Investing in Cycling & Walking: Rapid Evidence Assessment

A report for the Department for Transport

October 2016

BROOKLYNDHURST

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Acknowledgements

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Foreword from the Department for Transport

The positive impacts of cycling and walking are well-known. They provide cheaper travel, better health and broader employment opportunities. This is why the Government is committed to making cycling and walking the norm for shorter journeys and as part of a longer journey.

To make a country that works for everyone, our cycling and walking policies rely on robust evidence and research. The purpose of this Rapid Evidence Assessment (REA) is to provide a considered overview of the evidence to help policy makers understand all the impacts of continued investment in cycling and walking.

Over 300 sources were analysed, with 55 of these being selected for detailed review based on their relevance to the questions asked within the REA. The assessment highlighted the need for further research, particularly those that measure impacts over a longer-term, and this is something that the Department will reflect on.

We will also consider how the findings can support the Government's Cycling and Walking Investment Strategy in the future. The review's findings are also there to assist local Government and other organisations when considering effective interventions.

We will continue to develop polices based on robust evidence and highlight the impact of investing in cycling and walking. These include significant benefits such as lower congestion, better air quality, and vibrant, attractive places and communities to live and work.

We are thankful to Brook Lyndhurst who carried out the assessment on the Department's behalf.

1 Summary

Introduction

- This report presents the results of a Rapid Evidence Assessment conducted by Brook Lyndhurst Ltd on behalf of the Department for Transport.

- Against a background shaped principally by the draft Cycling & Walking Investment Strategy, this assessment is emphatically not a review of all research that might be relevant to cycling and walking; it is, rather, a review conducted specifically to support the Department's policy and investment-decision-making needs.

- Framed by a set of six research questions (see below) specified by the Department, the research process identified and then drew upon a selective but extensive evidence base, the quality and nature of which was calibrated specifically to meet the Department's needs.

- More than 300 sources were identified during the scoping phase of the research. Of these, 55 evidence sources were reviewed in depth. The report presents and summarises the work of others; no secondary analysis (e.g. of detailed cost data) has been undertaken.

Overview

- Evidence for some of the research questions is plentiful, and persuasive; for others it is in short supply and/or weak. Although all the evidence used in the detailed review passed a stern quality threshold, the evidence base, in the round, is best understood as indicative rather than definitive.

- More high quality evidence was uncovered applying to cycling rather than walking, and this is reflected in the coverage of the report.

- The evidence base is, overall, characterised by a number of important gaps. There are relative few longitudinal studies; there is little evidence on the origin of new or extended cycling or walking trips; and the evidence base on economic effects is almost entirely dependent on case studies.

- In addition, there are few 'joined up' studies that attempt to link micro- and macro-effects. For example, evidence suggesting that e.g. Cycle to Work days are effective at increasing cycling are not linked to possible consequences for e.g. absenteeism or productivity.

- There is a widespread agreement in the literature that the most effective mechanisms for boosting cycling and walking comprise integrated and complementary packages of intervention. Infrastructure is generally regarded as necessary but not sufficient to boost cycling and walking; while behaviour change

interventions in the absence of adequate enabling infrastructure are also judged unlikely to be effective.

- Whilst the literature has made it possible to identify a number of interventions that, on their own, can be judged effective, in general it seems that the best investment strategy may comprise a strategic, networked approach and is likely to comprise a mix of measures.

- The literature does not, however, make it possible currently to express what an optimal mix might look like; indeed, an optimal bundle of investment may always vary between different circumstances.

- The evidence base is clear that by far the largest benefits arising from increases in walking and cycling accrue in terms of health. There is also good evidence directly linking active travel interventions to health outcomes.

- There are challenges here, however. Health outcomes are measured in different ways by different organisations (QALYs versus the value of statistical life, for example); and the possible benefits of reduced morbidity (as opposed to reduced mortality) are not generally captured.

- In addition, and as many of the costed interventions identified illustrate, many of the interventions for which there is good evidence have been delivered under the auspices of health or public health interventions, rather than 'transport' interventions.

- The assessment has nevertheless shown that a good deal is known about the costs of a wide variety of interventions; the effectiveness of those interventions; and, importantly, how to target those interventions at particular groups of people.

- What is also clear is that the evidence base is growing rapidly; and the Department for Transport in the UK is well positioned both to make use of and to contribute to that growth.

The Six Research Questions

RQ1 What are the range of different interventions that can be used to impact on walking and cycling and how much do they cost?

- The review uncovered a very wide range of interventions that have been used to impact on walking and cycling; and, for many of these, details of their costs

- A typology for the interventions was developed, classifying them under four main headings:

  - physical infrastructure – bike lanes, walkways, signage etc
  - intra-individual – behavioural interventions aimed at individuals
  - socio-cultural – behavioural interventions aimed at people in groups e.g. in their community, at work, at school

  - policy – interventions in terms either of general or specific policies to promote active travel

- Cost data comes from a variety of sources, countries, currencies and years. In addition, minor variations in interventions (e.g. the width of a bicycle lane, the duration of a walking support programme) have implications for costs. Direct comparisons between sources are thus difficult; but the evidence makes it possible to identify broad ranges of costs.

RQ2 How effective are different interventions?

- The reviewed literature acknowledges and highlights the difficulties of assessing the effectiveness of interventions. The nature of the behaviours in question and the factors influencing those behaviours are inherently complex; and the challenges of measuring changes, and of attributing observed changes to interventions, are considerable.

- Given these challenges, the evidence base, in the round, is best understood as strongly indicative rather than definitive.

- There is a strong consensus across the literature that that the most effective approach to increasing cycling and walking is to implement a complementary package of measures - that is, a mix of hard and soft interventions. Infrastructural measures appear necessary but not sufficient to bring about change; and behavioural interventions in the absence of enabling infrastructure appear less likely to be successful.

- The literature does not identify an 'ideal' package of complementary measures: the most effective mix appears likely to depend on the precise characteristics of the location in question, but typically involves a mix of infrastructural improvements/provision, community-wide communications/campaigns, targeted (usually community-level) support and some individually-specific support.

- Some specific interventions did nevertheless emerge from the literature as being effective (in general and in a wide variety of countries and settings):
  - Personal travel planning
  - Walk/Cycle to Work days
  - Cycle-hire/bikeshare schemes
  - Pedometers
  - Walking groups
  - Provision of dedicated cycling lanes (and bicycle parking)
  - Some school-based interventions

- Caution is nevertheless required in interpreting the evidence base; there are very few studies in the literature that report on instances where a single intervention has been precisely studied in isolation from other possible explanatory factors; and there are examples in the reviewed literature where the effectiveness of a particular intervention seems not to be as great as the wider evidence base suggests.

- The evidence base on which interventions are most effective at changing perceptions of safety is weak. This is an important gap. Safety concerns are cited by (some) prospective cyclists as a reason for choosing not to cycle: evidence on perceptions of safety by new cyclists (rather than facts about safety *per se*) may be useful in encouraging such prospective cyclists to choose this travel option.

RQ3 How can we most effectively target cycling and walking interventions?

- Targeting prospective walkers and cyclists is, the literature suggests, characterised by two over-arching issues:
  - the S curve – the location of a particular location on the 'adoption curve' of walking and cycling behaviours i.e. whether the behaviours are very rare, or being taken up by 'early adopters' or becoming 'normal'
  - churn – it seems that it may be inappropriate to think of walking and cycling as 'on/off' behaviours – people walk and cycle more, or less, depending on a range of factors that vary over time, and that there is, as a result, a high rate of 'churn'

- There are, nevertheless, a range of typologies in the literature that can help to identify, and thus target, particular groups. Most of the typologies uncovered in the literature refer to cycling rather than walking; and these typologies focus on cycling attitudes and behaviours (e.g. 'contemplation/prepared for action/action' or 'summer-only cyclists') rather than more general socio-demographic characteristics (such as age, gender, social class).

- Detailed evidence on motivations and barriers is not especially widespread in the reviewed literature; but, where available, it is of good quality and is generally aligned with typologies just referred to.

- Two key motivators that recur in the literature are the **convenience of cycling** and the opportunity to **improve fitness**. Barriers, on the other hand, are often related to either safety concerns due to lack of appropriate infrastructure, or to various practical and contextual issues such as weather, topography, travel distances and the need to carry heavy bags.

- With respect to walking, the social element of interacting with other people appears to be a key motivator for various groups, from school children to older age groups.

- There is also evidence about attitudes towards interventions intended to boost walking and cycling. This evidence (which is more prevalent for walking interventions) tends to highlight the importance of social interaction of e.g. walking groups; the importance of convenience (i.e. accommodating the intervention into already-busy lives); and the power of group support in helping to make and sustain change.

- The evidence also strongly suggests that it is mainly women that respond to behavioural interventions such as walking groups, training etc. Women are also more likely than men to respond positively to dedicated cycling infrastructure.

- In general, however, there appears to be a relatively shortfall in evidence about how different groups in society – by age, ethnicity, health-needs and so on – respond to different interventions.

RQ4 Where do new or extended cycling and walking trips come from?

- The assessment found limited evidence on this research question, although there is some data from a small number of specific interventions – mainly cycle hire schemes.

- The evidence on whether cycle-hire trips are new, or represent modal switch, is limited and unclear. Where evidence of modal switch has been investigated, it suggests that most switching is from public transport to the bicycle; and that switching from driving a car is rare. Some of this finding may result from the fact that bike hire schemes are typically in dense urban locations, with corresponding modal distributions (i.e. typically a high reliance on public transport).

- Little or no evidence was uncovered that makes it possible to say who is making these new trips, nor the impacts on either other forms of transport or congestion more generally.

RQ5 What impact can cycling and walking investment have on physical activity and health, and the associated costs of this?

- A large and generally high quality evidence base provides a great deal of potentially useful information in respect of this research question.

- The reviewed evidence suggests that the scope for health benefits from walking and cycling interventions is significant, and the potential savings (to healthcare providers/systems) far outweigh the investment costs in most cases. These savings vary widely, depending on size of scheme, assumptions made etc.

- Directly attributing these benefits/savings to specific cycling/walking interventions is complex and rare.

- In general, the evidence suggests that walking and cycling interventions do increase physical activity levels (rather than acting as substitutes for other activity) but the scale of effect, its duration and its applicability to different groups within the population appears to vary considerably.

- The health benefits arising from these increases in physical activity can be considerable. They are expressed in terms of per person (e.g. cost savings to the NHS from community-based physical activity interventions range from £769 to £4891 per person) per city (e.g. Cycling Demonstration Towns produced benefits equating to healthcare savings of £45 million over 10 years) and at national level (e.g. cycling investments of $138-605 million [in the US] could result in health care cost savings of $388-594 million by 2040, and savings in the value of statistical lives of between $7-12 billion).

RQ6 What are positive and/or negative local economic impacts of cycling and walking interventions?

- There is relatively little robust evidence addressing this research question. The evidence available comes mainly from case studies.

- Cycling among employees has been associated with fewer sick days, improved productivity, and better quality of work. Evidence suggests that 'one day per year' less absenteeism as a result of cycling is a reasonable figure, but there are few sources for this figure; and no evidence was uncovered as to the measurable impacts on e.g. productivity and quality of work.

- The reviewed evidence suggests that investment into cycling and walking is often associated with positive impacts on retail spending at the local level, but the scale of the impact varies widely.

- Locations with increases in cycling (and, to a lesser extent, walking) following interventions tend to see an increase in the frequency of visit by cyclists who, though typically spending less per visit, tend to spend more in aggregate following the intervention.

- There is limited evidence that improved walking and cycling facilities (and public realm more generally) can have positive effects on tourism (both visitor numbers and spending); and some evidence, too, of positive effects on local property values; but these associations appear weak and have not been substantiated by robust research.

2 Introduction

2.1 Preamble

This report presents the results of a Rapid Evidence Assessment conducted by Brook Lyndhurst Ltd on behalf of the Department for Transport.

Against a background shaped principally by the legal requirement for Government to publish a Cycling & Walking Investment Strategy (draft issued in March 2016 and hereafter referred to as the Strategy) and the Government's ambition for increasing the number of people cycling and walking, the focus of the study was to identify evidence that will enable the Department to improve the quality of its assessment of the costs and benefits of different cycling and walking investment options.

The research addressed six specific questions (and a set of sub-questions beneath these headline questions) set out by the Department. The over-arching research questions (RQs) were:

Table 1 - Research Questions	
RQ1	What is the range of different interventions that can be used to impact on walking and cycling & how much do they cost?
RQ2	How effective are different interventions?
RQ3	How can we most effectively target cycling and walking interventions?
RQ4	Where do new or extended cycling and walking trips come from?
RQ5	What impact can cycling and walking investment have on physical activity and health, and the associated costs of this?
RQ6	What are positive and/or negative local economic impacts of cycling and walking interventions?

The RQs make it clear that this assessment is emphatically not a review of all research that might be relevant to cycling and walking; it is, rather, a review conducted specifically to support the Department's policy and investment-decision-making needs.

Neither is the assessment a **systematic review** of evidence. Instead, the research process identified and then drew upon a selective but extensive evidence base, the quality and nature of which was calibrated specifically to meet the Department's needs.

The assessment thus provides a carefully selected and structured presentation of an extensive evidence base.

2.2 Background to the research

The principal policy background to this assessment is provided by the draft Strategy[1], issued in March 2016. The Strategy, in turn, exists against a background of a range of projects, programmes and investments into cycling and walking that have taken place in England. These include the Cycling Ambition Cities programme, the work of Transport for London in London[2], the Cycling Demonstration Towns programme and others.

In addition to these various transport-led programmes, there has been an extensive array in recent years of public-health led initiatives to promote physical activity in England. These have generally been instigated by the Department for Health and/or Public Health England, but many other organisations, including local authorities, Sport England and others, have also played important roles.

For the purposes of providing broad context for this assessment, documentation associated with these various strategies and initiatives has been informally reviewed by the Brook Lyndhurst research team.

Such documentation does not, however, constitute 'evidence' for the purposes of this assessment (see 'Approach to the research', below) and detailed review of the policy background has not been conducted.

Indeed, neither providing an assessment of the broad policy position on cycling and walking, nor reviewing the various projects and programmes that have taken place to promote cycling and walking (except insofar as they may have generated high quality evidence relevant to the Research Questions (RQs)) lie within the scope of the present assessment.

It is nevertheless worthy of note – in that it provides an important backdrop to the present research – that there is a clear unanimity of ambition across all the policy and programme material: namely, to increase the amount of walking and cycling that people do.

Appropriate and sufficient evidence to support the achievement of this ambition is clearly essential; and it is hoped that the present document makes a useful contribution in that regard.

[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/512895/cycling-and-walking-investment-strategy.pdf

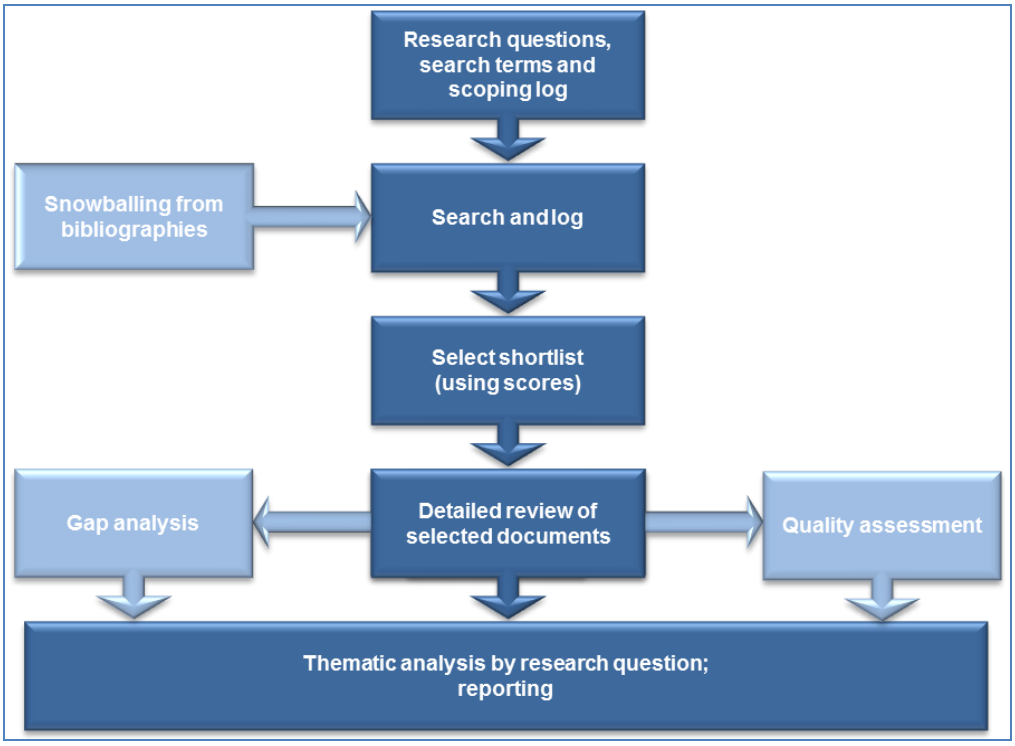
[2] http://content.tfl.gov.uk/gla-mayors-cycle-vision-2013.pdf

2.3 Approach to the research

Approach

This report presents the results of a Rapid Evidence Assessment. The assessment was conducted using the approach summarised in the diagram below and set out in detail at Annex 1.

Figure 1 – Research methodology



Given the background issues discussed in the preceding section, the approach to the Assessment was modified in two key respects:

- **active search** – given the breadth of potentially relevant research, and the specific uses to which the Department wished to put the findings, it was judged that a 'passive search' (using standardised search strings and semi-automated searches) would be insufficiently sensitive. A more intensive and sophisticated approach – deemed 'active search' – was therefore adopted;

- **quality** – given the need not only to meet high quality thresholds but also to cope with differential thresholds for the different research questions, a bespoke approach to assessing the quality of evidence was also required

Details of these modifications are included in the summary of the research method, below.

Method

The Assessment was conducted in three phases, the specifics of which are set out below.

Phase 1 - Scoping Phase

The purpose of the Scoping Phase was to identify a long-list of evidence sources from which a short-list could be drawn for detailed review. The principal mechanism for finding relevant evidence was through on-line searches.

The Scoping Phase began with a detailed inception meeting between Brook Lyndhurst and the Department's Project Steering Group. This agreed working protocols for the study. The scope for the Assessment was agreed as follows:

- Documents dated 2006 onwards included;
- Original evidence AND other reviews included (so long as they meet quality criteria – see below);
- Documents written or available in English to be included (exceptional documents in other languages were to be included if they emerged as particularly important);
- Cycling and walking for leisure, commuting and school journeys all to be included;
- Evidence on electric bikes to be included, if available;
- Research from the UK, northern and western Europe, Canada, Australia, New Zealand and the US, to be included.

