1. Health benefits of physical activity, including walking and cycling;
2. Health benefits of green or open space;
3. Health impact of living in different environments/ place-making;
4. Use of new walking and cycling routes;
5. Economic impacts of walking and cycling routes and other place-making;
6. Examples of good cycling infrastructure and other ALI designs.

Links to existing resources

The table below includes links to third party documents related to the six knowledge gaps outlined above. Many of these are currently being used by interview participants. Please follow the hyperlinks to access the resources (full web addresses are also included in Appendix A):

Topic	Resource (with hyperlink)
1. Health benefits of physical activity, including walking and cycling 	Health matters: getting every adult active every day (Public Health England) Physical activity and health - facts and figures (Sustrans) Walking & Cycling for Transport. How promoting active travel can help meet the physical activity challenge (CEDAR)
2. Health benefits of green or open space 	Urban green spaces and health. A review of the evidence (WHO) Planning for a health environment – good practice guidance for green infrastructure and biodiversity (TCPA/ The Wildlife Trusts)
3. Health impact of living in different environments/ place-making 	Planning healthy-weight environments – a TCPA reuniting health with planning project (TCPA/Public Health England) Spatial Planning for Health. An evidence resource for planning and designing healthier places (Public Health England)
4. Use of new walking and cycling routes 	Changing the way we travel. Infrastructure and our everyday transport choices (CEDAR) England's Cycling Potential. Results from the Department for Transport-funded Propensity to Cycle Tool project (CEDAR) Propensity to Cycle Tool Appendix 4 Cycle route infrastructure and cycling uptake: a review (p.83-113 of National Propensity to Cycle Tool Project: Summary Report)

5. Economic impacts of walking and cycling routes and other place-making 	Health Economic Assessment Tool (HEAT) (WHO/Europe)[1] Who pays and who benefits? Understanding the value of investing in 'healthy places' (TCPA) Development: The Value of Placemaking (Savills) The value of good design (CABE)
6. Examples of good cycling infrastructure and other ALI designs 	Active Design (Sport England) Better Streets Delivered 2. Learning from completed schemes (Transport for London) London Cycle Design Standards (Transport for London) Making Space for Cycling (Cyclenation) Sustrans design guidance (Sustrans) Streets And Transport In the Urban Environment (including Planning for Cycling) (Chartered Institute of Highways and Transportation) International Cycling Infrastructure Best Practice Study (Transport for London)

Other resources were also being used, alongside the National Planning Policy Framework, Manual for Streets, WebTAG and Health and Wellbeing Strategies and Joint Strategic Needs Assessments, including:

- 'Nature Nearby' Accessible Natural Greenspace Guidance (ANGSt) (Natural England)
- HUDU Planning for Health Rapid Health Impact Assessment Tool (London Healthy Urban Development Unit/ NHS)
- Secured by Design

[1] Free online training is available for HEAT. The next webinar is on 12th Nov 11:00-12:00. Please book via this link: https://ecf.com/users/lucy-slade/trusted-content/heat-4-webinar

Request for feedback

Please contact Anna Le Gouais if you would like her to develop evidence summaries on any of the six topic areas. These may be based on some of the documents listed above, or other similar documents, as well as recent academic literature. It would also be helpful to get feedback about the type and length of summary which is most useful for you.

Please complete and return the following tables to Anna by email: [email]

Q1. How useful would further evidence summaries on these topics be for you?

Topic	Very Useful	Useful	Unsure	Of Little Use	Not Useful
1. Health benefits of physical activity, including walking and cycling					
2. Health benefits of green or open space					
3. Health impact of living in different environments/ place-making					
4. Use of new walking and cycling routes					
5. Economic impacts of walking and cycling routes and other place-making					
6. Examples of good cycling infrastructure and other ALI designs					

Q2: How likely is it that you would engage with the following formats?