Within these parameters, three waves of search for evidence were conducted:

- an initial exploratory wave of on-line search, to test and refine search terms, confirm viability of scope etc, and including literature:
  - suggested by the research team
  - suggested by Department for Transport
  - suggested by a number of academics with extensive publication histories in the relevant fields and informally consulted as part of the study
- an extensive wave of detailed on-line search, and including following references from within the found material, applying lessons from the initial wave and assembling the majority of the long-list
- a third 'mopping up' wave, including feedback from DfT on a draft long-list

Initial search terms were developed during the first wave of search and then refined. The search term framework used to guide the search is included at Annex 2.

As explained above, the study entailed an 'active search' approach – as material was detected using initial search terms, researchers pursued avenues of further enquiry suggested by those research terms, by references and citations, by authors/researchers and so forth. Searches were conducted with respect to each RQ separately; and sources were cross-checked against the RQs in each case. The primary criteria for inclusion on the long-list were: relevance (to one or more RQs, and reflecting the researcher's judgment on the extent to which the source in question addressed the specific RQ); and quality (see below).

A detailed log was maintained, collating various details of the source: author, title, location, country of origin etc. The log also includes, importantly:

- the abstract and a summary of the source
- relevance and quality scores
- the specific terms (or other method) by which the source was identified

The log provides a useful resource in its own right and is separately submitted to DfT.

Considering the issue of quality, the first phase of research included a specially-convened workshop. The workshop considered the quality standards that the Department judged would be necessary given the uses to which they intend putting the results from the Assessment; possible scoring mechanisms, such as the adapted version of the Maryland scientific method scoring system used by the WhatWorks centres, and the resources necessary to deploy different scoring mechanisms; and the consequences of embracing within the Assessment a wide range of evidence types, for which different definitions of 'high quality' might be appropriate.

The workshop concluded with a Quality Statement, attached at Annex 3. This Statement explains the scoring mechanism applied through the scoping phase. The scores for each source, together with brief summaries of the methods used by each source, are included in the scoping log mentioned above.

In all, a total of 319 sources were included within the scoping log.

Phase 2 - Detailed Review

From the sources identified in the scoping log, a total of 55 sources were selected for detailed review.

The shortlisting process was conducted by the research team as follows:

- to ensure a broad coverage across the RQs
- to include sources scoring 'very relevant' or, occasionally 'relevant' against each RQ
- to only include sources with the highest quality scores against each RQ[3]

Each source was then reviewed in detail. Detailed notes against each RQ were recorded in a review log. The detailed log is submitted to DfT alongside this report and the aforementioned scoping log.

Phase 3 – Analysis & Reporting

In the final phase, the detailed notes assembled in the review log were systematically analysed against the research questions.

[3] Of these 55, 30 were given the highest quality score of 3, and 20 were rated '2'. Five studies, though rated '1', were included because (a) of a shortage of available evidence against the relevant RQ and (b) because of their very high relevance scores.

In addition, a collaborative analytical workshop was conducted, in which top-line findings were shared and discussed between the Brook Lyndhurst research team and officials from the DfT.

Finally, on the basis of the analysis, this report was produced. Throughout the report, figures given in brackets – such as (43) – indicate the source for a statement or assertion; and these sources are listed in the bibliography in the annex to this report (and at Annex 6 in the accompanying volume of annexes).

2.4 Structure of the report

Following this introduction, each of the six research questions is treated in turn with its own chapter.

Each chapter begins with a reminder of the overarching research question, as well as the sub-questions that lie beneath each overarching question.

The structure of each chapter varies, depending on the research question and the associated evidence.

The penultimate chapter presents a selection of additional material uncovered during the research that appears to be relevant to the set of RQs in the round but which does not fit comfortably under any of the specific RQs.

The final chapter presents a discussion of issues raised by the research and the evidence base, and presents the research team's suggestions for future research priorities.

A bibliographical annex completes the document; a series of additional annexes are included in a separate volume; and two spreadsheets, comprising the research logs mentioned above, complete the set of deliverables.

3 Interventions and costs

Research question 1	
RQ1	**What are the range of different interventions that can be used to impact on walking and cycling and how much do they cost?**
RQ1.1	What is the range of different interventions used to impact cycling and walking? This should include all types of intervention, not just new infrastructure (e.g. behaviour change programmes).
RQ1.2	How much of any given type of intervention can we typically expect to deliver for a given level of investment?
RQ1.3	What key factors can influence the cost of different cycling and walking interventions?

RQ1 - Summary

The review uncovered a very wide range of interventions that have been used to impact on walking and cycling; and, for many of these, details of their costs

A typology for the interventions was developed (based on Fishman (2011)), classifying them under four main headings:

- physical infrastructure – bike lanes, walkways, signage etc
- intra-individual – behavioural interventions aimed at individuals
- socio-cultural – behavioural interventions aimed at people in groups e.g. in their community, at work, at school
- policy – interventions in terms either of general or specific policies to promote active travel

Cost data comes from a variety of sources, countries, currencies and years. In addition, minor variations in interventions (e.g. the width of a bicycle lane, the duration of a walking support programme) have implications for costs. Direct comparisons between sources are thus difficult; but the evidence makes it possible to identify broad ranges of costs.

A number of factors were highlighted in the literature as influencing costs: national factors (e.g. labour market costs, materials costs); materials being used; timescale of interventions; economies of scale (and scope); and whether walking and cycling infrastructure is integrated into new schemes or retrofitted to existing schemes.

Given the volume of evidence collected, only illustrative examples are presented in this chapter; fuller details are presented in Annex 5, organised under the main headings of the typology.

3.1 Introduction

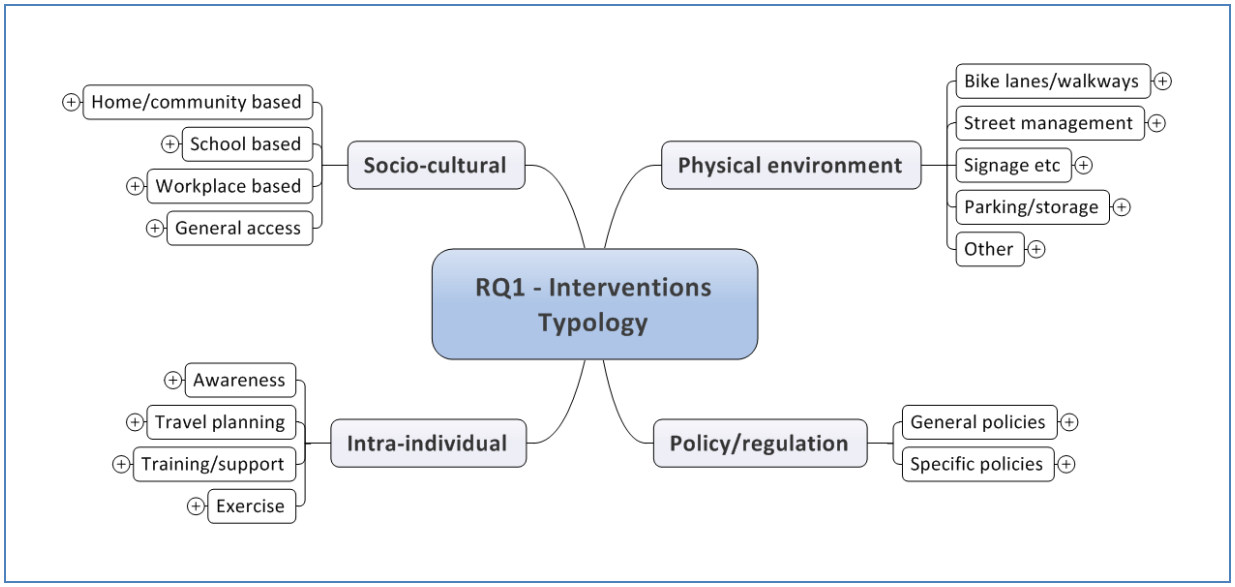
The literature review identified a wide range of interventions that can be used to try and increase walking and cycling. A number of ways of classifying these interventions were also uncovered.

The most comprehensive typology for classifying interventions was set out by Fishman et al (2011) which distinguished four categories:

- Physical environment;
- Socio-cultural environment;
- Policy/regulatory and
- Intra-individual.

The present research used this four-category typology as the starting point for a comprehensive classification, illustrated below.

Figure 2 - Intervention Typology



The mind map shown in figure 1 shows only the first 'layers' of the typology. In "Physical Environment" are captured the various infrastructural interventions identified by the review, grouped under five headings. Within "Bike lanes/walkways" the detailed material (presented in Annex 4) covers items such as dedicated bike lanes, shared bike lanes, raised bike lanes; tracks and pathways; and various types of bicycle-friendly junctions. Under "Street Management" there is evidence on various types of crossing, lighting methods and traffic calming. "Signage" covers both signs (such as painted lines, logos and direction finders) and signals (various types of push buttons, countdown timers and so forth). "Parking and storage" includes evidence on a wide variety of different bicycle parking and storage solutions (e.g. sheltered, unsheltered, guarded etc).

The "Policy/regulation" arm of the diagram leads to a variety of 'general' policies identified in the literature as being relevant (such as general travel demand measures, integration of

walking and cycling with public transport etc) and 'specific' policies (e.g. speed limits, helmet laws).

The "Intra-individual" section captures behaviour change interventions aimed specifically at individuals, including:

- awareness – travel awareness campaign, safety training
- travel planning – personal travel planning, individualised marketing
- training & support – pedometers, motivational interviews, peer-to-peer support
- exercise – exercise classes and advice

Finally, "Socio-cultural" captures group or community-level behaviour change interventions, grouped according the to focus on the intervention and ranging from the provision of healthy living maps, through community-led walking programmes, via school-based cycling projects to workplace cycle challenges and bicycle rental schemes.

The full breakdown, covering all the interventions identified during this assessment, is presented for each of the four limbs of the diagram, at Annex 4.

The typology is intended to be comprehensive i.e. any and all interventions can be located within the typology. Whilst cost data for many interventions was identified by this assessment, there are some omissions: the costs of policy and regulation, for example, were not uncovered by the research.

3.2 The Evidence on Costs

Because the evidence on costs collated by this assessment is so voluminous, evidence presented in the main body of the report is highly selective and illustrative only. Fuller material is presented at Annex 5.

The evidence on costs has been collated from a number of different sources, and they are not directly comparable. The reviewed literature presents cost data in a range of different formats, depending on the purpose of the source documents: this Assessment identified cost data for individual schemes, as well as collated data from multiple schemes, which were then presented in terms of averages, medians and ranges. In addition, these cost data originate from different years, as well as from different countries, and are therefore in different currencies. It is beyond the scope of this project to carry out the detailed calculations required to convert these data onto a comparable scale.

In one case (43)[4], the assessment identified an online database of costs, the contents of which necessarily cannot be replicated in a written document.

There are also other factors that need to be borne in mind when considering the cost data presented here:

[4] Available here - http://activelivingresearch.org/costs-pedestrian-and-bicyclist-infrastructure-improvements-resource-researchers-engineers-planners (accessed 13 September 2016)

- The figures are based on certain very detailed considerations about the interventions, for example:
  - Bushell et al (2013) present bicycle and pedestrian crossing costs, which **assume** bicycle lanes to be five feet in width and pedestrian crossings to be eight feet in width (43); and
  - The cost of bicycle training was (in 2011) estimated at £100-150 per person who goes on to cycle 'a lot' more. This was based on a training session length of one hour, and individuals normally taking between one and three lessons, at a cost of £30 per lesson – **where the subsidised rate to the user was £5 per lesson** (85) i.e. the cost to the public purse was not the apparent headline cost;
  - Cost data from NICE (2012) for personal travel planning gives an average cost of £11 per person contacted, a figure that includes materials, ongoing support and an assumed (but unstated) staff cost equivalent to one full-time staff member (193);
- The 'boundaries' around an intervention can vary, and some elements may or may not be included in the cost:
  - For example, Pringle et al (2010) describe a range of community-based physical activity interventions and their costs, noting that these costs do not include the indirect costs to partner agencies or the costs to participants (223).

It is clear from these various considerations that interpreting figures on the costs of interventions is not straightforward; and the examples, below, further illustrate this.

Table 2 – Costs of Selected Interventions
Signed Bicycle Route - $5,360-$64,330 per mile, average $25,070 per mile, median $27,240 per mile.
Shared Lane/Bicycle Marking pavement marking (painting) - $22-$600 each, average $180, median $160.
Push Button signals - $61-$2,510 each, average $350, median $230.
Bollard - $62-$4,130 each. Average $730. Median $650.
Source: Bushell (2013) *(Figures are US Dollars, 2012 prices. Avg 2012 exchange rate £1=$1.58)*
Workplace challenge to motivate employees to cycle - £270 per employee taking up cycling, average cost of £25 per employee.
Walking groups - £2000/year to motivate 100 people to walk more.
Bicycle training - £30/session, £100-150 to get a person to cycle 'a lot' more
Source: DoH (2011) *(Figures are £ in 2010 prices)*
Healthy living map with walking and cycling routes - £745 average implementation cost per month / £118 cost per participant (n=157) / £474 cost per completer improving MPA[5] (n=8)
Motivational interviews - MI for older adults including Black and Minority Ethnic (BME) in community, £1,764 average implementation cost per month / £696 cost per participant (n=76) / £1,253 cost per completer improving MPA (n=18)
Source: Pringle (2010) *(Figures are £ in 2009 prices)*

[5] MPA = Moderate Physical Activity

These examples illustrate, too, some further subtleties and complexities embedded in the evidence: the DoH data on bicycle training indicates a cost associated with getting someone to increase their cycling 'a lot', which is clearly a somewhat subjective measure; while the Pringle (2010) evidence, despite being of high quality, nevertheless is forced to rely on some very small samples.

3.3 Factors influencing costs

As well as the issues already discussed, there are other factors that influence the costs of cycling and walking interventions, as highlighted in the literature. The evidence here relates mainly to infrastructure, and the extent to which these same factors apply to other types of interventions cannot be inferred from the evidence reviewed.

- Costs vary between countries (91), as well as between cities and sites (43) depending on the local conditions, such as labour costs, materials costs and so on (43, 97);

- The size or scale of the intervention, as well as other scheme specifications, can have a significant influence on its cost (43);
  - There are economies of scale to be achieved where there is a fixed cost (e.g. access to a cement truck) that remains the same regardless of the scale of the project (43);
  - There are also "economies of scope" – for example, adding a cycle lane and pavement together is more cost-effective than adding the two as separate projects (43);
  - Retrofit projects are often more costly than new schemes (43);

- The materials selected for an infrastructure scheme will have an impact on its cost, and there may be further variation depending on manufacturer differences (43);

- Faster completion times can increase the cost of infrastructure projects – but this needs to be balanced out against the disruption that construction causes (43).

4 Effectiveness of interventions

Research question 2	
RQ2	**How effective are different interventions?**
RQ2.1	Which interventions have been shown to be most effective at boosting levels of cycling and walking? In what circumstances?
RQ2.2	Which interventions have been shown to be most effective at improving cycling and walking safety? In what circumstances?
RQ2.3	Which interventions have been shown to be most effective at changing people's perceptions of cycling safety? In what circumstances?

RQ2 - Summary

The reviewed literature acknowledges and highlights the difficulties of assessing the effectiveness of interventions. The nature of the behaviours in question and the factors influencing those behaviours are inherently complex; and the challenges of measuring changes, and of attributing observed changes to interventions, are considerable.

Given these challenges, the evidence base, in the round, is best understood as *strongly indicative* rather than definitive.

There is a strong consensus across the literature that that the most effective approach to increasing cycling and walking is to implement a complementary package of measures – that is, a mix of hard and soft interventions. Infrastructural measures appear necessary but not sufficient to bring about change; and behavioural interventions in the absence of enabling infrastructure appear less likely to be successful.

The literature does not identify an 'ideal' package of complementary measures: the most effective mix appears likely to depend on the precise characteristics of the location in question, but typically involves a mix of infrastructural improvements/provision, community-wide communications/campaigns, targeted (usually community-level) support and some individually-specific support.

Some specific interventions did nevertheless emerge from the literature as being effective (in general and in a wide variety of countries and settings):

- Personal travel planning
- Walk/Cycle to Work days
- Cycle-hire/bikeshare schemes
- Pedometers
- Walking groups
- Provision of dedicated cycling lanes (and bicycle parking)
- Some school-based interventions

Caution is nevertheless required in interpreting the evidence base; there are very few studies in the literature that report on instances where a single intervention has been precisely studied in isolation from other possible explanatory factors; and there are examples in the reviewed literature where the effectiveness of a particular intervention seems not to be as great as the wider evidence base suggests.

The evidence base on which interventions are most effective at changing *perceptions* of safety is weak. This is an important gap. Safety concerns are cited by (some) prospective cyclists as a reason for choosing not to cycle: evidence on perceptions of safety by new cyclists (rather than facts about safety *per se*) may be useful in encouraging such prospective cyclists to choose this travel option.

The relative shortage of data on the attitudes of new cyclists towards safety appears to be part of a more general shortage of time-series and survey-based evidence on the impacts of interventions.

4.1 Introduction

Assessing the effectiveness of interventions intended to boost levels of cycling and walking is – as the reviewed literature repeatedly makes clear – far from straightforward. There are three main reasons for this:

The character of cycling and walking

Cycling and walking are not 'simple' behaviours that can be adopted on a once-and-for-all basis. As chapter 5, below, explains, the amount of walking and cycling that an individual does can vary for a whole variety of reasons. The idea of a 'new cyclist', for example, is not clear cut: the evidence suggests that, in the spectrum between those that never cycle and those that cycle frequently, there is a group of people who cycle sometimes, or occasionally.

The complexity of factors that seem to influence a decision to walk or cycle – confidence, the weather, the availability of facilities and so on – suggests that, in common with other behaviours, efforts to boost walking and cycling need to address the underlying determinants[6]. In the case of relatively simple behaviours, it is sometimes possible to identify a relatively concise set of underlying factors and tackle those.

A useful analogy might be the comparison between recycling behaviour and waste minimisation behaviour. The former is, in fact, a relatively simple behaviour which lends itself to straightforward intervention and, in due course, the formation of new habits. Waste minimisation, by contrast, comprises a whole range of sub-behaviours which are altogether more difficult both to discern and to influence.

Whilst not perhaps as complex as waste minimisation, the behaviours called 'cycling' and 'walking' are not straightforward activities that, once adopted, automatically become normal everyday activities. As a result, and in short, the very nature of these behaviours makes them difficult both to influence and to measure.

[6] There is a wide literature on behaviour change and behavioural insight and it is impractical to reference it fully here. A useful starting point is the work of the Behavioural Insights Team - http://www.behaviouralinsights.co.uk/

The nature of interventions

Interventions intended to boost cycling and walking always take place in real places with real people. They attempt to address the complexities just hinted at – and they attempt to do so in social, geographical and cultural circumstances that are themselves complex.

As the preceding chapter indicated, there is a very wide range of potential interventions, ranging from direct physical infrastructure (which itself covers everything from bike lanes through signalling through street management) via behaviour change programmes (including training, travel planning, community walks and workplace-based initiatives) to the general policy milieu which may give more or less priority to active travel.

In circumstances of such complexity, it is almost impossible directly to link cause and effect. Observed changes in the amount of walking and undertaken in a particular place may be the result of some, or one, or all of the interventions in that place – or they may simply be the result of wider changes. As a result, very considerable challenges need to be addressed by any attempt to evaluate impacts.

The challenges of evaluation

Given the complexities of both the behaviours in question and the range of interventions available to influence cycling and walking, methods to assess impact are under very considerable pressure.

It is, for example, virtually impossible to conduct Randomised Control Trials (RCTs, which are often held to be the gold standard for assessing impact) to assess purely infrastructural interventions. And, whilst it is technically feasible to conduct RCTs to assess behavioural (or 'soft') interventions such as information campaigns, training or changes in service provision, there are several factors limiting the extent to which this occurs in the evidence base. These factors include the scale and time required for impacts to be observed; the practicalities of isolating an intervention from other possible effects; issues of equity and fairness; and the high costs that are often associated with RCTs.

Indeed, these challenges are not limited to RCTs: the well-regarded Maryland scale[7], for example, highlights the hurdles that need to be overcome before the evidence from any given study can be regarded as fully robust and any observed changes can truly be attributed to a specific intervention.

Despite these challenges, the review conducted for this present assessment has uncovered numerous studies and reviews that have, to a greater or lesser extent, measured and passed judgment on the impact of interventions intended to boost walking and cycling. All of the studies drawn upon for this assessment have passed a 'quality threshold' specifically developed by the research team and the DfT to meet the Department's needs (see section 2.3, above, and Annex 3). In the round, however, the evidence base remains constrained by the challenges outlined above, and care needs to be taken in interpreting the results. It is,

[7] See http://www.whatworksgrowth.org/resources/the-scientific-maryland-scale/ for an introduction (accessed 14 October 2016)

perhaps, the repetition and consistency of key findings that provides the most convincing case, rather than individual and specific instances.

With that in mind, this chapter begins by looking at 'multi-component interventions', not least since the literature has consistently shown that it is indeed multi-component interventions that are most effective at boosting walking and cycling.

Following that, the assessment turns in sections 4.3 and 4.4, to consider specific interventions. Section 4.3 presents some over-arching findings concerning how interventions can be compared; while section 4.4 works through a range of specific interventions which have, despite all the challenges previously outlined, been found to be effective. The chapter closes, in section 4.5, with evidence uncovered by the assessment on safety and perceptions of safety.

The reader is once again reminded that, given the complexities and challenges outlined above, the findings on effectiveness in the round should be interpreted as indicative rather than definitive.

4.2 Multi-component intervention packages

The literature suggests that the most effective approach to increasing cycling and walking is to implement a package of measures – a mix of hard and soft interventions – that are complementary. Town-wide initiatives that make use of a host of measures have been found time and again to have the greatest impacts on walking and cycling.

International evidence suggest that a combination of measures – segregated cycling facilities along heavily trafficked roads and at intersections, traffic calming in residential areas, cycling rights of way, bicycle parking, integration with public transport, education and training (for cyclists and motorists) and promotional measures – are needed to achieve high levels of cycling (228). Multi-faceted active travel interventions generally appear to have the strongest benefit-to-cost ratios (97). Infrastructure and policy measures that support active travel need to be combined with 'softer' measures that aim to influence individuals' travel decisions, in order to achieve a long-term shift to sustainable modes (204). The range of potential policy packages is very broad, but a not-untypical package (204) includes: the creation of bicycle accounts; marketing to improve co-existence of pedestrians and cyclists; route promotion marketing; innovative parking solutions; healthy cyclist campaigns; cycle website improvements; and safety strategy improvement. Pucher et al (2010) also recommend supportive land use planning as well as restrictions on car use (233).

Scheepers et al (2014) suggest that addressing active travel 'in the round' may be necessary in order to create the most cost-effective approaches (247). It is, however, worth bearing in mind that different agencies (public health, transport, local economic development etc) may share the same goals for different reasons, which means they may wish to target different groups of people and focus their evaluations on different aspects (196).

This is not to say that stand-alone active travel interventions have no impact – the evidence suggests that they can and do influence people's travel choices - but such interventions tend to be more effective when they form part of a comprehensive package of measures (233,

247) (and see below). Pucher et al (2010) suggest that by exploiting the synergies between different interventions, their impacts can be magnified (233).

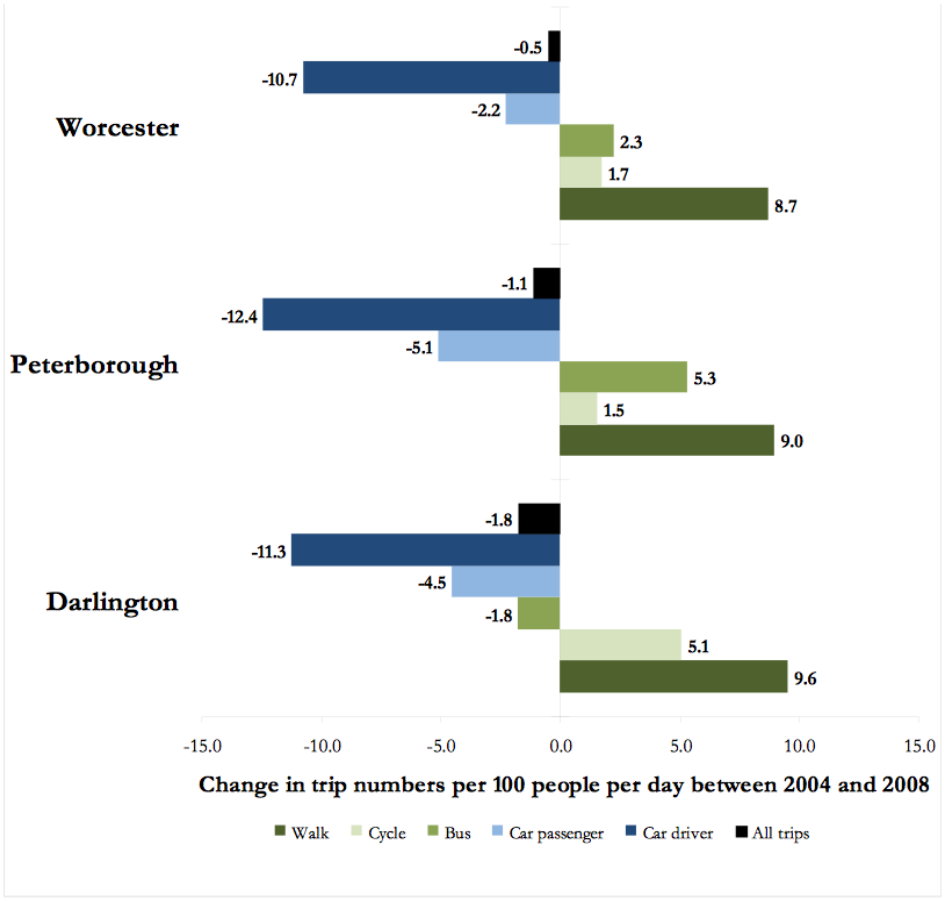
There are a number of examples in the literature of the impacts of such intervention packages. However, these have been measured using different indicators, on different timescales. Although there is a lot of variation in the degree of change achieved (97), the majority of the evidence supports the conclusion that packages of measures are effective at increasing cycling and walking.

- The Sustainable Travel Towns programme in the UK – which comprised packages including personal travel planning, travel awareness campaigns, cycling and walking promotion, public transport information and marketing, school travel planning, workplace travel planning and the development of a strong brand identity - saw the following increases in walking and cycling between 2004 and 2008:
  - Cycle trips per resident increased by between 26%-30% and walking trips per resident increased by between 10-13%;
  - The proportion of respondents who reported that they walked or cycled "almost daily" increased by 6%, or 2.8 percentage points, from 46.6% to 49.4%;
  - The proportion of respondents in household travel surveys who reported that they "almost never walked or cycled" fell by 11%, or 2.5 percentage points, from 23.4% to 20.9% (31, 97, 85, 254);

- The Cycling Demonstration Towns project operated in 18 towns and cities across England, which varied considerably in their size, cycling infrastructure and cycling cultures. Initiatives were therefore tailored to each setting, but all towns spent a mixture of capital investment (e.g. building cycle lanes, creating cycle parking) and revenue investment (e.g. promotional activities, cycle training), with an average capital:revenue ratio of 3:1. Towns also shared an emphasis on taking a 'whole town' rather than a piecemeal approach and saw:
  - An average annual 4% increase in the number of cyclists;
  - A 27% increase in the number of cycle trips between 2005 and 2009;
  - An increase in the proportion of residents who reported cycling for at least 30 minutes once per month from 11.8% in 2006 to 15.1% in 2008, an increase of 3.3%-points or 28%;
  - A decrease in those classified as 'inactive' from 26.2% to 23.6% (31, 193, 309).

- Darlington, which was both a Sustainable Travel Town *and* a Cycling Demonstration Town, saw an increase in cycle trips per person of 89%-113%, and an increase in distance cycled of 76%-112%, as measured through a household survey, while town-wide automatic cycle counters showed an increase in cycle activity of 50-60% between 2004/5-2008/9, and town centre cordon data showed an increase of 84-116%.
  - Darlington was designated a Cycling Demonstration Town in October 2005), and saw a significant increase in cycling from Spring 2006, following non-infrastructure interventions (cycling events, information resources, cycle initiatives at schools, cycle parking), and further growth from Spring 2008 following various infrastructure improvements (254).

Figure 3 – Impacts of Sustainable Travel Towns [Source: *Sloman et al, 2010*]



Notes: Data are for numbers of trips of <50km, weighted dataset. Base: between 11,954 and 12,909 trips by approximately 4,000 respondents in baseline and ex-post surveys in each town. Trips by other modes not shown for purposes of clarity. For an indication of scale of change, absolute number of trips <50km per 100 people per day in 2004 (aggregated dataset)=292, of which walk=72; cycle=9; car driver=124; car passenger=63; bus=20; train=1; other=3.

- In more detail, Goodman et al (2013) report that the six Cycling Demonstration Towns (funded 2005-2011) and 12 Cycling Cities and Towns (funded 2008-2011) achieved an increase in prevalence of cycling to work from 5.8% in 2001 to 6.8% in 2011, and an increase in prevalence of walking to work of 1.71 percentage points on the same timescale (112).

Figure 4 – Impacts of Cycling Demonstration Towns and Cycling Cities and Towns [Source: *Goodman et al, 2013*]

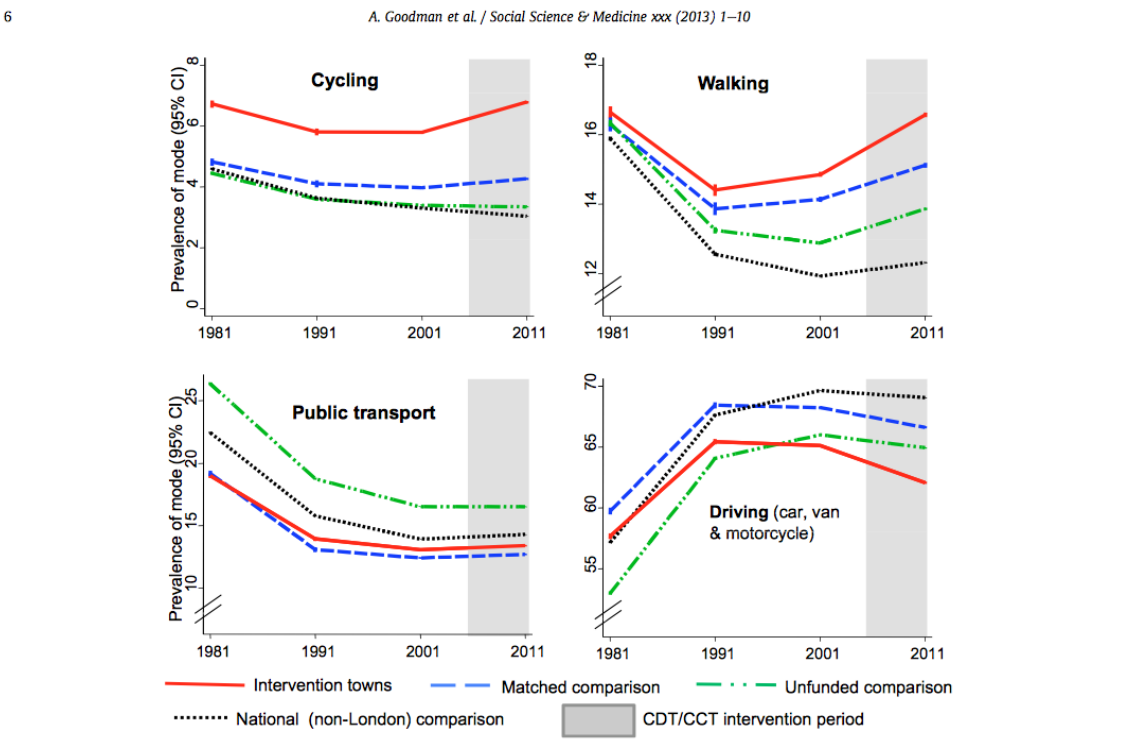


Fig. 1. Prevalence of cycling, walking, driving and use of public transport to travel to work among commuters living in the intervention towns and in the comparison towns, 1981–2011.

- Although the evidence shows that new cycling infrastructure generates benefits that outweigh the cost of investment, investment is also needed into a supporting package of measures to attract new people to cycle, instead of simply getting existing cyclists to cycle more (21).

- Physical infrastructure and behaviour change support measures are complementary – neither will achieve their full potential without the other (21).

There is also some contradictory evidence, which cautions that multi-component interventions may not necessarily be effective in every instance:

- Pucher et al (2010) consider 14 case study cities which have implemented various packages of measures to increase cycling, and note that the impacts have not been consistently large in every case (233);

- NICE (2012) collate evidence on the effectiveness of multi-component interventions on increasing walking and cycling. The evidence is described as 'weak' or 'moderate', and not all of it supports the conclusion that such interventions are effective (194).

In summary, whilst the majority of the evidence suggests that packages of measures are effective, there is some evidence to suggest that an intervention is not *automatically* going to be effective simply because it has multiple components. It nevertheless seems likely that combinations of measures can be effective in certain contexts (and if the quality of intervention is high) and that a tailored approach will therefore be required in individual locations in the future.

4.3 Comparing interventions

Comparing the effectiveness of individual intervention types is – as already hinted at above – hampered by a number of issues:

- The indicators that have been used to assess the effectiveness of interventions vary from evaluation to evaluation;

- Some interventions are designed to have a large impact on a small number of people, while others have a small impact on a large number of people, making comparisons complex;

- The effectiveness of an interventions is influenced by the baseline level of activity: depending on what the participants' starting point is, there is more or less scope for impact (115);

- Follow-up evaluation of interventions has been carried out at varying lengths of time after the intervention, making it impossible to draw consistent comparisons;
  - Many interventions have demonstrable short-term impacts, but evidence is limited on whether these impacts are sustained in the long term (206) – although Fishman et al (2011) suggest that "there are strong arguments to support at least medium-term durability" (97);

- Not all evaluations use a control area, which can lead to a significant degree of bias in impact data – and even where a control is used, other sources of bias often remain (309); and

- Statistical significance (and power analysis) of identified impacts is rarely reported in the literature (247).

This review identified three sources which, despite these complexities, set out to compare different intervention types – although it needs to be noted that all three cover a selection of active travel interventions rather than the entire potential universe of interventions.

Brennan et al (2012) conclude that TravelSmart is the most cost-effective of the interventions considered, followed by the Sustainable Travel Towns programme, then pedometer interventions, and finally Cycling Demonstration Towns (31). Ogilvie et al (2007) reviewed walking interventions, with "interventions delivered at the level of the individual or household or through group based approaches" being the most effective (206). Pringle et al (2010) compared physical activity interventions, and found no intervention type to be more

cost-effective than another, since there was so much variability within intervention types (223).

Overall, the reviewed literature suggests that, to some degree, a large number of interventions have at least the *potential* to be effective. The benefit-to-cost ratios of active travel interventions are usually positive, generally falling between 2 and 20, often due to the impact of social benefits (91, 97). Only a handful of interventions were identified here that were found not to be effective. These interventions either lacked a clear focus on the target behaviour of walking or cycling (309) – for example, home zones were found to have no impact on cycling (233) – or were too elaborate and costly for the target audience – such as the Dutch example of a 'product' comprising a bicycle locker at the home end, bus travel pass, and a locker and rental bicycle at destination end, for 500-650 euros per year (172). Interestingly, mandatory helmet laws were reported in one study as having *reduced* cycling (233)[8].

In terms of the scale of potential impact, systematic reviews of cycling interventions (309) and walking interventions (206) (which offer a high degree of confidence in the findings) suggest that cycling interventions can achieve "net increases of up to 3.4 percentage points in the population prevalence of cycling or the proportion of trips made by bicycle" (309)[9], whilst walking interventions can increase walking as a mode of transport in the general population by up to about 15-30 minutes a week on average, or walking in general by up to 30-60 minutes a week on average in non-transport interventions (206).

The effectiveness of individual interventions is strongly influenced by the current 'state of play' in active travel in the target area. Gotschi (2011) points out that the cost effectiveness of transport interventions "is characterized by a nonlinear S-shaped return-on-investment curve, where early investments yield little, midway investments yield maximum, and later investments again yield less return per invested dollar" (115). As a result, there is usually a correlation between the level of infrastructure, active travel policies and programmes that are in place, and levels of active travel (233).

Bidwell (2012) references work that suggests infrastructure investment to make cycling and walking to everyday destinations convenient and safe is more effective than individual behavioural interventions (21). This reinforces the arguments set out in the previous sub-section – namely, that it is bundles of intervention that work best; that infrastructure provides a necessary but not sufficient enabler of change; and that, on their own, behaviour change initiatives are not necessarily reliable.

[8] Source for this is a systematic review which states: "Studies in Australia in the 1990s found declines in bicycle counts one year after the implementation of a helmet law of 36% in Melbourne, 36% in New South Wales, and 20% in Perth (Clarke, 2006; Robinson, 2006)."