Type of resource	Very Likely	Likely	Unsure	Unlikely	Definitely Not
Report (10-40+ pages)					
Short summary (1-4 pages)					
Academic research article					
Podcast (5-10 mins)					
Infographic					
Other (please specify)					

If you have any further questions or comments please contact Anna Le Gouais:

Email: [email]

Tel: [number]

Appendix A: Full web addresses for resources

Topic	Resource title (with hyperlink)	Organisation	Web address
1. Health benefits of physical activity, including walking and cycling	Health matters: getting every adult active every day	Public Health England	www.gov.uk/government/publications/health-matters-getting-every-adult-active-every-day/health-matters-getting-every-adult-active-every-day
	Physical activity and health - facts and figures	Sustrans	www.sustrans.org.uk/policy-evidence/the-impact-of-our-work/related-academic-research-and-statistics/physical-activity
	Walking & Cycling for Transport. How promoting active travel can help meet the physical activity challenge	CEDAR	www.cedar.iph.cam.ac.uk/resources/evidence/eb-why-active-travel-web/
2. Health benefits of green or open space	Urban green spaces and health. A review of the evidence	World Health Organisation (WHO)	www.euro.who.int/__data/assets/pdf_file/0005/321971/Urban-green-spaces-and-health-review-evidence.pdf?ua=1
	Planning for a health environment – good practice guidance for green infrastructure and biodiversity	Town and Country Planning Association (TCPA)/ The Wildlife Trusts	www.tcpa.org.uk/Handlers/Download.ashx?IDMF=34c44ebf-e1be-4147-be7d-89aaf174c3ea
3. Health impact of living in different environments/ place-making	Planning healthy-weight environments – a TCPA reuniting health with planning project	TCPA/ Public Health England	www.tcpa.org.uk/Handlers/Download.ashx?IDMF=7166d749-288a-4306-bb74-10b6c4ffd460
	Spatial Planning for Health. An evidence resource for planning and designing healthier places	Public Health England	assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/729727/spatial_planning_for_health.pdf
4. Use of new walking and cycling routes	Changing the way we travel. Infrastructure and our everyday transport choices	CEDAR	www.cedar.iph.cam.ac.uk/resources/evidence/eb-15-changing-travel/
	England's Cycling Potential. Results from the Department for Transport-funded Propensity to Cycle Tool project	CEDAR	www.cedar.iph.cam.ac.uk/resources/evidence/eb-14-englands-cycling-potential/

	Propensity to Cycle Tool ; Appendix 4 Cycle route infrastructure and cycling uptake: a review (p.83-113 of National Propensity to Cycle Tool Project: Summary Report)	CEDAR/ University of Cambridge/ University of Leeds/ University of Westminster/ Department for Transport/ Welsh Government	www.pct.bike/ assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/510268/national-propensity-to-cycle-full-report.pdf
5. Economic impacts of walking and cycling routes and other place-making	Health Economic Assessment Tool (HEAT)	WHO/Europe	www.heatwalkingcycling.org
	Who pays and who benefits? Understanding the value of investing in 'healthy places'	TCPA	www.tcpa.org.uk/Handlers/Download.ashx?IDMF=fb52f9a8-fdc5-43f7-a300-45b3a35262f6
	Development: The Value of Placemaking	Savills	pdf.euro.savills.co.uk/uk/residential---other/spotlight-the-value-of-placemaking-2016.pdf
	The value of good design	CABE	www.designcouncil.org.uk/sites/default/files/asset/document/the-value-of-good-design.pdf
6. Examples of good cycling infrastructure and other ALI designs	Active Design	Sport England	www.sportengland.org/facilities-planning/active-design/
	Better Streets Delivered 2. Learning from completed schemes	Transport for London	content.tfl.gov.uk/better-streets-delivered-2.pdf
	London Cycle Design Standards	Transport for London	tfl.gov.uk/corporate/publications-and-reports/streets-toolkit#on-this-page-2
	Making Space for Cycling	Cyclenation	www.makingspaceforcycling.org/MakingSpaceForCycling.pdf
	Sustrans design guidance	Sustrans	www.sustrans.org.uk/our-services/our-expertise/route-design/sustrans-design-guidance
	Streets And Transport In the Urban Environment (including Planning for Cycling)	Chartered Institute of Highways and Transportation	www.ciht.org.uk/knowledge-resource-centre/resources/streets-and-transport-in-the-urban-environment/
	International Cycling Infrastructure Best Practice Study	Transport for London	content.tfl.gov.uk/international-cycling-infrastructure-best-practice-study.pdf

Appendix 6.B: Questionnaire results by type of stakeholder

Table 6.B.1: Questionnaire results: 'How useful would further evidence summaries on these topics be for you?'