[9] "Six studies examined interventions aimed specifically at promoting cycling, of which four (an intensive individual intervention in obese women, high quality improvements to a cycle route network, and two multifaceted cycle promotion initiatives at town or city level) were found to be associated with increases in cycling. Those studies that evaluated interventions at population level reported net increases of up to 3.4 percentage points in the population prevalence of cycling or the proportion of trips made by bicycle." Ynag et al (2010)

4.4 Effectiveness of specific interventions

Although it has not been possible to draw direct comparisons between different interventions due to the issues described previously, it is possible to make some qualitative commentary on their relative effectiveness. This section presents, firstly, a general overview of the findings before, secondly, presenting the evidence (referenced) on each specific intervention in turn.

Notable highlights include the apparent effectiveness of personalised travel planning, in particular the Australian TravelSmart scheme which, despite some concerns about evaluation methods, appears to have been successfully replicated in a number of locations. Cycle to Work Days also appear to be effective, with impacts that (perhaps counter-intuitively) last well beyond the event itself – suggesting that this type of intervention may be effective at breaking through the inertia among 'marginal' cyclists. In addition, cycle hire schemes have significantly increased the number of cycling trips in a range of locations.

With respect to walking, pedometer interventions appear to be highly effective at increasing walking in the short term, although it is uncertain how long these impacts are maintained. Pedometer interventions appear to work particularly well when implemented in a health context, for example as 'walking prescriptions' through GPs. Walking groups and organised walks are also popular, although the focus here is on leisure walking rather than active travel.

The provision of walking and cycling infrastructure is crucial in enabling people to use these modes of travel in the first place. However, the evidence is mixed as to whether infrastructure provision alone can increase walking and cycling levels, or whether it needs to be supported with other measures. One clear exception is the provision of cycle parking, which has been shown to increase cycling.

The evidence from school-based interventions is mixed, and it seems likely that the degree of interest and commitment from the school may be a key factor in determining whether an intervention succeeds. It is also important to consider what the aims of any school-based interventions are: to increase active travel to schools, or to instil active travel habits for later in life – the evidence (see subsequent chapters) suggests that people alternate their travel modes depending on their situation and convenience, so while school-based interventions may instil active travel as an option whilst at school, there is nothing indicating that participants continue to travel actively after leaving school.

With regard to other types of interventions, the evidence is too scant to draw conclusions on their effectiveness.

Personalised travel planning

Personalised travel planning (PTP) is reported to be able to increase walking trips by up to 5 percentage points, and cycling trips by up to 1 percentage point. PTP projects run by Sustrans were associated with an average relative increase of 15% in walking trips and 35% in cycling trips, or a 14.7% relative increase in all forms of active travel combined. Evidence from elsewhere suggests that PTP interventions can increase walking by up to 30-60 minutes a week on average (85).

Some anxieties have, however, been expressed about the methodologies used to evaluate PTP (97, 194, 233) and insufficient appears known about which elements of PTP are critically important to success and which are not[10]. The evidence, overall, suggests that PTP should be considered as having potential, and that further research effort may be warranted.

TravelSmart

The Australian TravelSmart initiatives, which utilise personal travel planning approaches, have been extensively evaluated and, according to the systematic reviews assessed, were reported as effective. Different sources put the increase in walking at between 19.8-35% and the increase in cycling at between 32.1-61% (233, 247), although it is not clear from the evidence how these figures have been measured and calculated. The Brisbane North TravelSmart Project was found to increase time spent in active travel by an average of 16 hours per person per year, or 18.4 minutes per week (97). There is also some evidence to suggest that the changes resulting from TravelSmart schemes are sustained for at least five years (97).

Other sources, however, describe the effectiveness of TravelSmart more cautiously, suggesting the impacts are "modest" and adding caveats around evidence quality (97, 194, 233).

Workplace travel planning

Workplace travel plans have been associated with a doubling of the proportion of staff commuting by bus, train, cycling and walking (85), but there is a great deal of variation in costs and impacts, with one review finding no clear correlation between the two (97).

Workplace travel plan evaluations tend to focus on reductions in car use, but evidence has also been found for increased cycling (233). One example is the University of Bristol workplace travel plan (utilising measures such as economic incentives and improved facilities) which saw the proportion of staff usually (4 or 5 days a week) walking to work from 19% to 30%, and usually cycling to work from 7% to 12% (not a significant impact) between 1998-2007 (247). Another example comes from Peterborough, where commuter travel was targeted as part of the Sustainable Travel Towns initiative. Active travel increased at 12 of the 19 participating organisations (254).

Walk to Work Day / Cycle to Work Day

Annual events where a campaign encourages people to walk or cycle to work on a specific day have been found to have positive impacts on walking and cycling, which also appear to be maintained beyond the day of the event by up to one year (194, 97, 233).

The San Francisco Cycle to Work Day in 2008 found bicycle counts to be 100% higher on Cycle to Work Day compared to a control, and 25.4% higher several weeks later. Bicycle mode share was 48.3% before Cycle to Work Day, 64.1% on Cycle to Work Day, and 51.8%

[10] See also e.g. A comparative evaluation of large-scale personal travel planning projects in England (Chaterjee, 2009)

afterwards (233). The Australian Walk to Work Day resulted in a (statistically significant) 9% increase in trips combining walking and public transport in New South Wales. In other metropolitan areas, walking/cycling trips increased at the expense of combined walking and public transport trips (247).

Cycle to Work Days appear to attract new cyclists. The Seattle Cycle to Work Day saw 845 new cyclist commuters in 2004, and 2,474 in 2008. The Portland Cycle to Work Day saw 433 new cyclist commuters in 2002, and 2,869 in 2008. In Victoria, Australia, 27% of those who commuted to work by bicycle for the first time on Cycle to Work Day were still doing so 5 months later (233).

Cycle hire schemes / bikeshare

There are many studies reporting the effectiveness of cycle hire or bikeshare schemes (100). However, it is important to note that to some extent the impacts of the cycle hire or bikeshare scheme itself are difficult to differentiate from the impacts of infrastructure improvements that often accompany the implementation of these schemes (233, 97).

Woodcock et al (2014) put the number of cycle trips generated by the London cycle hire scheme at 7.4 million in 2011-2012 (307), while Fishman et al (2015) give a figure of 9,040,580 trips in 2012 (100).

Table 3 below illustrates the impacts of a number of cycle hire schemes in terms of the number of trips made and number of members (100). It is interesting to compare some of these figures. While the variation in annual trips per bike varies almost 10-fold between schemes, the variation in annual trips per member is much smaller – only about double. This is obviously a small sample of cycle hire schemes and no definite conclusions can be drawn from such comparisons, but these variations suggest that thorough analysis of cycle hire scheme data sets could reveal some interesting trends that give clues as to the key factors that influence their impact.

Table 3 - Impacts of cycle hire schemes

	London	Washington	Minneapolis	Melbourne	Brisbane
Bicycles	8,000	1,800	1,325	600	1,800
Trips (2012)	9,040,580	2,008,079	268,151	138,548	209,232
Annual members	76,283	18,000	3,500	921	1,926

Source: Fishman et al (2015)

The Dublin bike share scheme (550 bikes) resulted in over three million trips over the first 3 years (47), while a bikeshare scheme implemented at Dutch railway stations has resulted in 100,000 trips per year, with a substantial increase in trips at the destination end. (172).

The London cycle hire scheme has generated between 68.90-80.80 million additional minutes of active travel per year – the 2012 figure was just over 74 million minutes (100). Of the scheme members, 48% did not cycle in Central London prior to the scheme (278).

The London cycle hire scheme found that, one year after implementation, 6% of users had switched from the car to cycling. Data from the Montreal bikeshare scheme (using 5,050 bikes) in 2010 shows that 21% of users replaced walking trips and 10% replaced car trips with cycling trips (247).

Bikeshare schemes can also have additional positive impacts. The London Cycle Hire scheme is reported to have led 19% of scheme members to buy their own bicycle, while 9% have increased the amount they cycle on their own bicycles (278). Woodcock et al (2014) estimate that the London cycle hire scheme has reduced individual journey times by around 20% (307), while Pucher et al (2010) cite evidence which suggests that public transport usage has increased as a result of cycle hire programmes (233).

Pedometers

Pedometers are described as "cheap, effective and user-friendly" (196). The built-in feedback and self-monitoring mechanisms can create a sense of achievement and motivate people to walk more (148). Interventions utilising pedometers, complemented by supporting measures, have been found to be effective at increasing walking – either actual step counts or self-reported levels of walking (206, 31). Evidence on longevity of impacts is mixed, with some studies suggesting impacts were not sustained 24 weeks post-intervention (206), and others finding that impacts could last up to 6 or even 12 months (194). The removal of the pedometer at the end of an intervention effectively removes an element of motivation, which can limit the long-term impacts (148).

Pedometer interventions have been found to be effective when implemented through GP surgeries or in combination with a physical activity consultation – leading to 71% of participants reporting they walk more for everyday journeys, and step counts showing increases of 1,500 steps (equivalent to 15 minutes of walking) per day per participant after six weeks (85, 193). NICE (2016) suggest that combining pedometer use with monitoring, support and goal setting is crucial to their success (196). There is also some evidence to suggest that workplace-based, school-based or community-based pedometer interventions are also effective, although in the community context they appear to appeal more to women than men (194).

It is also worth noting that setting targets is unlikely to be useful unless done in the context participants' current activity levels, and that some people can be put off if pedometers are used to create a sense of competition (196), while others – especially young people – can be motivated by the challenge (148).

Walking groups

Walking groups and led walks, as well as information about places to walk, have been found (by sources including NICE) to be effective, seeing the proportion of people walking more for everyday journeys by between 17-41% (85, 31), though again other sources add a note of caution about evidence quality and consistency (194). One study goes so far as to conclude that advice provision alone can be as effective as led walks (196).

Infrastructure and route provision

The provision of cycling infrastructure tends to be associated with an increase in the level of cycling, although this is not always the case, and, as previously explained, evaluation of impacts is complex (97). Some of the evidence suggests that studies on a large (city or district) scale tend to find a positive and statistically significant relationship between the presence of cycle lanes and levels of cycling, but when looking at the smaller scale, results tend to be more mixed (233). Overall, international evidence shows a consistent and strong correlation between comprehensive infrastructure provision to segregate cyclists from heavy and fast traffic and high levels of cycling (278).

A number of studies have identified specific walking and cycling impacts that have been associated with infrastructure interventions:

- The National Cycle Network in the UK saw a total of 698 million trips in 2012 (303 million cycling and 395 million walking trips), and 748 million trips in 2013 (325 million cycling and 423 million walking trips), with three quarters of users stating that the Network increases their regular physical activity (269);

- In Delft, Holland, improving the connectivity of the cycle network (that is, improving the ease of connection between previously separated bike lanes) increased the proportion of household trips made by bicycle from 40% to 43% (309);

- A review of Danish cycling interventions highlighted an integrated set of transport corridor improvements (junction changes, bus stop layouts, bicycle parking) combined with promotion of bike-and-ride which saw an increase in bus passengers and an increase in the number of bike-and-ride users to about 25% of all bus passengers (no baseline given) (172);

- Evidence from London and from North American cities shows increases in the number of cyclists after installation of cycle lanes, although one study suggested that cyclists were more likely to have diverted to the cycle lane than to be new cyclists (233);

- The provision of a Downtown Crossing in Boston to improve pedestrian facilities corresponded with an 11% increase in pedestrians on weekdays after 2 years (though 2% points of this was attributed in the research to increased employment in that time period) (247);

- There tends to be a positive association between bicycle boulevards, traffic-protected cycle tracks, coloured cycle lanes, and levels of cycling (although good estimates of the quantitative effects on actual cycling rates are lacking) (233).

Reflecting the complexities referred to above, not all infrastructure interventions are reported to have similar impacts, however:

- The construction of a neighbourhood trail in Utah led to a decrease in walking, and no change in cycling (247);

- Evaluation of a new trail constructed as part of the UK National Cycle Network found no impacts on levels of cycling or walking (247);

- Evidence on the effectiveness of off-street paths in general appears to be mixed (233); and

- The iConnect study found that new infrastructure (such as a traffic-free bridge in Cardiff, a similar bridge over a trunk road in Kenilworth and an upgraded riverside footpath in Southampton) was more likely to be used by existing cyclists and walkers, and that their travel mode tended to remain consistent before and after the intervention – although it is important to note that identifying new journeys was not something the authors explicitly set out to do (113).

Evidence from Holland suggests that routes which do not require cyclists to make stops increase cycling mode share: 0.3 fewer stops per km along a route was associated with a 4.9% higher share of cycling (233).

The UK iConnect study found that new infrastructure (a walking/cycling route) was more commonly used for walking or cycling for recreation than for transport (113).

Bicycle parking

The provision of bicycle parking has been found to increase levels of cycling, mainly in the context of commuting and public transport access trips.

The provision of bicycle parking at work can make people more willing to cycle to work, as well as making people willing to cycle further (233), leading to increased commuting by bicycle (97, 172).

Better bicycle parking (and general integration of cycling with public transport) has been shown to increase levels of cycling, although the evidence for this only comes from a small number of cities (233). Pilot projects have been carried out in Holland to improve bicycle parking at railway stations and bus stops, and the results suggest that there is more potential for bike-and-rail than for bike-and-bus (172).

- Improving bicycle parking at railway stations has led to an increase in the number of parked bicycles, as well as an increase in cycling for access trips among bike-and-ride users (172);

- A pilot project to improve bicycle parking facilities (and other improvements) at seven rural bus stops increased the number of bike-and-ride users at five bus stops: 9% of existing bus users started cycling to bus stops, and 1% changed the bus stop they used (172);
- A pilot project to improve bicycle parking at bus stops along secondary roads in rural areas and small towns was found to have limited impact, with 25% occupancy of new parking facilities, some car, bicycle or public transport trips replaced by bike-and-ride trips, and some people changing the bus stop they used (172).

An interesting point to note is that standard cycle parking is more popular among users than bicycle lockers, which tend to be under-utilised (although it is worth noting that the evidence for this comes from Holland and may not apply to the UK) (172).

As well as increasing cycling levels, the provision of good cycle parking at public transport interchanges may also increase public transport use (233).

School-based initiatives

There is a wide range of interventions which aim to increase walking and cycling as modes of travel to school. However, the impacts of these interventions appear to vary between, as well as within, intervention types. Although the reasons for such variation have not been well researched, it is likely that school characteristics and degree of commitment to the scheme have an influence on degree of impact (97).

Some school-based interventions are described as successful in the literature, though impact data is lacking. These include Sustrans' 'Tackling the School Run', which saw an increase in the numbers of pupils walking and cycling to school (97), and 'Bike It', which saw a doubling in the number of pupils cycling to school (baseline not given) (85). Multi-component school-based interventions, walking school buses and walking sessions have also been found to have some impact, though evidence quality is variable (194).

School travel was one of the facets covered by the Sustainable Travel Towns initiative (see above). In Darlington, cycling increased from approximately 1% to over 6% of trips to school. In Peterborough, active modes of travel rose by 8-12% (or 4-7 percentage points). In Worcester, active modes of travel rose by 7-14% (or 4-7 percentage points) (254). In Cycling Demonstration Towns, the proportion of children cycling to school increased by 16% (253).

The Safe Routes to Schools programme (which typically involves identifying and then promoting, in partnership with the school, a restricted number of routes to school which are safer [for both cyclists and walkers] than some established routes) has had mixed results, with walking and cycling increasing in some cases (233). In Dublin, the percentage of school children (aged 5-12) cycling to school increased from 1.3% in 1996 to 1.8% in 2006 and 2.4% in 2011, in conjunction with the scheme (47). The BikeTexas Safe Routes to School intervention had no impact on school travel behaviour, but led to an increase in leisure cycling after one school term (309).

Evidence from Australia suggests that, even where school-based interventions have not succeeded in increasing levels of walking and cycling, they may be stalling any increase in car use (97).

Interventions that do not focus on schools directly can also influence school travel behaviour. The Cycling Demonstration Towns in the UK have led to an increase in cycling to and from primary schools (more so than in the wider community) (97).

Other interventions

There are a number of other interventions mentioned in the reviewed literature, which do not fall under any of the categories discussed above (but which are nevertheless framed by the typology introduced above). These have had variable impacts - outlined below – and further reinforce the message of this sub-section: there is a long list of interventions which seem capable, in some settings and on some occasions, of making a positive contribution to increases in cycling and walking; but a definitive list does not yet exist.

- Mass media campaigns have been found to positively contribute to the update of walking and cycling, provided they are combined with other measures (247);

- Community-wide promotional activities, combined with improved infrastructure, may contribute positively to increases in cycling rates (by "modest" amounts) (196);

- Improved cycling facilities may – though not necessarily – contribute to increased cycling (107);

- A bicycle proficiency education programme in Columbia, which trained 300 people (children and adults), saw 75% of participants using their bicycles more often, and 35% of car trips being replaced by cycle trips, after six weeks (247);

- A study of tax-free loans to purchase bicycles found that 48% of those who had not owned a bicycle in over 7 years had started cycling on a weekly basis (47);

- The Bike Now programme implemented in 27 workplaces in New Zealand found that 32% of post-intervention survey respondents (n=675) claimed to cycle to work more often than a year previously, while 49% claimed to replace a car journey by cycling (247);

- The 'Walk In to Work Out' pack, providing educational and practical information, and implemented at three workplaces in Glasgow, led to:
  - Those in the intervention group spending a significantly larger average time per week walking to work than those in the control group, after 6 months (note that sub-samples are fairly small);
  - 25 % of the intervention group (n=145) becoming regular active commuters after 12 months;
  - No changes in cycling behaviour (247);

- A campaign to reduce car use in Phoenix, US saw an increase of 1% in commuter cycling after one year (247);

- A social and individual marketing intervention in a health care setting in Sydney saw an increase in the proportion of staff using active transport to work from 37% to 45% (not significant) after one year, as well as a significant reduction of 20% in proportion driving to work 5 days a week (247);
- Marketing aimed at individuals can have a "consistent and positive" impact on cycling behaviour (196);

- In 8 case studies in California employees were financially rewarded for not driving to work, resulting in walking and cycling mode share increasing from 3% to 4% (247);

- The Trondheim Toll Ring in Norway, implementing a toll for access to the city centre, was associated with a decrease in walking and cycling (247);

- Speed limits have been shown, in some studies, to increase cycling (233).

- Evaluation of the AustCycle training programme suggests:
  - 96.8% of participants indicated they intended to continue cycling
  - Three months after the programme, 82% had cycled in the last month
  - One year after programme, 76.9% of those who had previously cycled infrequently or not at all said they had cycled in the last 3 months.
  - Training adults and children in cycling proficiency was found to appeal mainly to new cyclists: 61% of participants registered beginners' skills training and learning to cycle (239).

- One scheme in Wimbledon, South London, to incentivise children to walk to school using 'swipe cards' to swipe on readers on their route to school to gain rewards (cinema tickets and Topshop vouchers) for numbers of days walked, appeared to increase walking even after the incentive scheme (123).

- Studies of the London and Montreal bikeshare schemes show that these have increased active travel, though the London scheme did so to a greater degree (100).

- Impacts of a bicycle sharing scheme in Barcelona included (between March 2007 and August 2009):
  - 11% of the municipal population subscribed to the scheme;
  - Cycle trips increased by 30%, with more than two thirds of trips for commuting to work or school, and over a third combined with another travel mode;
  - Mean distances cycled were 3.29km on a working day and 4.14 km at weekends per user (21).

- There is no robust evidence on the effectiveness or otherwise of mobile phone apps (196).

4.5 Improving walking and cycling safety

The reviewed evidence contains relatively little on how effective walking and cycling interventions have been in terms of their contribution to safety and, importantly, to *perceptions* of safety. Given that safety concerns are often cited as a barrier by – especially - prospective cyclists (see below), this lack of data must be considered a significant shortfall. It would clearly be extremely helpful to demonstrate to prospective cyclists that previously reticent cyclists had either overcome their safety fears, or had found their fears misplaced, or had discovered that new infrastructure (or some other intervention) had helped them address their safety concerns. This is an important research gap which future research could usefully address.

The following points from the evidence are nevertheless worth noting:

- Speed limits have been shown to increase cyclist safety (233), with limits of 20 mph achieving a 13% reduction (baseline speed limit not given) in accidents, with the number of casualties falling by 15% - although these changes are not statistically significant (85);

- In Denmark, legislation requiring routes to school to be made safe has been associated with a rapid decline in child casualty rates (97);

- A number of studies have found that with larger numbers of cyclists, the crash risk for individuals is reduced (a phenomenon commonly known as "safety in numbers") (115, 228);

- In the Sustainable Travel Towns, injury risk per km walked or cycled was reduced in all three towns, while absolute casualty numbers also decreased – though numbers of certain types of casualties increased (254);

- Injury rates are lower on cycle hire bikes than for cycling in general – this may be because the hire bicycles tend to be slower and have built-in lights, because a lower proportion of cycle hire trips are made on roads, or because drivers may be more careful around hire bicycles (307);

- Cycletracks, coloured bicycle lanes, and bicycle phases in traffic signals appear to be effective at increasing cycling safety (233);

- Although advance stop lines appear to have no significant impact on cyclist safety (possibly due to low level of baseline accidents making improvement difficult to measure), they do appear to increase cyclists' perceptions of safety (233);

- Segregated cycling infrastructure has been shown to lead to a lower risk of cyclist injury and a reduction in accidents; for example, the implementation of segregated cycle tracks in New York City was associated with a decrease in total cyclist injuries between 30% (on 8th Avenue) and 62% (on Prospect Park West), while the overall reduction in the rate of cyclists killed or seriously injured was 73% across the city between 2000-2011 (278);

- Improvements to cycling infrastructure and restrictions on car use in Holland have been associated with an 81% fall in the cyclist fatality rate between 1978-2006 (228);

- There is some evidence to suggest that traffic calming improves both cycling safety and perceived safety (233); and

- One review suggested that, whilst improved cycling facilities (in general) can make cycling safer, this does not necessarily lead to more cycling (i.e. some people may be citing safety concerns beforehand as a reason for not cycling, but in practice there are other factors that are more important) (107).

- The introduction of a diagonal pedestrian crossing at Oxford Circus has led to increased walking speeds, a decrease in crossing time, and a 10% reduction in personal injury accidents in the first year (161).

5 Effective targeting

Research question 3	
RQ3	**How can we most effectively target cycling and walking interventions?**
RQ3.1	What does a 'marginal' cyclist or walker (someone more likely to take it up or cycle more) look like?
RQ3.2	What are the motivators and barriers to cycling for marginal cyclists?
RQ3.3	What are the motivators and barriers to cycling for those less likely to cycle? How do they differ from those for marginal cyclists?
RQ3.4	Have any of the interventions identified been shown to be more or less effective with different groups?

RQ3 - Summary

Targeting prospective walkers and cyclists is, the literature suggests, characterised by two over-arching issues:

- the S curve – the location of a particular location on the 'adoption curve' of walking and cycling behaviours i.e. whether the behaviours are very rare, or being taken up by 'early adopters' or becoming 'normal'
- churn – it seems that it may be inappropriate to think of walking and cycling as 'on/off' behaviours – people walk and cycle more, or less, depending on a range of factors that vary over time, and that there is, as a result, a high rate of 'churn'

There are, nevertheless, a range of typologies in the literature that can help to identify, and thus target, particular groups.

Most of the typologies uncovered in the literature refer to cycling rather than walking; and these typologies focus on cycling attitudes and behaviours (e.g. 'contemplation/prepared for action/action' or 'summer-only cyclists') rather than more general socio-demographic characteristics (such as age, gender, social class).

Detailed evidence on motivations and barriers is not especially widespread in the reviewed literature; but, where available, it is of good quality and is generally aligned with typologies just referred to.

Two key motivators that recur in the literature are the **convenience** of cycling and the opportunity to **improve fitness**. Barriers, on the other hand, are often related to either safety concerns due to lack of appropriate infrastructure, or to various practical and contextual issues such as weather, topography, travel distances and the need to carry heavy bags.

With respect to walking, the social element of interacting with other people appears to be a key motivator for various groups, from school children to older age groups.

As well as evidence about motivations and barriers towards the *behaviours* of walking and cycling, there is also evidence about attitudes towards *interventions* intended to boost walking and cycling. This evidence (which is more prevalent for walking interventions) tends to highlight the importance of social interaction of e.g. walking groups; the importance of convenience (i.e. accommodating the intervention into already-busy lives); and the power of group support in helping to make and sustain change.

The evidence also strongly suggests that it is mainly women that respond to behavioural interventions such as walking groups, training etc. Women are also more likely than men to respond positively to dedicated cycling infrastructure.

In general, however, there appears to be a relatively shortfall in evidence about how different groups in society – by age, ethnicity, health-needs and so on – respond to different interventions.

5.1 Introduction

When considering how 'marginal' walkers and cyclists might be targeted, literature reviewed for this Assessment presented two overarching issues:

- the idea of an 'S-curve' – capturing the overall level of cycling/walking in a particular location, and which suggests that the 'marginal' cyclist/walker has different characteristics at different stages of the uptake of cycling/walking

- the issue of 'churn', in which individuals oscillate between mode choices depending on a variety of factors, with the consequence that the notion of a 'new' cyclist or walker may not be appropriate

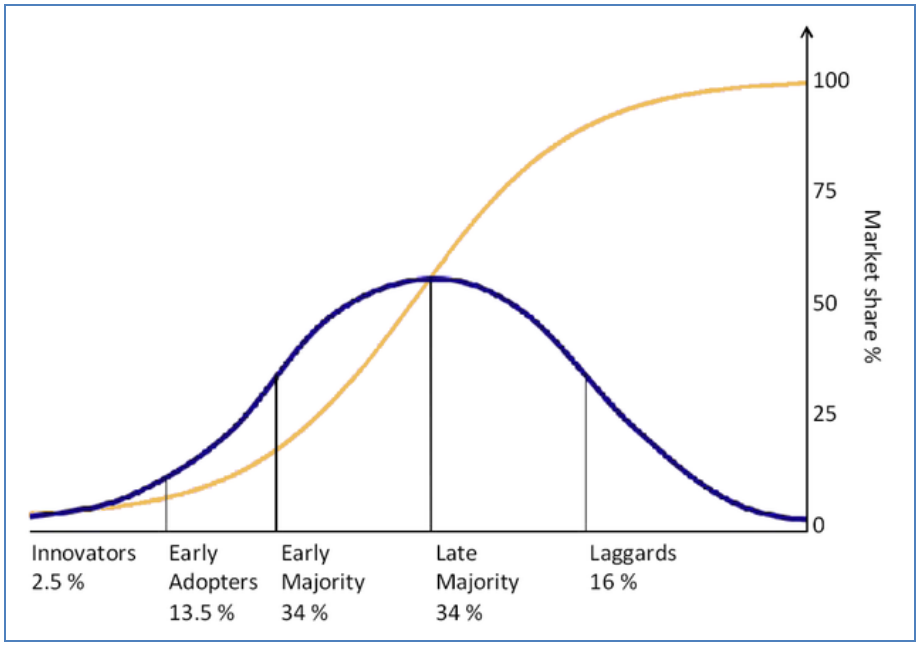
The S-curve of walking and cycling

The 'S-curve' is a well-established pattern in the uptake of new products and behaviours, in which 'innovators' first introduce a new behaviour/product and are followed by 'early adopters'. First described by Everett Rogers[11], the pattern suggests that, as the product/behaviour becomes more established, an 'early majority' and then a 'late majority' take up the behaviour sequentially, before 'laggards' bring adoption towards 100%.

A typical pattern for this sequence is shown in the figure below.

[11] "The Diffusion of Innovations", Everett Rogers (1962)

Figure 5 – Stylised S-curve



In order to effectively target cycling and walking interventions, it may be necessary firstly to establish where any given location is on the "S-curve": is it in the initial stages where walking and cycling are rare; in the middle where walking and cycling are increasing rapidly; or near the end where walking and cycling are commonplace? This will determine whether there is potential to attract new walkers and cyclists, or whether it is better to target existing walkers and cyclists to walk and cycle more (64).

The evidence suggests that walking and cycling in the UK are at different stages of the curve, with cycling in the initial stages and walking somewhat further along. Cycling is only used for around 2% of all journeys in Britain (193), as well as for 2% of journeys less than 5 miles (107). In contrast, walking accounts for 25% of journeys and 18% of travel time in the UK (though only for 2.8% of total mileage) (97), and of all journeys less than 5 miles in Britain, 38% are walked (107)[12].

The implication of this may be that attracting *new* cyclists will be a crucial aspect of pushing cycling further up the S-curve, whereas for walking there is likely to be more scope for working with both new and existing walkers.

The concept of a 'marginal' walker/cyclist

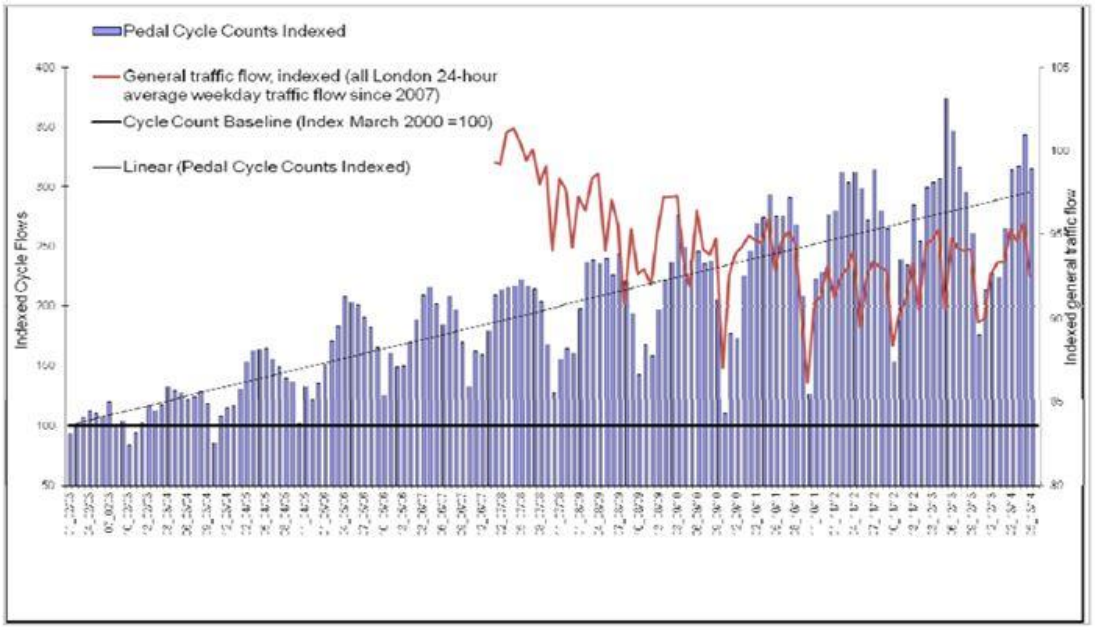
People do not necessarily fall into neat categories of walkers and non-walkers, and cyclists and non-cyclists. Pooley et al (2014) identified 'mobility identities' associated with cycling, walking and the car - but 58% of variance in people's attitudes cannot be explained through

[12] It is important here to note the difference between 'trips' and 'stages': stages are much more important than trips for walking and cycling as part of a multi-modal journey. The adoption of walking and cycling as a travel option may be at different points on the S-curve, depending on whether one is considering trips or stages.

these three factors, suggesting that there is a segment of people who are not committed to any particular form of travel, but are open to changing their travel behaviours (221).

The evidence from cycling research suggests there is a significant amount of 'churn' in people's cycling frequency, which means that identifying marginal, new or frequent cyclists is not necessarily straightforward as people go through periods of taking up and giving up cycling. This behaviour can be linked to factors such as seasonality (64), as illustrated in figure 6 below. Whether or not this same issue of churn applies to walkers is not clear from the literature, but it seems reasonable to assume that it does.

Figure 6 – Seasonal cycle flows [Source: *TfL, 2014*]



Crockett et al (2011) reference the Attitudes to Cycling survey 2009, which found that 22% of all cyclists had taken up cycling during the previous year. Their own work put the figure at 17%. A significant proportion of cyclists are therefore 'new cyclists' at any given moment – for example, for Greater London it is estimated that 'new cyclists' make up approximately 15-25% of all cyclists (64).

It is interesting to note that this issue of churn also means that a stable number of cyclists does not equate to there being no new cyclists – but simply a balancing out of numbers of new and lapsed cyclists over time (64).

However, other research does suggest that there exists a group of people who do not currently cycle but could potentially be persuaded to do so. This group is in contrast to regular cyclists, who appear to consist of a small minority of people who cycle under most circumstances because they enjoy it, and those who have never considered cycling (107). The size of this group appears unclear: Gatersleben and Appleton (2007) suggest they are a minority (107), while TfL (2014) reference research that claims approximately seven out of

ten non-cyclists are prepared to consider cycling, provided that relevant barriers can be addressed (278).

5.2 Characteristics of new/marginal cyclists and walkers

Although the reviewed evidence includes some commentary on the characteristics of 'new' cyclists, the conclusions that can be drawn from this are limited.

Crockett et al (2011) found that new cyclists in their study in London were skewed towards women (64), while Goodman et al (2013) found weak evidence to suggest that men may have been more likely to use the new infrastructure they evaluated (113). TfL (2014) also suggest that men, specifically high-income white males aged 25-44 are some of those in the 'near market' for cycling (278). Research elsewhere suggests that women appear to be more resistant to cycling than men (107).

Other characteristics of new cyclists in the London study cited above were that they were more likely to be established residents than newcomers to the area, and that they tended to already own a bicycle, and/or purchase a new one shortly before or just after starting to cycle (64).

None of the reviewed sources commented on the characteristics of new walkers, though Ogilvie et al (2007) note that most participants in interventions intended to promote walking (not necessarily new walkers, therefore) were women. They also caution that such interventions may appeal more to "better-off groups in the population", thereby increasing health inequalities (206).

Cyclist typologies

In the absence of information about the characteristics of marginal cyclists (and walkers), there may be some useful pointers that can be inferred from research with existing cyclists that attempts to categorise them according to their characteristics. Perhaps the most useful categorisation is that used by Gatersleben and Appleton (2007), who group people by 'stage of change' (and which is analogous to the S curve described above) as follows:

- Pre-contemplation;
- Contemplation;
- Prepared for action;
- Action; and
- Maintenance (107).

They identify different barriers that apply to people at these different stages (discussed below).

Gatersleben and Appleton (2007) also cite other work which grouped cyclists into:

- Winter (and summer) cyclists;
- Summer-only cyclists;
- Infrequent cyclists; and
- Never-cyclists (107).

Crockett et al's (2011) survey of 'new cyclists' in London groups them into five clusters (note the small sample sizes):

- "Die hard frequent cyclists in any time, any weather" (n=6);
- "Cycle to work frequently or occasionally, weather permitting" (n=15);
- "Anytime non-work" (n=8);
- "Off-peak, any day for non-work" (n=9); and
- "Weekend only for non-work" (n=24) (64).

5.3 Motivations for and barriers to cycling and walking

The review uncovered limited research into motivations for cycling as they relate to marginal cyclists and walkers specifically. However, a number of relevant points can be identified from the literature.

Two key motivators that recur in the literature are the **convenience of cycling** and the **opportunity to improve fitness**. Barriers, on the other hand, are often related to either safety concerns due to lack of appropriate infrastructure, or to various practical and contextual issues such as weather, topography, travel distances and the need to carry heavy bags. These issues may all be related to the 'churn' factor described above: they may prevent people from cycling temporarily, but when these conditions change – the weather improves, or a house move affects travel distance and topography, for instance – they may take up cycling again. In other words, when cycling is a sufficiently convenient option, it will be taken up again (107, 64).

With respect to walking, the social element of interacting with other people appears to be a key motivator for various groups, from school children to older age groups. Interestingly, fitness is not mentioned in the literature as a motivation for walking – and there is some suggestion that it may not be perceived as vigorous enough to be considered exercise (194, 148).

In the remainder of this sub-section we highlight:

- motivations for, and barriers against, cycling and/or walking, by 'stage of change' – showing how these motivations and barriers differ depending on where an individual is in terms of their personal adoption of these behaviours

- motivations for, and barriers against, *interventions* intended to encourage the adoption of new walking and cycling behaviours

- evidence – albeit light – on what is known about how motivations and barriers vary between different groups within the population

Motivations and barriers by 'stage of change'

The Gatersleben and Appleton (2007) study referenced above, which used the 'stage of change' categorisation, found the following barriers and potential enablers for the key non-cycling groups:

Table 4 – Motivations and barriers by stage of change

Stage	
Pre-contemplation	Those at the 'pre-contemplation' stage, who had never contemplated cycling: ➢ Said they would not cycle under any circumstances; ➢ Were more likely than others to claim they lived too far away to cycle, even though their average travel distances were similar to the other groups; ➢ Believed they would feel strange on a bicycle and that other people would also find it strange if they cycled;
Contemplation	People at the 'contemplation' (and, indeed, the 'prepared for action') stage suggested a number of improvements that would encourage them to cycle; most commonly: ➢ More safe cycle facilities; ➢ Better weather; and ➢ Flatter terrain;
Prepared for action	Those at the 'prepared for action' stage were *less likely* than others to: ➢ Feel that they lived too far away to cycle; ➢ Perceive lack of facilities as a barriers; Those at the 'prepared for action' stage were *more likely* than others: ➢ to experience more personal barriers (e.g. work and family commitments);

Those in the 'action' and 'maintenance' stages claimed they would cycle more in better weather and flatter terrain, as well as stating that infrastructure needed to be improved (107).