Role	Total contacted	Total responses	Health benefits of physical activity, including walking and cycling			Health benefits of green or open space			Health impact of living in different environments/ place-making			Use of new walking and cycling infrastructure			Economic impacts of walking and cycling routes and other place-making			Examples of good cycling infrastructure and other ALI designs		
			Very useful/ Useful	Unsure	Of little use	Very useful/ Useful	Unsure	Of little use	Very useful/ Useful	Unsure	Of little use	Very useful/ Useful	Unsure	Of little use	Very useful/ Useful	Unsure	Of little use	Very useful/ Useful	Unsure	Of little use
Councillor	3	1 (33%)	0	0	1	0	0	1	1	0	0	1	0	0	1	0	0	1	0	0
Cycling promotion	4	2 (50%)	2	0	0	1	0	0	1	0	0	2	0	0	2	0	0	2	0	0
Green spaces	5	4 (80%)	2	1	1	4	0	0	3	1	0	4	0	0	4	0	0	4	0	0
Other	3	2 (67%)	1	1	0	2	0	0	1	1	0	2	0	0	2	0	0	2	0	0
Public health	3	1 (33%)	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0
Transport planning - LA	4	3 (75%)	2	1	0	1	2	0	0	3	0	2	1	0	2	1	0	2	1	0
Transport planning - Private	2	1 (50%)	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0
Urban planning - LA	11	6 (55%)	5	1	0	6	0	0	6	0	0	5	1	0	4	2	0	4	1	1
Urban planning - Private	8	4 (50%)	3	0	1	3	0	1	3	1	0	3	0	1	3	0	1	3	1	0
Total	**43**	**24 (56%)**	**17**	**4**	**3**	**19**	**2**	**2**	**17**	**6**	**0**	**21**	**2**	**1**	**20**	**3**	**1**	**20**	**3**	**1**

Table 6.B.2: Questionnaire results: 'How likely is it that you would engage with the following formats?'

Role	Total contacted	Total responses	Report (10-40+ pages)			Short summary (1-4 pages)			Academic research article			Podcast (5-10 minutes)			Infographic		
			Very likely/ Likely	Unsure	Unlikely/ Definitely not	Very likely/ Likely	Unsure	Unlikely/ Definitely not	Very likely/ Likely	Unsure	Unlikely/ Definitely not	Very likely/ Likely	Unsure	Unlikely/ Definitely not	Very likely/ Likely	Unsure	Unlikely/ Definitely not
Councillor	3	1 (33%)	1	0	0	1	0	0	0	1	0	0	0	1	1	0	0
Cycling promotion	4	2 (50%)	0	0	1	2	0	0	1	0	1	2	0	0	2	0	0
Green spaces	5	4 (80%)	4	0	0	4	0	0	3	0	1	2	0	2	3	1	0
Other	3	2 (67%)	1	1	0	2	0	0	1	1	0	0	2	0	2	0	0
Public health	3	3 (66%)	2	0	0	2	0	0	2	0	0	1	1	0	2	0	0
Transport planning - LA	4	3 (75%)	1	1	1	3	0	0	1	0	1	0	2	0	3	0	0
Transport planning - Private	2	1 (50%)	1	0	0	1	0	0	1	0	0	0	1	0	1	0	0
Urban planning - LA	11	6 (55%)	5	0	1	6	0	0	1	3	2	4	2	0	5	1	0
Urban planning - Private	8	4 (50%)	2	1	1	4	0	0	1	2	1	1	0	3	3	1	0
Total	**43**	**25 (58%)**	**17**	**3**	**4**	**25**	**0**	**0**	**11**	**7**	**6**	**10**	**8**	**6**	**22**	**3**	**0**

Appendix 6.C: England 2 - participant information sheet and consent form

MRC Epidemiology Unit UNIVERSITY OF CAMBRIDGE CEDAR Centre for Diet and Activity Research

Interview Participant Information Sheet

Study title: Understanding context for new walking and cycling infrastructure research project

Researcher: Anna Le Gouais (PhD student)
Supervised by: Dr Louise Foley and Dr Cornelia Guell
University reference number: HSS.REC.20/243

Please read this information carefully before deciding to take part in this research.