This same study then went on to recruit 22 people who expressed an interested in cycling to try cycling for two weeks. Key motivations identified through interviews were:

- Convenience (mentioned by 40% - but note the small sample size here);
- Getting fit (37%); and
- The environment (37%) (107).

Crockett et al (2011) surveyed 64 new cyclists (i.e. those that had recently reached the 'action' stage) and found:

Table 5 – Attitudes of new cyclists	
Reasons for taking up cycling	• 69% mentioned getting fitter/losing weight; • 31% wanted more independence; • 31% other; • 25% going to a new place; • 22% more spare time; • 16% cost of car parking or fuel.
Barriers overcome	• Road and traffic conditions (52 mentions across the sample); • Lack of confidence or skills (25 mentions); and • Facilities for cyclists (23 mentions).

The authors note that despite these new cyclists having overcome these barriers to start cycling, they may still limit how much, where and when they cycle (64).

Considering those that do indeed cycle, Gatersleben and Appleton (2007) cite work which has found the most common reasons for cycling to be enjoyment, fitness, low cost, flexibility and relative speed – however, even among existing cyclists there is variation in motivations. For example, all-weather cyclists were found to be particularly motivated by the opportunity to exercise. Their own research suggests that commuter cyclists may be more motivated by the relative flexibility of bicycle travel rather than by health and environmental benefits (107). This reflects the evidence described above on new cyclists. Elsewhere, health reasons, "showing off", environmental benefits, efficiency, speed, sense of autonomy and freedom are cited as motivations for cycling to work (148).

Interestingly, Crockett et al (2011) found that once people had taken up cycling, they perceived more benefits than they had as aspiring or new cyclists (64).

Gatersleben and Appleton (2007) list the most frequently cited barriers to cycling as: travel distance, gradient, traffic safety, heavy traffic, inconsiderate drivers, pollution, bad weather, not being fit enough and social pressure (107). Traffic appears to be a key issue, with an estimated 90% of all current and potential cyclists described as 'traffic-intolerant' to some degree (278). In addition, Crockett et al (2011) suggest that issues to do with bicycle maintenance and repair may create barriers to cycling (64).

Erznoznik, G. et al (2014) identified barriers to cycling and potential motivators or facilitators for cycling, as perceived by car drivers, who may well be some of those less likely to cycle (i.e. in the 'pre-contemplation' stage) (91):

Table 6 – Attitudes of non-cyclists	
Key motivations	• Cycling as an enjoyable activity; • Health benefits; • Environmentally friendly activity; • Good for physical exercise
Key barriers	• Inability to transport heavy things; • Dependence on weather conditions; • Safety concerns; • Insufficient availability of cycling routes; and • Incomplete cycling route signage.

Another study noted that travel time was cited as being particularly important in non-cyclists' mode choice; and that weather conditions are a particularly important influence on mode choice for those occasional cyclists who only cycle in the summer (107). Additionally, the risk of bike theft may also be a factor deterring new cyclists, though the extent to which this is a barrier is unclear (64).

Motivations for and barriers to taking part in interventions

Studies into motivations and barriers about interventions distinguish motivations and barriers with respect to engagement (i.e. getting involvement in the first place) and maintenance (i.e. sticking at it).

The evidence in this area mainly relates to walking interventions, with less on cycling interventions.

Table 7 – Motivations and barriers towards walking interventions (194, 148)

	Motivations	Barriers
Engagement	• Presence of role models; • Organised routes; • Group support; • Opportunity for children to participate in a free activity (for families); • Opportunity to improve health and enjoy fresh air and nature.	• Conflicts between walking activities and work/school schedules, other family commitments, and changes of plans; • Busy lives / lack of time (especially among younger people); • Cultural lack of acceptance in regard to work-based activity; • Physical and psychological limitations (e.g. religion, illness/injury, tiredness, access); • Not considering walking as a form of exercise (among men); • Safety issues (especially for women, but also more widely and including e.g. fast cyclists, traffic, narrow pavements); • Fear of falling in inconsistent external environments (among older adults, e.g. on ice in the winter); • Environmental barriers, including neglected local environments (notably mentioned in deprived areas), litter, and noise; and • Practical problems (e.g. unsuitable shoes, terrain); • Lack of motivation and laziness (as reported in a study in a deprived area); • Poor weather conditions.
Maintenance	• Social interaction (especially for older adults, women and families), social support – including from friends and family – and security; • Extent to which activities could be integrated into daily life; • Monitoring activity (though this could also introduce unwanted competition); • Feedback (although it must not be intrusive); • Perceived benefits of fitness, physical and mental wellbeing, and weight loss; • Variation in walking routes; • Enjoyment and fun.	Barriers to maintaining participation were: • Difficulty of integrating walking and attendance at clubs into daily routines; • Boredom; • Dissatisfaction with elements of the club (e.g. pace, atmosphere); • Incongruent aims

With respect particularly to cycling, convenience is highlighted as the top motivator for engaging with an intervention, this time in relation to participating in cycle hire schemes (100). Fun and social elements of cycling can be motivating for young people (148). In addition, the key motivation for taking up cycle training is a desire to "gain confidence in using a cycle", relevant to 77% of participants (85).

Key motivations for participating in a bicycle-purchasing scheme with tax-free loans were identified as:

- Health benefits; and
- Flexibility of cycling (47).

Key motivations for *taking part* in the AustCycle training were:

- To improve cycling skills (34% of participants)
- To improve health (33%) – with part-time and unemployed participants most likely to participate in order to improve their health (79%), and with health improvement and physical activity a relevant motivator for 9 out of 10 participants.

In addition, key motivations for AustCycle participants *continuing* to cycle were[13]:

- Fun and exercise (85% of participants)
- Transport (26%)
- Fun (20%) (239).

One US study found that motivations for using trails in the US include general health (51% of users) and weight loss (8.2%) (222).

Variation in motivations by socio-demographics

There is a relative shortfall of evidence about how motivations and barriers vary between different groups within the population – though the evidence that does exist suggests that there are in some cases marked differences in motivations between people of different ages and genders.

The main **motivator** for walking for travel or leisure among older adults is social interaction (194). Social interaction also appears to be important to children and women. Men and young people are more likely to find competition motivating (148).

Barriers to walking among older people are limited mobility and fears for safety, both of which are mediated by the external environment: fears of falling or of fast traffic are common. Walking indoors is seen as a safer alternative, and can also involve a social aspect (194).

The main motivator for **active travel to school** is the social aspect of walking and spending time with friends or parents (97, 194). Health benefits can also be a motivator (148). Peer pressure is also an important factor in children's travel choices (194) (and its influence could go either way).

Barriers to active travel among children and young people include:

- Lack of time / busy lives (most common reason);
- Travel distance;
- Need to carry heavy bags (e.g. to school);
- Poor weather;

[13] Respondents were able to tick more than one option

- Uncomfortable shoes (sic)
- Lack of cycle lanes and lack of facilities to store bicycles;
- Fear of bicycle theft;
- Perceived image of cycling and a dislike of wearing cycling helmets;
- Parents' and children's lack of time (e.g. due to existing commitments);
- Parents' fears for children's safety, including danger from traffic and danger of intimidation or attack by other people; and
- Conflicting messages from schools (194, 148).

In deprived areas, key barriers to walking have been identified as:

- Safety fears;
- Lack of time; and
- Lack of motivation.

Also in deprived areas, for women in particular, safety fears, family commitments, lack of motivation and lack of walking companions were barriers, whereas men did not consider walking sufficiently vigorous to be 'exercise' (194).

5.4 Interventions appealing to specific groups

There appears to be limited research into how effective different interventions are with specific groups of people, but it does seem that some interventions appeal more to certain types of people.

Walking groups have been found to be popular with women, as well as with older people (85). Similarly, community-based physical activity interventions tend to appeal to older women, particularly those who consider themselves white British (223).

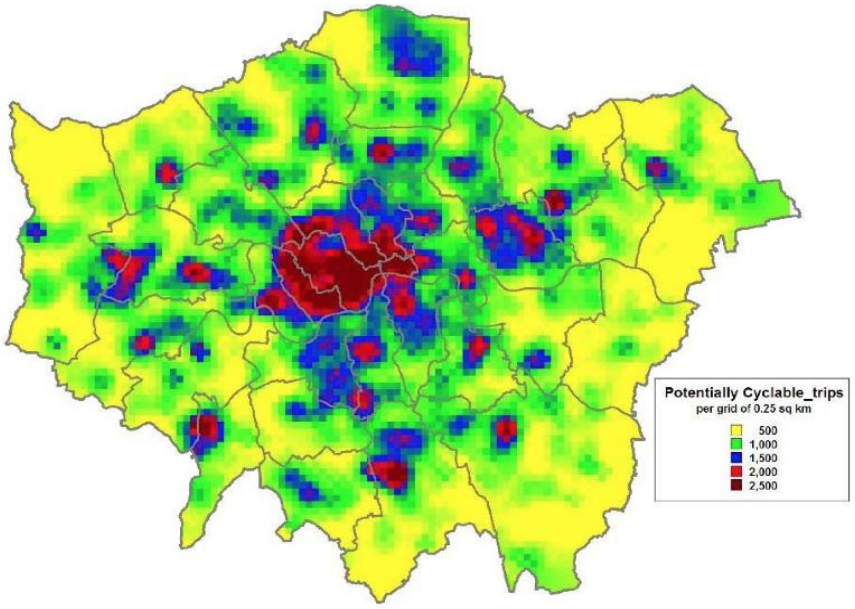
Cycling infrastructure appears to be particularly effective at increasing the number and proportion of women cycling. In one case study in Melbourne, a street was made tram and cycle friendly (including a traffic ban), leading to a doubling of cyclists and an increase in the proportion of female cyclists from 26% to 39% (20). Another study found that bicycle boulevards appealed to women in particular. However, although women prefer routes that have less traffic, they can also find off-street paths less appealing, potentially due to safety concerns (223).

A similar pattern is found among more and less experienced cyclists, with less experienced cyclists preferring segregated infrastructure and more experienced cyclists preferring on-street paths because of faster travel times on these routes (233).

The cycle hire scheme in London was found to appeal mainly to men and to younger people (307), while bicycle training appeals to both 'beginners' and 'improvers', with 85% of training taken up by women (85).

TfL have carried out analysis of potentially cyclable trips in London, mapping these out to identify cycling demand 'hotspots' (see figure 7 below). Considering the mapping data together with the characteristics and location of 'near market' cyclists can help target resources (278).

Figure 7 – TfL mapping of potentially cyclable trips by destination in London [Source: *TfL, 2014*]



6 New and extended trips

Research question 4	
RQ4	**Where do new or extended cycling and walking trips come from?**
RQ4.1	To what extent are increases in cycling and walking *new* trips, *extended* trips or mode switch? And who undertakes these trips?
RQ4.2	What impacts does any mode switch have on congestion or crowding for other modes of transport?

RQ4 - Summary
The assessment found limited evidence on this research question, although there is some data from a small number of specific interventions – mainly cycle hire schemes.
The evidence on whether cycle-hire trips are new, or represent modal switch, is limited and unclear.
Where evidence of modal switch has been investigated, it suggests that most switching is *from* public transport to the bicycle; and that switching from driving a car is rare. Some of this finding may result from the fact that bike hire schemes are typically in dense urban locations, with corresponding modal distributions (i.e. typically a high reliance on public transport).
Little or no evidence was uncovered that makes it possible to say who is making these new trips, nor the impacts on either other forms of transport or congestion more generally.

6.1 Introduction

The assessment found limited evidence on this research question, although there is some data from a small number of specific interventions – mainly cycle hire schemes – on how many new trips they achieved, as well as on the extent of mode switch. None of the reviewed literature investigated the possibility of trips being extended.

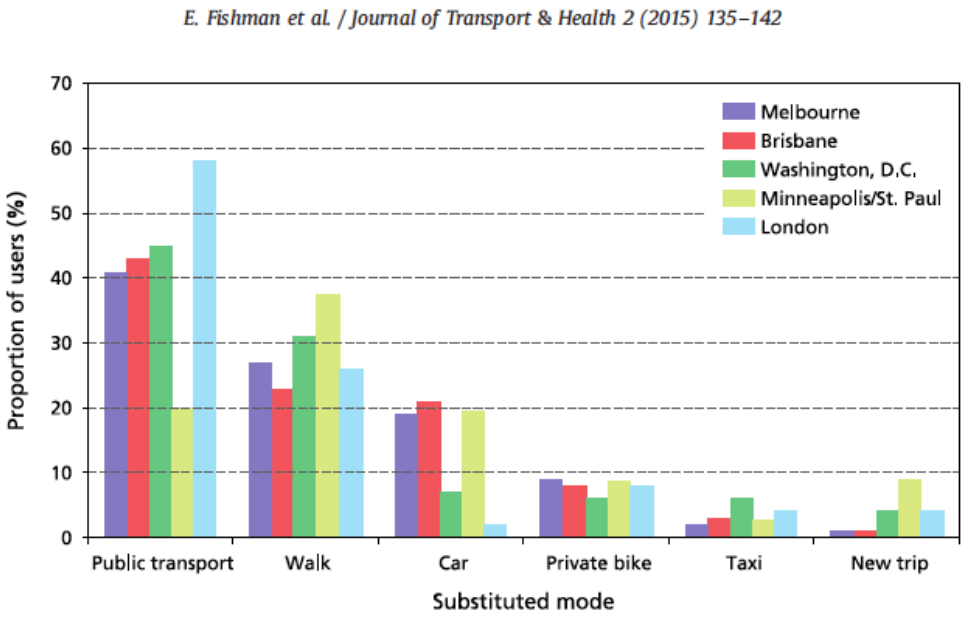
6.2 New trips and mode shift

Some of the reviewed literature has, however, attempted to quantify the number of new trips and the proportion of those made by new cyclists. Notably, a study of cycling growth in London - not related to a specific intervention – found that 50%[14] of new cycle trips were entirely new trips not previously made, while 45% were trips switched from another mode (4% did not know and 1% were other types of trip). In contrast, a study of cycle hire schemes found that only a small proportion of cycle hire trips were entirely new, with the majority switching from another mode (100).

[14] Worth noting that these figures come from a relatively small sample of 155 survey respondents.

Some studies also indicate that active commuting and active travel to school do not tend to replace other physical activity – suggesting that in these cases mode switch is taking place which is not compensated for by reduced active travel elsewhere in the day (97).

Figure 8 – Bikeshare mode switch [Source: *Fishman et al, 2015*]



Fishman et al (2015) analysed data from cycle hire schemes and concluded that where bikeshare trips replace existing trips, the main mode shift comes from public transport, then walking, followed by cars, private bikes, and finally taxis (100). Similar results were found in the Dublin bikeshare scheme (47), which has replaced walking and public transport trips, as well as in the evaluation of the Dutch "public transport bicycles" (similar to a cycle hire scheme) provided at railway stations, which have mainly replaced public transport trips, but also a small number of car trips. There has also been a small degree of mode switch from the car to the train plus public transport bicycle (172). A study of the London cycle hire scheme put the 2011-12 mode switch figures at 47% from public transport and 31% from walking (307). On average, 60% of bikeshare trips replace sedentary modes of travel (100).

The ranking described above is influenced by the existing modal split. The relatively low mode shift from the private car is due to the fact that cycle hire schemes tend to be located in inner cities with low levels of car use to begin with (100).

This pattern is also reflected in other evidence which suggests that good cycling infrastructure can attract public transport users and walkers onto bikes, but is unlikely to lead to significant mode shift from the private car (107). Evidence from the Netherlands shows that improved bicycle parking in workplaces and at regional bus stops has also led to a modest mode shift from the car to the bicycle (172).

Evidence from Sustainable Travel Towns, where cycling and walking trips increased, suggests that these changes involved a degree of mode shift (with unchanged destination), some switches of both destination and mode, as well as “trip evaporation” (i.e. not making a trip) (254).

6.3 Who makes new trips?

Although evidence on this point is limited, there are some suggestions that many new trips may be made by those new to cycling or walking. However, it is worth repeating here the finding highlighted above on ‘churn’ in cycle trips: active travel can be taken up and given up in cycles, making the concept of ‘new cyclists’ or ‘new walkers’ difficult to define. Indeed, one comprehensive review of cycling interventions found that most studies were unclear on whether increases in cycling resulted from new trips by new (or even infrequent) cyclists, or from additional trips by existing cyclists (309).

However, the London study of cycling growth (not related to a specific intervention) suggested that, of new cycling trips, approximately half were made by new cyclists, and approximately half were made by existing cyclists (64). In addition, community-based physical activity interventions have been found to lead to increased activity levels among those who are least active (223).

The iConnect study of new infrastructure found that new routes tended to be used by those who lived nearby, as well as by people with better general health, higher education and income, by non-students and bicycle owners. It was, however, used by people of various activity levels – though it is worth noting that the trips made by these people may have been diverted rather than new trips (113).

6.4 Trip type

The London study referenced above found that the most common trip purpose for 'new cyclists' was classified as leisure, entertainment, recreation or sport (64). Similarly, the Dutch public transport bicycles are mainly used for less frequent trips, for example as business trips and visiting family or friends (172). The London study also found weekday cycling to be more prevalent (63%) than weekend cycling (38%) (64), though these figures seem to suggest disproportionately more cycling at weekends.

6.5 Congestion impacts

This review identified very limited evidence on congestion impacts of mode switch. One study estimated that a 20% increase in cycling levels from 2011 to 2015 could save the economy £207m through reduced traffic congestion (91).

Other evidence suggests:

- The air pollution costs of driving are estimated at 10¢ per mile at urban peak-time (164).
- Noise costs are estimated to decline with a mode shift to active travel (186).
- The noise reduction benefit of a mode shift from driving to cycling is estimated at 3¢ per mile in an urban peak context (164).

- Research in Sustainable Travel towns suggested a congestion BCR of 4.5:1 (87).

7 Health impacts

Research question 5	
RQ5	**What impact can cycling and walking investment have on physical activity and health, and the associated costs of this.**
RQ5.1	For those who take it up does cycling or walking replace, supplement or introduce physical activity?
RQ5.2	How physically active are people who take up cycling and walking?
RQ5.3	What are the health impacts of increased cycling and walking that result from interventions?
RQ5.4	How could any changes resulting from cycling and walking investments translate in to savings for government (including the NHS)?
RQ5.5	How could any changes resulting from cycling and walking investments translate in to savings for business?