What is the research about?
The built environment can influence levels of physical activity and population health, particularly for walking and cycling. I want to understand how case study examples are used in decision-making for new walking and cycling infrastructure and what contextual issues are necessary to appear relevant to decision-makers. This will be done through interviews with key stakeholders, many of whom will have been interviewed by me as part of my earlier study 'Evidence and Active Urban Environments Research Project' in 2017/18. This is because this study follows on from the first, where contextually relevant case study examples were highlighted as important to many decision-makers.

I am a final year PhD student, originally a civil engineer, and now doing public health research which is funded by the Medical Research Council and based at the MRC Epidemiology Unit and The Centre for Diet and Physical Activity Research (CEDAR) at the University of Cambridge. This research project will focus on two local authority areas in the UK in 2020.

Why have I been chosen?
You were involved with the original Evidence and Active Urban Environments Research Project or have been in contact with me since then and received information from that project. In total I plan to interview around ten people in my research.

What will happen to me if I take part?
You will be invited to arrange a time for an interview on your views about case study examples and contextual relevance for decision-making for new walking and cycling routes. This may be done face to face in your offices, or by phone or Skype. If you agree, the interview will be recorded so that it may be transcribed to assist with the research. It is expected that each interview will take an hour or less.

Taking part is completely voluntary and you may refuse to take part or withdraw at any point without giving a reason and without penalty or loss of benefits which you may otherwise be entitled.

Are there any benefits in my taking part?
The information collected during this study will help to better understand context for case study examples which could influence new walking and cycling routes. By taking part you are helping to identify what could be done to improve the reporting and dissemination of case study examples which could lead to more healthy planning decisions and facilitate healthier communities.

Are there any risks involved?
There are minimal risks involved in taking part.

Will my participation be confidential?
Your participation will be treated as confidential and the information you provide will be held and used in accordance with the Data Protection Act 2018 and stored securely at the MRC Epidemiology Unit in Cambridge. All interviewees will be identified by an ID number which relates to your professional role and any information about you will have your name and place of work removed so that you cannot be recognised from it.

What will happen to information about me collected during the study?
Any information we hold and share about you will have your name and address removed so that you cannot be recognised from it and it will not be used or made available for any purpose other than for research.

Identifying details (such as your name, email or other details you may have given us to get in touch with you) will be kept separately from the transcript of your interview and linked only by an ID number. The database containing personal information is on a secured, password-protected drive on computers in the MRC Epidemiology Unit, University of Cambridge.

Extracts from your anonymised interviews may be included in reports or talks presenting study findings.

With your permission, the full anonymised transcripts of your interviews will be stored by the MRC Epidemiology Unit so other researchers may be able to use your valuable interviews for approved future research projects. These researchers might be from other places, including outside the UK, and might also include partners and collaborators from outside of academia.

Occasionally our studies may be monitored by our Sponsor (University of Cambridge). This is to ensure our research is conducted soundly. This procedure is routine and carried out by fully qualified personnel. Data confidentiality will be adhered to at all times.

What happens if I change my mind?
You are free to withdraw from the study at any time and without giving a reason. If you do decide to withdraw, or if you are no longer able to take part in the study, we will use the data collected up to the time of your withdrawal.

What if there is a problem?
If you have a concern about any aspect of this study, you should contact Anna Le Gouais on [number/email]. She will do her best to answer your questions. If you remain unhappy and wish to complain formally, the normal University of Cambridge complaints process is available to you through the University of Cambridge Clinical School Secretary: [number/email].

What will happen to the results of the study?
When the study is completed, reports and papers will be published and talks given to share the findings with researchers and other stakeholders. Your identity and personal details will be kept confidential. No information that could identify you, like your name, will be published in any report about this study. We will also prepare a summary of the findings for all interview participants, which we will send to you if you are interested in what your interviews have shown!