RQ5 - Summary
A large and generally high quality evidence base provides a great deal of potentially useful information in respect of this research question.
The reviewed evidence suggests that the scope for health benefits from walking and cycling interventions is significant, and the potential savings (to healthcare providers/systems) far outweigh the investment costs in most cases. These savings (presented in the main body of this chapter) vary widely, depending on size of scheme, assumptions made etc.
Directly attributing these benefits/savings to specific cycling/walking interventions is complex and rare (see chapter 4).
In general, the evidence suggests that walking and cycling interventions *do* increase physical activity levels (rather than acting as substitutes for other activity) but the scale of effect, its duration and its applicability to different groups within the population appears to vary considerably.
The health benefits arising from these increases in physical activity can be considerable. They are expressed in terms of per person (e.g. cost savings to the NHS from community-based physical activity interventions range from £769 to £4891 per person) per city (e.g. Cycling Demonstration Towns produced benefits equating to healthcare savings of £45 million over 10 years) and at national level (e.g. cycling investments of $138-605 million [in the US] could result in health care cost savings of $388-594 million by 2040, and savings in the value of statistical lives of between $7-12 billion).
Evidence on potential savings for business, as well as other economic effects, is covered in the next

chapter.

7.1 Introduction

Cycling and walking interventions have potential to bring about positive health benefits through increased physical activity. As well as cyclists and pedestrians being among the most satisfied transport users, active commuters tend to be physically and mentally healthier. Physical activity has also been associated with higher school grades and improved learning (235).

The reviewed evidence suggests that the scope for health benefits from walking and cycling interventions is significant, and the potential savings far outweigh the investment costs in most cases (e.g. 21, 223, 186, 234). In fact, health benefits alone can outweigh scheme costs (97) and are estimated to comprise between half and three quarters (from different sources) of total monetised benefits (87, 97).

Physical inactivity contributes directly to illness, and the associated cost to the NHS has been calculated at between £0.9-1 billion per year (2006-07 prices). Indirect costs add another £8.2 billion per year (2002 prices) to this (87). US data puts the cost of physical inactivity at an average of $544 per person per year (2008 prices) (115).

The health benefits from cycling and walking can be valued in a number of different ways.

- Overall, the direct health benefits from a 10% increase in physical activity would equate to £85 million (87);
- US data suggests that if 10% of adults took up regular walking, the savings from heart disease reduction alone would be $5.6 billion (87);
- The health benefits from cycling have been valued at $19 to $1,175 per person (although not all estimates include the same components) (115), or £22-498 per additional cyclist (where again the variation results from different factors) (97);
- Achieving a 5% cycling mode share in London could generate over £183m per year in financial benefits due to reduced mortality (278);
- Potential savings to the NHS are £28.30 for each additional cyclist per year (87);
- Modelling work shows that if the UK could achieve cycling levels similar to Copenhagen, the savings to the NHS would be substantial: between £6 and £27 billion over 20 years (21);
- If a driver switches to cycling for a 5-km commute (one way) 5 days/week and 46 weeks/year, the health benefit is worth about 1300 €/year, while for walking this figure is 1192€/year (234); and
- For every 100,000 people taking up regular cycling commuting there would be 50 fewer deaths per year, translating into a net benefit of just over £50 million (or £82.7m if using statistical deaths) (87).
- Residents of more multi-modal communities have been found to exercise more; they are also less likely to be overweight, in comparison to residents of car oriented communities (87).
- For every £1 invested into Cycling Demonstration Towns, the value of decreased mortality of adults aged 20-60 years is £2.59 (21).

7.2 Data issues

Attributing health impacts to specific interventions and calculating the resulting cost savings is a complex undertaking. The reviewed evidence highlights a number of issues which make it difficult to pin down precise impacts and savings.

One of the difficulties is that the cost-benefit ratios calculated for walking and cycling interventions vary widely (115), and this is often due to researchers including different elements in their calculations. However, health benefits tend to make up the bulk of the benefits in these calculations. This is even though the calculations tend to include mortality reductions alone, while morbidity reductions – which would improve the benefit-cost ratio – tend to be excluded (87).

The impacts of walking and cycling interventions on health will vary depending on how physically active the intervention participants are to begin with. If participants are already meeting recommended levels of physical activity, then interventions may have no additional health benefits (56, 100). However, these baseline activity levels are often not known (87). In addition, the health benefits from active travel may not be immediate, and can take some time to manifest (97). Further, new cyclists and walkers may decide to cut back on other physical activity, counterbalancing the health impacts of active travel (100).

Flaws in research design can also make it difficult to attribute impacts to interventions with certainty (309). A common issue identified in the literature is the absence of no-intervention control groups (222).

It is also interesting to note here the difference between schemes that have a large health impact on a small number of individuals, versus schemes that have a small health impact on a large number of individuals. The London cycle hire scheme, for example, was found to have a relatively small impact on individual physical activity levels, but the total health impacts at population level are significant (307). Comparisons between these two types of schemes are difficult.

7.3 Impacts of interventions on health

Impacts on activity levels

The baseline levels of physical activity of walking and cycling intervention participants is rarely known, as noted above. Where evidence exists, it suggests that these levels can vary widely. The AustCycle programme found that 48.9% of participants had a body mass index higher than 25 and were at risk of chronic disease – suggesting they were not physically active (239). At the other end of the scale, 70% of participants in the UK Cycle to Work scheme were already meeting recommended weekly physical activity levels before participating in the scheme (56). It is also worth noting here that, in general, factors that make individuals less likely to participate in active travel interventions include older age and disabilities (202) – and both of these groups may be characterised by lower physical activity levels.

It seems likely that different schemes will appeal to people with different baseline physical activity levels. The AustCycle evidence – based on the evaluation of a programme which gathered information from 6,700 participants (239) - is encouraging in that it shows it is possible to engage large numbers of physically inactive participants in active travel schemes.

Data from a wide range of interventions shows that participants increased their levels of physical activity as a result of the schemes. Although there are standard measures of physical activity levels, these are still often measured in different units, making it difficult to compare interventions.

- Smarter Choices, Smarter Places: individuals in intervention areas were on average 6% more likely to meet physical activity guidelines compared to individuals in non-intervention areas, in data collected in 2009 and 2012; although both areas experienced a decline in activity levels, the decline was larger in the control area (from 39.8% to 24.9%, compared to from 34.2% to 30.8% in the intervention area) (202);

- Cycling Demonstration Towns: the proportion of residents in the intervention areas categorised as inactive significantly decreased, while the proportion categorised as moderately inactive increased (309);

- Cycle to Work scheme: the minimum and median level of reported levels of physical activity increased, regardless of baseline levels of cycling; however, only around half of respondents increased their physical activity levels;
  - The increase was greatest among those who already owned a bike but cycled infrequently or not at all before the scheme;
  - Those who were below the recommended level of physical activity benefited substantially: only 11% of them remained below the recommended level after the scheme;
  - However, 6% of respondents reduced their level of physical activity as a result of the scheme – by replacing walking with cycling, resulting in less active time per week (56);

- Travel Actively: 10 schemes delivered and monitored by Sustrans were associated with a 9% increase (from 32% to 35%) in survey respondents doing at least 30 minutes of physical activity on five or more days a week (87);

- In the AustCycle programmes, 12 month follow-up data showed that 90.7% of participants were achieving adequate levels of physical activity (239); and

- Midwestern Trails in the US: 74% of users of four recreational bicycle/pedestrian trails reported that they were more physically active since they began using the trails (222).

- Investing in cycling and walking infrastructure can offset the health costs of sedentary lifestyles (21).

- Evidence from Cycling Demonstration Towns suggests that the health benefits from increased cycling among adults do not appear to have been offset by reduced physical activity elsewhere, and the greatest increased in physical activity appear to have

occurred among middle and older age groups, who stand to benefit the most from physical activity (79)

- Building footpaths is estimated to increase residents' average daily non-motorised travel by 0.097 miles, which translates into a monetised healthcare benefit of $560 per year per obese resident (97).

Impacts on energy use, weight and illnesses

This review identified a small number of studies where the health impacts of walking and cycling interventions had been measured in terms of energy use, weight loss and/or likelihood of illness.

One source referenced work that suggested building footpaths can increase walking and cycling with an average impact of 15 kcal/day burned in additional physical activity, potentially offsetting weight gain in about 37% of the population (97). The AustCycle programme led to an average weight loss of 1.58kg per person 12 months after the intervention, with 20.7% of respondents reporting they had lost weight (239).

The AustCycle evaluation also identified self-reported health improvements, including improved fitness (36.6% of respondents) and general increased well-being (24.8%) (239). A comprehensive review of the health impacts of active travel schemes identified reductions in all-cause mortality, CVD, type 2 diabetes, weight gain, cancer, falls, and impaired mental health (186).

Impacts on mortality / life years

Some of the reviewed literature included modelling studies to investigate the impacts of active travel interventions on mortality or additional life years. The results are influenced by the inputs into the models, but the outputs give an indication of the scale of impact that could potentially be achieved.

- Modelling of the London bikeshare scheme suggests between 3.3-10.9 deaths averted per million users per year (307);
- The Barcelona bikeshare scheme has been calculated to avoid 12 net deaths per year, made up of 12.46 deaths avoided from increased physical activity, but taking into account an additional 0.03 deaths from traffic injury and 0.13 from exposure to air pollution through cycling (21); and
- Scenario modelling work (Woodcock et al (2009), cited by Bidwell (2012)) suggests that increasing active travel could result in 7,439 DALYs[15] and prevention of 541 premature deaths per million population in London over one year by 2030 (21).

Additional versus substituted activity

Whether the uptake of active travel constitutes an increase in physical activity, or whether it replaces existing physical activity, seems to vary between interventions. Some work suggests

[15] DALY – disability-adjusted life year – see http://www.who.int/healthinfo/global_burden_disease/metrics_daly/en/

that increases in active travel translated directly into increases in total physical activity (202). However, the possibility of activity substitution is often not considered. The Cycle to Work scheme research found some evidence to suggest that active commuting replaced existing activity for some who took up cycling (56). It is also possible that changes in active travel habits have negative impacts on physical activity levels: replacing a walking trip with a cycling trip reduces the amount of time spent engaging in physical activity, and the benefits per km travelled (100).

7.4 Healthcare cost savings from interventions

Cycling and walking interventions have the potential to generate significant impacts on health, which can translate into large healthcare cost savings. A number of the reviewed sources have calculated the monetised health benefits and healthcare cost savings for a range of interventions. The question is not so much whether walking and cycling interventions can deliver healthcare cost savings, but rather which types of interventions can do this most cost-effectively. Issues with data comparability, however, make this difficult to pin down.

- Future cost savings to the NHS from community-based physical activity interventions ranged from approximately £769 to £4,891 per participant (see table 4 below), while the cost per QALY[16] gained was approximately £47 to £509 (223);

- The Cycle to Work scheme was calculated to generate between £448,000-485,000 of physical benefits over 10 years (depending on calculation methodology used) (56);

- The Cycle to Work scheme attracted a high proportion of participants who did no regular cycling beforehand: they made up 53% of all users in the sample (56).

- DfT research (2015) suggested that a typical 'cycling city' (undefined) is estimated to potentially be worth £377 million to the NHS in healthcare cost savings (2011 prices) (235);

- The health benefits of the National Cycle Network have been calculated as £526 million for pedestrians and £277 million for cyclists in 2013 (269).

- Cycling Demonstration Towns are estimated to generate a maximum annual health benefit (once the maximum health benefit had been reached after an estimated five years) valued at £8.9 million – taking into account the build up of health benefits, the mean annual benefit was estimated at £4.5 million, equating to a saving of £45 million over 10 years provided cycling levels were maintained (253);

- For every £1 invested into Cycling Demonstration Towns (total cost of programme was £18.7 million) the value of decreased mortality is £2.59 (87), while the mean benefit of

[16] QALY – a 'quality-adjusted life year' – see https://www.nice.org.uk/glossary?letter=q

reduced mortality is estimated at £4.52 million per year (NPV of £45 million over 10 years) (222); and

- Cycling investments of $138-605 million could result in health care cost savings of $388-594 million by 2040, and savings in the value of statistical lives of between $7-12 billion (115).

Table 8 - Cost savings to the NHS from community-based physical activity interventions

Community-based physical activity intervention type	Savings to the NHS (per completer)
Primary care activity classes for older adults	£3,413
Motivational interviewing for older adults including BME in community	£3,286
Primary care referral of young people with diabetes to activity classes	£3,089
Motivational interviewing for adults in primary care	£3,036
Walking groups for older adults in community	£2,961
Outreach leading to classes for single parents in the community	£2,629
Activity classes for older adults in community	£2,516
Walking groups for older adults in community	£2,961
Primary care referral of adults and young people to one to one instruction for moderate physical activity in community	£2,126
Promotion of walking/cycling using print media	£1,972
Outreach leading to classes for adults in community	£1,776
Healthy map with walking and cycling routes	£1,480
Post primary care referral classes for older adults in community	£1,289
Mailing of stage matched moderate physical activity materials to adults	£846
Activity classes for young people in community	£769

Source: 223

7.5 Variation in benefits by demographics

The health benefits of cycling and walking interventions can vary between different socio-demographic groups. Key differences have been identified between age groups and between genders.

Older people tend to benefit more from shifting to active travel, because they are more at risk of developing chronic health conditions (307, 186). In contrast, cycle hire scheme research (in London) suggests that for young people, the increased injury risk may even outweigh the health benefits (307). However, older people are less likely to participate in active travel interventions (202).

The research into the London cycle hire scheme identified the main health benefit for men to be reduction in ischaemic heart disease, while the main benefit for women was reduction

in depression (307). In addition, males may be safer travelling actively compared to car travel (186). The total health benefits from active travel schemes appear clearer for men than for women (307, 186).

In addition, disadvantaged ethnic sub-populations have been estimated to benefit more from participation in active travel than the general population (186).

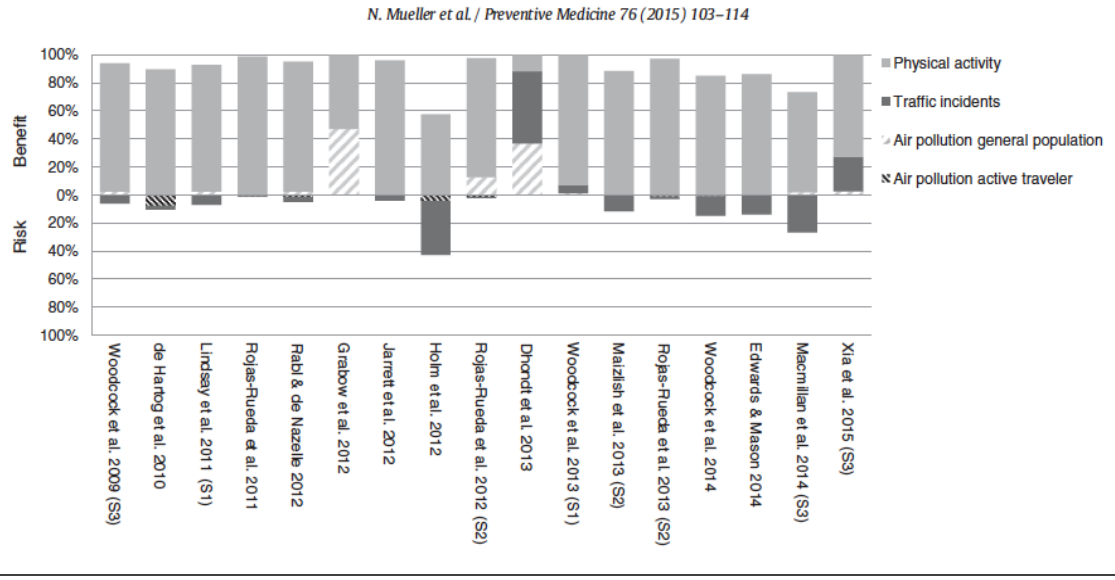
7.6 Health risks of active travel interventions

Active travel may increase certain health risks for individuals. With cycling interventions in particular, there is an increased risk of traffic accidents and injuries, although the precise level of risk is dependent on local context (234) and is generally outweighed by the health benefits of cycling (186, 91). Interestingly, cycle hire scheme data suggests that the scheme has a lower injury risk than cycling in general (307).

Exposure to air pollution as a result of active travel is another potential health risk (186), but again the exposure levels vary between different contexts (234) and the health benefits of the physical activity outweigh the risks (115).

Overall, data suggest that the health benefits from increased physical activity through active travel exceed any health risks (234, 186), as illustrated in figure 9 below.

Figure 9 – Health pathway contribution to estimated health impact of a mode shift to active transportation [Source: *Mueller et al, 2015*]



8 Local economic impacts

Research question 6	
RQ6	**What are positive and/or negative local economic impacts of cycling and walking interventions?**
RQ6.1	How do the shopping and consumption habits of cyclists and walkers differ from other transport users?
RQ6.2	What impact do localised cycling and walking schemes have on different types of retail and other business? This should include impacts on retail sales and interventions aimed at reducing car use.
RQ6.2	What local barriers have been identified to local authorities or developers considering or providing provision for cycling and walking?

RQ5 - Summary
There is relatively little robust evidence addressing this research question. The evidence available comes mainly from case studies.
Cycling among employees has been associated with fewer sick days, improved productivity, and better quality of work. Evidence suggests that 'one day per year' less absenteeism as a result of cycling is a reasonable figure, but there are few sources for this figure; and no evidence was uncovered as to the measurable impacts on e.g. productivity and quality of work.
The reviewed (case study) evidence suggests that investment into cycling and walking is often associated with positive impacts on retail spending at the local level, but the scale of the impact varies widely.
Locations with increases in cycling (and, to a lesser extent, walking) following interventions tend to see an increase in the frequency of visit by cyclists who, though typically spending less per visit, tend to spend more in aggregate following the intervention.
There is limited evidence that improved walking and cycling facilities (and public realm more generally) can have positive effects on tourism (both visitor numbers and spending); and some evidence, too, of positive effects on local property values; but these associations appear weak and have not been substantiated by robust research.

8.1 Introduction

Evidence on the local economic impacts of cycling and walking interventions suggests that impacts can be grouped into the following categories:

- Reduced absenteeism and increased productivity in the workforce;
- Impacts on local retail spending;

- Tourism impacts;
- Impacts on property values; and
- Other impacts.

Most of the evidence identified in this review comes from case studies. Raje and Saffrey (2015) point out that cost-benefit analysis of infrastructure projects generally does not include these types of indirect economic impacts. The evidence that does exist, however, tends to suggest positive impacts (235). It is also worth noting here that the economic benefits of walking and cycling infrastructure are both difficult to demonstrate and difficult to quantify (161).

8.2 Absenteeism and productivity

Cycling among employees has been associated with fewer sick days, improved productivity, and better quality of work (91). Raje and Saffrey (2015) state that regular cyclists take one less sick day per year compared to others (235) , while TfL (2014) give a more precise figure of 1.3 days (278). Fishman et al (2011) cite Hendriksen et al (2010) whose research in the Netherlands found that whereas non-cyclists took an average of 8.7 sick days during the study year, cyclists only took 7.4 (97).