Who has reviewed the study?
This study has been reviewed by an independent group of people, called the Research Ethics Committee, to protect your safety, rights, wellbeing and dignity. The study has been given a favourable opinion by the University of Cambridge School of the Humanities and Social Sciences Ethics committee.

Where can I get more information?
If you would like more information or have any questions, please contact Anna Le Gouais on [number/email].

MRC Epidemiology Unit | UNIVERSITY OF CAMBRIDGE | CEDAR Centre for Diet and Activity Research

Participant Consent Form

Study Title: Understanding context for new walking and cycling infrastructure research project

University of Cambridge reference number: HSS.REC.20/243

Name of Principal Investigator: Dr Louise Foley

Name of Researcher: Anna Le Gouais

Participant ID: ……………………..

Please **initial** to confirm the statements below:

[ ] I confirm that I have read and understood the Interview Participant Information Sheet version 1.0, dated 03 February 2020 for the above study. I have had the opportunity to consider the information and ask questions. The questions I have asked have been answered satisfactorily.

[ ] I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my legal rights being affected.

[ ] I agree that the information gathered about me will be looked after and stored securely by the MRC Epidemiology Unit, University of Cambridge. It may be used anonymously in approved future projects, by us and our collaborators, who may include those outside the UK, and/or outside of academia.

[ ] I agree that the interview will be audio-recorded and that quotations can be used which contain no identifiable information.

[ ] I agree to take part in the above study.

PLEASE SIGN DATE

-- ------------------------------

PRINT YOUR NAME (BLOCK CAPITALS)

NAME OF PERSON TAKING CONSENT	*SIGNATURE*	*DATE*
--	------------------------	--------------------

1 copy for participant and 1 copy for researcher

Appendix 6.D: Example local authority background information sheet

BACKGROUND INFORMATION

[Local authority name]

The Connect2 programme involved the creation or improvement of 84 walking and cycling routes across the UK. It was led by Sustrans, alongside local authority and other partners. Routes normally involved construction of a bridge, tunnel or other crossing point, alongside extension of walking and cycling routes. Schemes were all completed between 2010 and 2013. Baseline and follow-up monitoring were done for each scheme to find change in users. The iConnect study involved a postal questionnaire for people living near to three Connect2 sites, completed at baseline, 1-yr and 2-yr follow-up.

[Image from local authority]

Change in type of route user:
The proportion of each user group included in the 4-day manual count or route user intercept survey was calculated and combined with the total estimated annual users (see details on right) to calculate the estimated total of each user group. People living in the most deprived Index of Multiple Deprivation (IMD) quintile were identified from their home home postcode and associated LSOA.
User groups of interest were selected on the basis that they tend to have lower levels of physical activity (women, older people and disabled/with long-term illness), are often under-represented (female cyclists), or which may impact on congestion (peak time users).

[Map of local authority]

Local authority information:
Car ownership and percentage cycling commuters from 2011 Census;
Potential for cycling from the 'Go Dutch' scenario of the Propensity to Cycle Tool (PCT)

Change in estimated total annual users:
Multiple monitoring sites used, including automatic counter data, 4-day manual counts and 4-day route intercept surveys, with adjustments to count data calculated according to trip purposes and distances.
Where completely new routes were built a proxy monitoring point was used as a baseline.

Benefit cost ratios:
Calculated using the Health Economic Assessment Tool (HEAT), based on number of adult trips. It also used car km replaced, amenity, absenteeism and accident benefits over 30 years.

Appendix 6.E: England 2 - semi-structured interview guide

Context study - Interview guide

[Documents used as discussion aids: 1 - Links to resources; 2 - New route examples (6 for the relevant local authority); 3 – Background information; and 4 - Summary of Connect2 study results.]

Introduction: Purpose of the study and how it follows on from some of the findings about contextually relevant examples raised in the earlier project on decision-making for walking and cycling infrastructure and open spaces.

Stage 1: How case study examples are used and how they're accessed (including thinking back to previous interview comments and feedback about resources previously sent)

No.	Main question	Possible follow-up
1	Can you explain if and how you **use examples** of walking and cycling routes to inform decisions about new walking and cycling infrastructure here?	• Do you have any **examples** of when they influenced decision-making for new walking and cycling infrastructure?
2	**Where** do you get case study examples from?	• Are they from this local authority or elsewhere? • How do you find out about them? • Do you use any of the **resources** I previously sent links to? [show links to resources sheet]

Stage 2: Discussion about usefulness of new route case study examples [up to 6] and contextual features

I've got [six] examples of new walking and cycling routes which were built with Sustrans and local authorities as part of the Connect2 programme. I think there are some similarities between them and this local authority but I'd like to get your feedback on whether you think these examples could be useful here to influence decision-making.

[Spread out the 1-page new route examples and background information]

No.	Main question	Possible follow-up
3	What **contextual features** or route characteristics do you think are	• Discuss some contextual factors which are clear in the **examples**: Rural/urban;

	most and least important to make them useful as examples to you?	topography; percentage cyclists; car ownership; level of deprivation. • What else would be useful to know about? Prompt about social/political issues if only physical environmental issues mentioned.
4	Is the information about how **different groups** of people may use the routes useful?	• How much might you consider **inequalities** when influencing decisions about new walking and cycling infrastructure?
5	Can you comment on the information about **benefit-cost ratios**?	• Do you think it is useful? How/why? Or why not?

Stage 3: Discussion about how aggregate research findings may or may not be useful.

Our research group has been involved in evaluating the Connect2 schemes using data from Sustrans - there were 84 in total from across the UK. We have combined information across all of these schemes to get a sense of the overall picture of how much the schemes are used and who by. I'd like to get your views on whether this type of evaluation is useful to you, or how you think it could influence decision-making for new walking and cycling infrastructure.

[1-page summary of the Connect2 study results]

Outline study findings: Summary of the results e.g. percentage of schemes with increases in users; association between context/ scheme characteristics and outcomes found from analysis. *(Material may be amended slightly to align with finalised study findings and following feedback from the pilot interview)*

No.	Main question	Possible follow-up
6	Do you think these types of overall findings can be useful in decision-making for new walking and cycling routes?	• What would be more influential: doubling users or having a very high BCR? • Is the information about peak time users useful?
7	Can you comment on the usefulness of absolute and relative changes in users?	• Are infrastructure decisions here influenced by the government's target to double the number of cyclists? • Prompt that low baseline may be easier to double than high baseline.

[Allow interviewees to give unpromoted feedback on the presentation of the 1-page summaries but if necessary explain that this is not the main aim of the study, rather it is to understand whether this type of information may be useful.]

Wrap up:

9. Any other comments/thoughts?

Thank you for your time. I'll put together a summary of findings and share them with you, like I did with the first part of the study.

Appendix 6.F: England 2 - list of codes

Name	Files	References
Aspirational example	5	12
Needing to take a leap of faith	2	8
Personal enthusiasm	1	1
Existing ALI not used	1	5
Free car parking	1	1
Lack of signage and knowledge of routes	2	8
People don't want to be told what to do	1	4
Safety and connectivity	3	12
Sceptisicm that new walk&cycle routes need to be built	5	22
Seating and other supportive infrastructure	1	1
Existing ALI used only by certain groups	5	12
Frustration	2	6
Ineffective council	1	2
Not good enough walking and cycling infrastructure	2	2
Good proxy (what makes a good proxy)	5	17
Addressing safety	1	3
Bus and taxi use	1	1
Car ownership	2	3
Clarity of what happened and why	5	20
Community group	1	1
Commuter or leisure route	1	2
Purpose	1	2
Where the money came from	2	3
Connectivity	4	13
Economic context differences	5	10
England examples	4	4
Good design principles - inspiration	4	16
Convenience	3	3
Roads and traffic	6	14
Safety	3	5
Seeing examples in practice	3	8
Illustrate delivery issues	1	1
International examples	6	18
Assume it's always been like that	1	2
Local	3	7
Learn from mistakes	2	2
Not fussy - any positive examples	1	5
Not highest spec	1	1
Political alignment	5	13
Not following example of a neighbouring place	2	2
Topography	5	6
Urban or rural	5	12
Use them to educate people	7	22
Lacking good examples (and why)	3	7
Accessibility of examples	4	6
Changing a context	1	2