The “one less sick day per year per cyclist” currently translates, on the basis of current cycling levels, into savings to the UK economy of £128m a year from reduced absenteeism. Other research suggests that cycling could save the economy an additional £2 billion over ten years through reduced absenteeism (91). In addition, evidence from the Netherlands suggests that "an average person who starts to cycle saves his employer some $3000” – however, this is based on Dutch figures which assume a relatively high baseline physical activity level (91), and the benefits could in fact be greater in the UK.

This review identified few studies directly linking interventions to absenteeism and productivity impacts, but Raje and Saffrey (2015) do note that facilitating cycling to work decreases staff turnover (235) and Lawlor (2014) references a case study in London where a canal towpath was converted into a high quality walking and cycling route, with the resulting health benefits leading to reduced absenteeism valued at £5,487,130 (161). Commuters who walk or cycle tend to be more productive and take fewer sick days (87). Absenteeism savings to employers from the Cycle to Work scheme are estimated at between 0.4 and 2.1 days gross salary costs (56).

8.3 Local spending

The reviewed evidence suggests that investment into cycling and walking is often associated with positive impacts on retail spending at the local level (e.g. 34, 161, 290). This evidence comes mainly from case studies, a selection of which is presented below. On average, Lawlor (2014) estimates that the increase in retail sales that results from walking and cycling projects is 30% (161).

- Public realm improvements at Sheffield’s Peace Gardens were followed by a 35% increase in footfall in the City Centre, of which between 20% and 44% was attributed

directly to the improvements. This in turn corresponded with a net increase in visitor numbers of 350,000–770,000, and a net increase in spending of £4.2m (161);

- In New York, implementation of bicycle infrastructure between 8th and 9th avenues' 'complete street' was followed – according to a study by the city's Department for Transport - by a 177% increase in bicycle volumes, whilst locally-based businesses between 23rd street and 21st street saw a 49% rise in retail sales (compared to 3% borough wide) (20);

- A "road diet" along York Avenue in Los Angeles replaced car lanes with cycle lanes, and sales tax revenue (a proxy for business success) was subsequently higher on the section of road with the new bike lane compared to the rest (although there was an increase in both sections after the intervention) (290);

- In Seattle, a new bicycle lane replaced 12 parking spaces on 65th Street, leading to an increase in the sales index on 65th Street (especially compared to the rest of the neighbourhood) (290); and

- Pedestrianisation in the Takapuna shopping district in Auckland, New Zealand, led to pedestrian shoppers spending approximately $80 more per month following scheme implementation (161).

Although the majority of the identified case studies suggested that cycling and walking interventions increase local retail spending, a small number of studies also identified negative or no impacts.

- In Vancouver, there was a net decrease in sales after the implementation of a separated bike lane – although the data comes from business surveys supported with limited sales data (290); and

- In Seattle, a new cycle lane in the Greenwood district had no impact on the retail sales index in the area (290).

The literature suggests certain behavioural characteristics that apply to the local shopping and spending habits of cyclists and pedestrians. However, the evidence here is somewhat contradictory.

Some of the evidence states that cyclists and/or pedestrians spend more money overall in local retail areas than drivers (43, 290, 235, 161, 57). Raje and Saffrey (2015) suggest that, per square metre, cycle parking delivers five times higher retail spend than car parking (235). However, collating all of the actual spend data reported in the reviewed documents (see table 9) the picture is more mixed.

Table 9 - Retail spend by travel mode

Cyclists	Pedestrians	Drivers	per	Location	Source
$34		$47	trip	Not given	290
$43		$47	trip	City centres	290
$16.20		$27	hour	Melbourne	290
$163		$143	week	New York	290
	£93	£56	week	London	196
228 euros		237 euros	month	Dublin	290
$250		$180	month	California	290

Even if no firm conclusions can be drawn from the spend data, there are a number of other behavioural characteristics on which there is more of a consensus in the literature. Cyclists tend to buy smaller quantities per trip than drivers (97), which translates into a lower spend per trip (290). However, cyclists also tend to shop more frequently (97) – which can mean that they spend more over time (57), as illustrated in figure 9 below. They may also be more likely than drivers to become 'regular customers' (290), thereby delivering repeat business. Some of the evidence also suggests that cyclists visit more shops per trip than drivers do (20).

Figure 9 – Average consumer expenditure, trips per month and estimated average spend per month, by mode of travel [Source: *Clifton et al, 2012]*

Figure 4-5 Average Consumer Expenditures per Trip

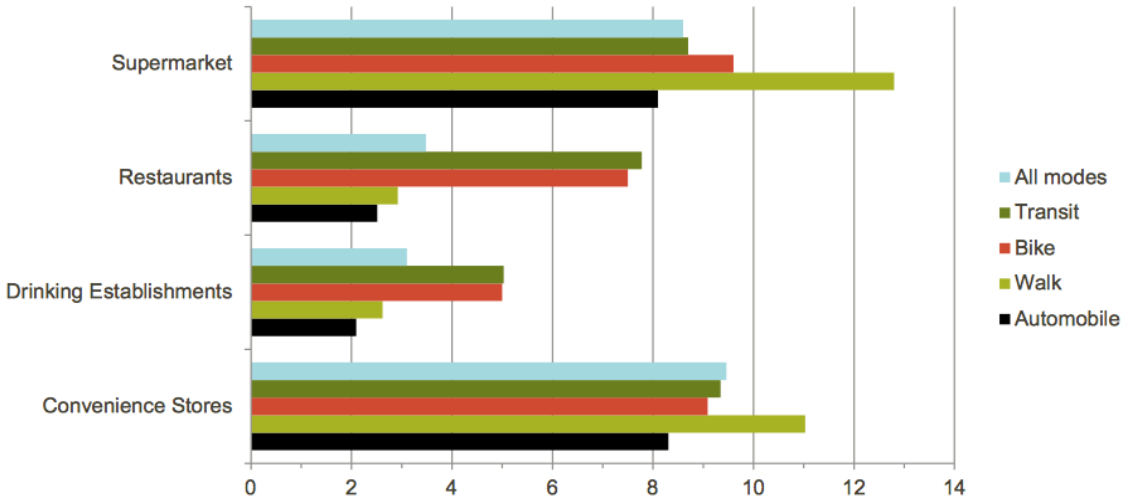


Figure 4-6 Average Consumer Trips per Month

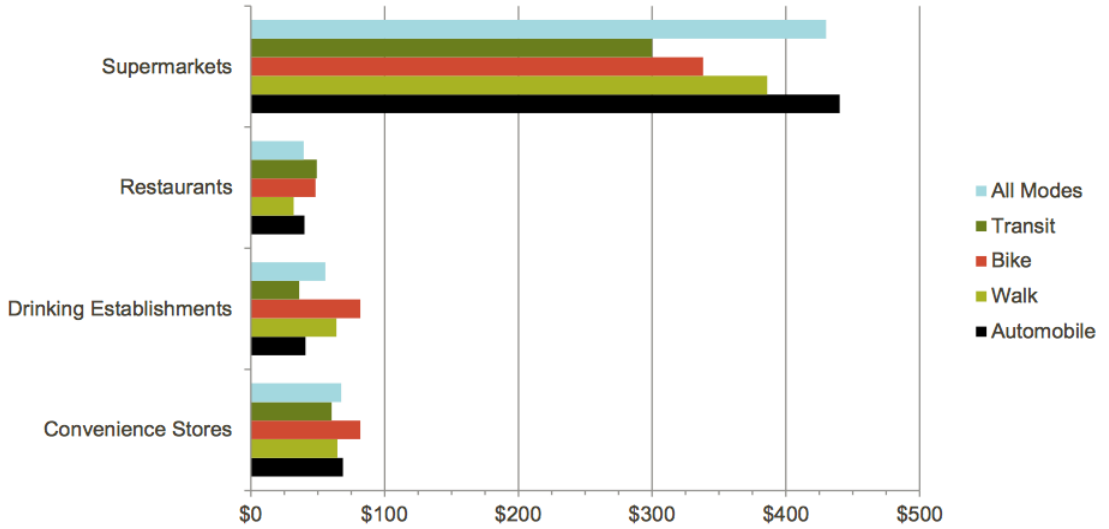


Figure 4-7 Estimated Average Spending per Month

It appears that cyclists' and pedestrians' shopping and spending behaviour varies between different contexts. A number of sources suggest that in city centre locations, cyclists and pedestrians contribute more to retail revenue. In New York, for example, it was calculated that total retail spend by non-drivers accounted for 95% of all retail spend (290). In Denmark, cyclists and pedestrians accounted for approximately 50% of retail revenue in large cities outside Copenhagen, and approximately 25% in small and medium-sized cities (20). Even in locations where drivers were found to spend more than cyclists, this gap was smaller in city centres than in other locations (290).

German evidence suggests that most shopping trips are short enough, and the amount of shopping bought is small enough, that there is scope for more walking and cycling for shopping trips (97). These patterns are replicated elsewhere: in Denmark, one survey found that 89% of respondents lived less than 2 km from a grocery store. Almost a third of respondents drove on their last shopping trip. Only 21% of car users lived more than 2 km from a grocery store (20).

8.4 Tourism

Tourism may benefit from cycling and walking interventions (97), and there are a small number of examples from the reviewed evidence where these benefits have been quantified.

- Rail trails in Australia were calculated to generate an average of $258 per cycle tourist per day (97);

- On average, cycle tourists spend approximately 9% more per head per trip than others, or approximately £81 per head per trip (235); and

- Rebuilding the North Terrace of Trafalgar Square to improve the quality of the pedestrian environment was associated with an increase in visitors of over 300% (161), although it is worth noting that direct causality is difficult to establish for an example such as this.

8.5 Property values

There appears to be a positive association between cycling and walking infrastructure and property values, which is highlighted in the reviewed literature (e.g. 43). Lawlor (2014) states that walking and cycling projects typically increase land value by between 70-300% (161). This association seems to apply to infrastructure in particular, as opposed to other types of intervention, and the focus is on accessibility rather than walking and cycling opportunities for leisure.

Residential and commercial property values, including retail rents, have been found to be higher in areas with better walkability (97, 161). Walking interventions are estimated to increase retail and commercial rents by around 10-30%, with the average retail rent increase at 21.7% and the average commercial rent increase at 24.2% (161). Similarly, homes near bicycle paths have been found to have higher sales prices (43). Trails, on the other hand, appear to have no impact on property values (97).

In a UK example from Sheffield, a regeneration scheme to improve the public realm led to a net increase in rental values of £1.60–£2.40/sq.ft. (based on a 40–60% attribution rate). In another example, a pedestrianisation scheme in Hong Kong led to a net increase of 17% in the rental value of retail shops (161).

8.6 Other impacts

Some of the evidence also suggests other local or regional economic impacts from walking and cycling interventions.

- Two studies identified impacts on employment and job creation:
  - Public realm improvements at Sheffield's Peace Gardens are estimated to have created between 341 – 527 additional net jobs (161);
  - US data suggests that investment into walking infrastructure can create 10-13 jobs in the supply chain per $1 million spent (which is more than for road construction projects) (161);

- Reduction in vehicle expenditure and the shifting of this spending onto other goods is estimate to create approximately nine regional jobs, increasing regional income by around $250,000 (97);

- In the UK, cyclists can benefit from lower car insurance (20).

A potential barrier to realising the local economic benefits of walking and cycling interventions is that local retailers may be reluctant to support local walking and cycling measures due to a belief that reduced car access would have negative impacts on their revenue.

Retailers tend to overestimate the importance of the car in accessing local retail facilities (57). For example, a retailer survey in Bristol found retailers estimated that 41% of their customers drove to the shops and 6% cycled, when the actual figures were 22% for driving and 10% for cycling. The pattern was repeated in a similar survey in Dublin (290). However, Clifton et al (2012) note that the provision of bicycle parking is in fact associated with higher bicycle mode share among customers, as is an access network (57).

9 Supplementary evidence

During the course of this assessment, a selection of additional evidence items came to light that did not fit comfortably under any of the six Research Questions but which were nevertheless deemed of potential value to the Department. They are outlined in this penultimate chapter.

The net benefits of cycling/walking interventions outweigh costs

- A literature search and review of existing published reports showed that most studies concluded that the net benefit of infrastructure for walking and cycling outweighed the cost (222).

- Sælensminde's study (2004), which comprised a cost benefit analysis of walking and cycling track networks in three Norwegian cities, concluded 'investments in walking and cycling networks are more beneficial to society than other transport investments' BUT no itemised health benefits were calculated (222)

Health benefits are the most significant chunk of the benefit side of the equation

- Overall it seems that increased physical activity was the main benefit from schemes. (186)

- 'Despite large uncertainties one can firmly conclude that by far the most important item is the health benefit due to the physical activity'. (234)

- Health benefits were by the far the highest proportion of benefit calculated at 74% of total monetised benefits (systematic review of 16 schemes). (87)

- Health benefits comprise about half to two thirds of the monetised benefits of active transport interventions. (97)

- Travel behaviour and active transport interventions CBAs suggest "health system benefits being between 0.8 and 3.5 times the investment in their own right". (97)

Average BCRs of cycling/walking interventions

- A report compiling latest available cost benefit evidence from UK (some calculated using the DfT's own WebTAG) and abroad concludes that "evidence is compelling". Typical BCRs are greater than the threshold of 4:1 which is considered by DfT as 'very high' value for money (for UK schemes it is 5.62:1 and for all schemes including those abroad it is 6.28:1). Much of the benefit is from reductions in premature death with large consequent savings in terms of health and knock on benefits to economy (87)

- Research for Cycling England suggests an average BCR of 10:1 (This figure did vary considerably but some projects were only recently completed) (87)

- A systematic review of 16 studies showed that BCRs of walking and cycling infrastructure projects are generally positive (15 out of 16 positive). The median BCR was 5:1 (87)

Turning to BCRs from specific individual schemes, the Assessment found:

- Wang study (2005) - Cost analysis of the built environment: the case of bike and pedestrian trials in Lincoln, Nebraska - The cost-benefit ratio (taken from a much earlier separate study in 1988) was estimated at 2.94 (222)

- Cycling Demonstration Towns (CDTs) - the HEAT tool derived an 'adult mortality benefit-to-cost ratio' of 2.59 to 1. (222)

- Yeadon to Guisely Link to Schools scheme showed health benefits of cyclists as £195,193 over a ten year appraisal period. (87)

- For all 9 Sustrans Link to Schools schemes the health benefits were by far the largest benefit (approx. £4 million out of approx. £5 million, but no exact figures stated) (87)

- A study giving the example of Paris where 20,000 bicycles have been bought for users to rent, at a total cost of 64 M€ /yr (they also have provided more cycling lanes). The benefits are estimated to be 176.9 million€ /yr. (234)

- A US study of five cycle trails for which a ratio of "2.94 between health benefits from trail use and costs associated with trail construction and use" was calculated. (115)

- Cavill, Cope and Kennedy (2009) estimated that "an integrated program to encourage walking in British towns has a benefit-cost ratio of 2.59 (£2.59 of benefits for each £1 spent) as a result of reduced mortality. Including other benefits (reduced morbidity, congestion and pollution) would increase this value." (97)

10 Closing Remarks

10.1 Discussion

As explained at the beginning of this report, the express intention of this assessment was to collate and present evidence relevant to the process of supporting the Department for Transport as it makes complex investment decisions into walking and cycling.

As a result, and perhaps inevitably, the findings from this assessment do not easily reduce to a succinct series of summary statements. Instead, the devil is very much in the detail.

The research team has, nevertheless, had the opportunity to reflect on the evidence base framed by the six Research Questions. In this final chapter of the report, we offer those reflections for consideration. These are not 'conclusions' in the traditional sense, but we hope the following observations prove useful to those charged with increasing the uptake of cycling and waking.

A Catch 22?

Whilst this assessment was able to draw on a large body of research, the evidence base is, in our view, characterised by a number of important gaps. There are relative few longitudinal studies; there is little evidence on the origin of new or extended cycling or walking trips (RQ4); and the evidence base on economic effects (RQ6) is almost entirely dependent on case studies.

In addition, there are few 'joined up' studies that attempt to link micro- and macro-effects. For example, evidence suggesting that e.g. Cycle to Work days are effective at increasing cycling are not linked to possible consequences for e.g. absenteeism or productivity.

In our view, the situation appears to have the character of a Catch-22. Despite the almost universal policy support for increased cycling and walking (as mentioned in the Introduction), investment into walking and cycling has historically been much lower than, and not as consistent as, investment into other transport modes. As a result, there appears to be less evidence available on the impact of such investment. The absence of evidence seems, in turn, to make it harder to make the case for investment into walking and cycling, thus limiting future investment, thus limiting the emergence of the evidence that would be necessary to make the case for increased investment.

The complexity of success

There is a widespread agreement in the literature that the most effective mechanisms for boosting cycling and walking comprise integrated and complementary packages of intervention. Infrastructure is generally regarded as necessary but not sufficient; while

behaviour change interventions in the absence of adequate enabling infrastructure are also judged unlikely to be effective.
Whilst the literature has made it possible to identify a number of interventions that, on their own, can be judged effective (RQ2), in general it seems that the best investment strategy may comprise a strategic, networked approach and is likely to comprise a mix of measures.

The literature does not, however, make it possible currently to express what an optimal mix might look like. In this case, our reflection is that this absence of data may be less to do with the Catch-22 just described and more to do with an inherent feature of investment into cycling and walking – namely, that the unavoidable variations between different places at different times, with different physical and cultural features, mean that the 'optimal' bundle of investment will always vary between different circumstances.

The complexity of costs and benefits

The evidence base is clear (RQ5) that by far the largest benefits arising from increases in walking and cycling accrue in terms of health. There is also good evidence directly linking active travel interventions to health outcomes.

There are challenges here, however. Health outcomes are measured in different ways by different organisations (QALYs versus the value of statistical life, for example); and the possible benefits of reduced morbidity (as opposed to reduced mortality) are not generally captured.

In addition, and as many of the costed interventions identified for RQ1 illustrate, many of the interventions for which there is good evidence have been delivered under the auspices of health or public health interventions, rather than 'transport' interventions.

Potentially most challenging is the mis-alignment between costs – which are typically incurred upfront – and benefits – which typically accrue only slowly and over a long period of time. Establishing clear and convincing links between costs and benefits is therefore challenging; and those costs and benefits are often distributed unevenly between individuals and institutions.

Furthermore, the calculation of future health benefits is often critically dependent on two numbers in particular – just how much of an increase in physical activity is caused by an investment; and how long that increase lasts. These two numbers are among those most conspicuously absent from the evidence base: only a very few studies have convincingly estimated these figures.

There is nevertheless good news

Despite these gaps and difficulties, this Assessment has clearly shown that a great deal is indeed known about the costs of a wide variety of interventions (RQ1); the effectiveness of those interventions (RQ2); and, importantly, how to target those interventions at particular groups of people (RQ3).

What is also clear from our review is that the evidence base is growing rapidly; and the Department for Transport in the UK is well positioned both to make use of and to contribute to that growth.

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