Cultural differences - 'you don't understand us'	8	18
Easy to use famous examples	3	5
Lack of rural examples	1	1
Need to understand a place	1	1
Other interventions going on	2	4
Scepticism of places with high levels of cycling	4	8
Methods and data	0	0
Absolute numbers	3	5
Aligning with other data	2	2
BCR	8	31
Census data	1	5
Complicated schemes difficult to believe	1	2
Displacement or new users	1	1
Health and wellbeing measurements - difficult	7	13
Affected population (type of people)	4	6
Other nudges	1	2
Out of date data	1	3
PCT	2	4
Pdfs demonstrating benefits	5	16
Relative change	6	15
Government target to double cycling	1	3
Research output summary	7	15
Sales data	1	1
Trend data or repeated monitoring	4	9
Watertight justification of calculation	5	11
Wider economic impact	3	7
Personal experience	4	11
Planning application	5	21
Adding to costs	3	9
Arguing for S106 money	2	6
Capacity of council officers	5	8
Council only advisary	2	4
Developer learning from international examples	1	2
Justifying to planning inspector	2	2
Legal difficulties	2	3
Mitigating impacts of development	4	12
Only way to fund cycle&walk routes	3	4
Policy not supportive	1	3
Practice different to plan	2	2
Reluctance to change from traditional layouts	5	10
Unbelievable impact of active travel	1	1
Within red line of application	2	4
Worse-case example for transport assessment_looking backwards	1	9
Public sector commission	5	17
Design Codes	1	1
Maintenance costs	1	2
Multiple benefits	7	23
No monitoring	1	1
Supportive local authority or forward thinking	8	30
Unable to afford it	5	13

Sub-groups of users	4	7
Older people, disabled, deprived	5	9
Peak hour traffic	5	13
Women	1	2
Women cyclists	1	2
Z_Great quotes	8	28
Great summary sheets	5	9

Appendix 6.G: England 2 - mind maps of initial findings

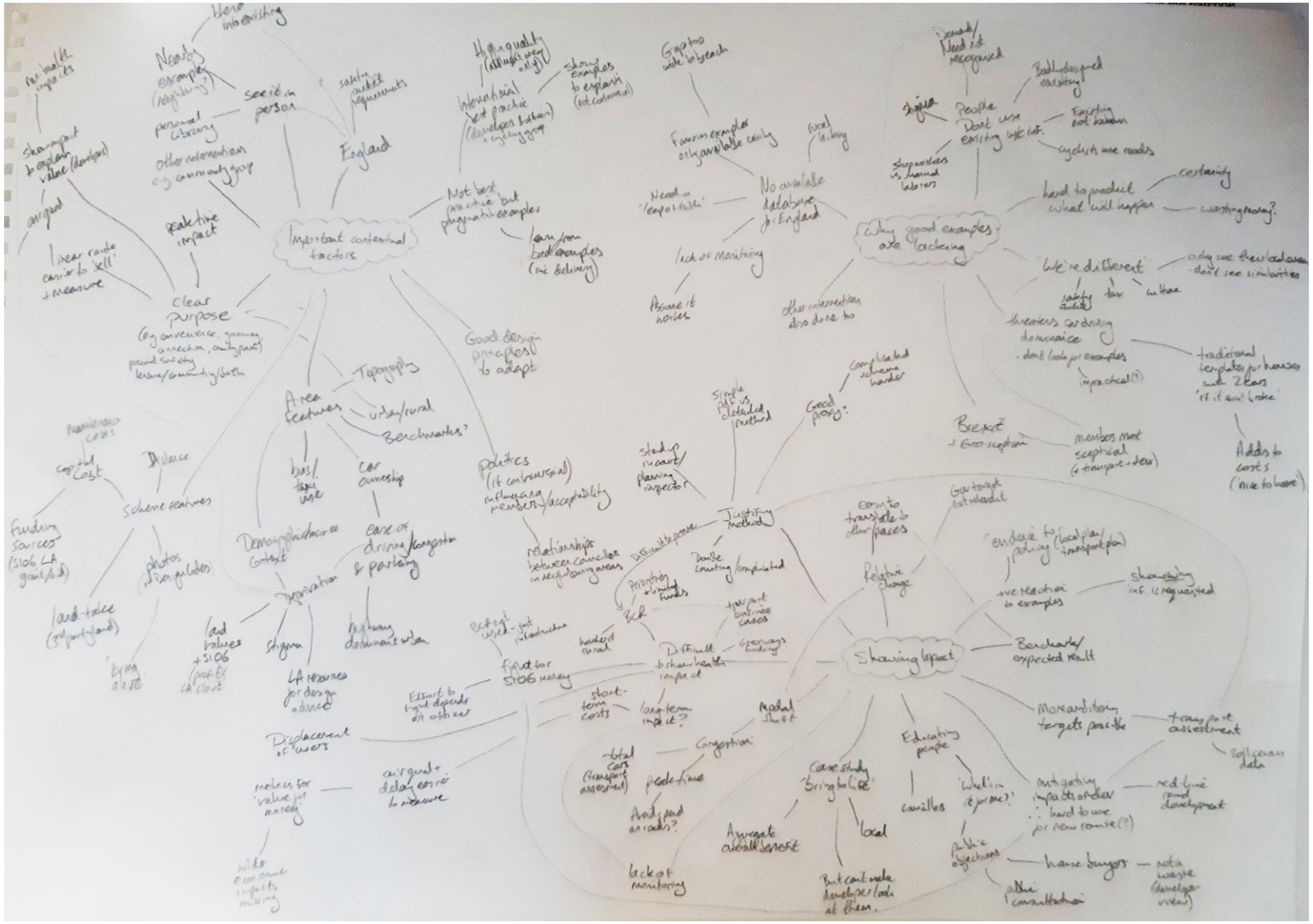


Figure 6.G.1: Mind maps of domain summaries: Important contextual features; Why good examples are lacking; and Showing impact.

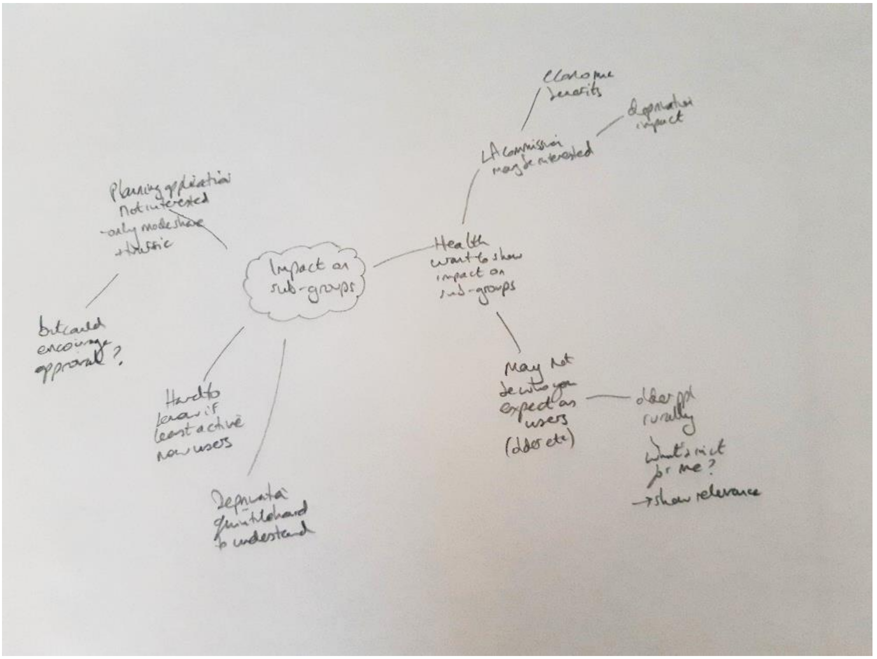


Figure 6.G.2: Mind map of domain summary: Impact on sub-groups