SPORT ENGLAND

Active Travel & Physical Activity Evidence Review

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FOREWORD

Walking and cycling for transport make a valuable contribution to our nation's activity levels. Be it walking to school, cycling to work, or many other everyday journeys, active travel can offer a convenient, accessible and affordable way to move more. For those with busy and hectic lives, it may be one of the few opportunities to create a regular habit.

We were therefore delighted when Sport England commissioned us to carry out this valuable research – to assess and highlight the great potential of active travel and mark Sport England's own ambition for how walking and cycling can support their vision of a more active nation.

We are now very pleased to present the final report, which presents a definitive case for investing in active travel to support physical activity. Our expert, independent research team reviewed the best quality evidence and found a wide range of effective interventions that increased walking and cycling, with the strongest evidence pointing to integrated approaches across whole places.

The report provides clear consensus of active travel's huge potential. To harness this, it's crucial we engage with and listen to people in the places they live and work – to recognise barriers, challenges and local context, and understand how active travel can work for them. The report also carries recommendations to invest and collaborate in active travel more effectively, and an important reminder of how further research and robust evaluation can help us continue to improve provision and delivery.

The message is clear: active travel has a vital role to play in achieving a more active nation. This review is an important step towards fulfilling that promise.

Andy Cope
Director of Insight, Sustrans

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1. EXECUTIVE SUMMARY

Purpose and context

Sport England commissioned a review of the evidence on the link between active travel for transport and physical activity. Active travel means making journeys by physically active means, like walking or cycling. These are usually short journeys, like walking to the shops, walking the kids to school, cycling to work, or cycling to the station to catch a commuter train. The review distils the available evidence in an accessible form, based on robust quality thresholds. It is wide-ranging, drawing on both formally published and non-traditional, non-academic sources. The review is intended to represent the best available evidence. To this end high thresholds are set for inclusion criteria. In particular, literature is included that includes a control mechanism to support comparison between the intervention and non-intervention locations. This degree of rigour is not common outside of academia, but the decision to apply this approach for the Review was taken in order that the output is an authoritative overview.

Summary of the evidence

Eighty-four studies met the inclusion criteria. These were then clustered by a series of intervention typologies:

- City and town wide interventions
- Building or improving routes or networks
- Social marketing including marketing of infrastructure
- Workplace and other institution based interventions
- Interpersonal interventions
- School based interventions

We distinguish city and town wide interventions from the other intervention typologies by virtue of the fact of the approach applied being usually a combination of measures. These combinations typically include measures included in the other typological clusters. The other groups of identified typologies tend, in the research literature and in the practicality of delivery, to be relatively more localised.

Overall, the review concludes that there is strong evidence for the positive impact of interventions to increase active travel. This in turn increases levels of physical activity [13] [15]. Of the different intervention typologies the evidence was strongest (in terms of volume and robustness) for city or town-wide interventions. Each of the other intervention types reported some increases in walking and or cycling.

Key messages

The evidence shows a largely positive impact of interventions to support active travel. Of 84 studies, over two thirds (61) found interventions had led to increased levels of active travel. Most of the remaining studies showed no significant change or showed mixed results across a number of indicators. A small number showed decreases in active travel.

The review found the evidence for positive impact was greatest for town and city-wide interventions. All of the peer reviewed studies addressing whole town or city-wide interventions showed that interventions increased levels of cycling and walking compared to controls. The evidence available for city and town wide programmes shows change at the population level. However, the evaluations did not discriminate between different population sub-groups.

The review also found evidence for the positive impact of walking and cycling interventions at a more localised level. Interventions to build or improve local routes or networks report increased walking or cycling in most cases.

There is also strong evidence of the impact of interventions in school settings. As such interventions have the potential to develop active travel habits that may be continued into adult life, we may postulate that this is a potentially important area for investment (although this is not revealed in the evidence).

The evidence for the effectiveness of workplace-based interventions was slightly more equivocal, with two out of four evaluations showing some positive changes in cycling or walking. It is noteworthy that many evaluations of workplace interventions are available, but as many did not use control groups they were not included in this review. That is to say, the lack of strong evidence in this case does not necessarily mean that interventions in this setting are not effective.

The evidence for the effectiveness of individualised marketing was also strong, demonstrating that once people have stated their desire to change travel behaviour, they can be encouraged to change through the provision of relatively simple information.

The characteristics of the interventions varied considerably from those focused on either infrastructure or behaviour change to broader marketing of both infrastructure and behaviour change. While school travel studies comprised the largest grouping of studies, the strongest body of evidence is for the effectiveness of whole town and city interventions. In these, whole populations were exposed to a range of intervention types.

Economic evidence was limited. The Sustainable Travel Towns programme did report some evidence for benefit-to-cost ratios (BCR). A cost-benefit analysis, undertaken on a relatively conservative basis and considering congestion benefits only, produced a BCR of 4.5:1 i.e. for every £ invested there was a return on investment of £4.50. Schemes returning over £4 are stated as ‘very high’ value for money by the Department for Transport. A similar level BCR was report for the Local Sustainable Transport 11 major projects, and BCRs between 2.6 and 3.5 : 1 were reported for the Cycle Demonstration Towns [18].

Study limitations

There is important context within the evidence base. For example, evidence on intervention in the schools setting is particularly notable for the large body of literature relative to the other typologies. This may be a factor of the relative ease of access for research or the prominence in some countries of government funded programmes addressing school travel. But a large volume of material is not commensurate with a greater extent of impact. The

converse is the low number of studies of interventions in workplaces, and the equivocal implication of effectiveness. In this case the small number of studies and the lack of strength of the findings does not necessarily mean that workplace interventions are not effective. Rather it means that the evidence is uncertain.

The availability of robust evidence on the active travel impacts among different population subgroups is a major gap. The study was not able to evidence different extents of impact among groups identified on the basis of affluence, ethnicity or sexuality. These gaps are a concern for research commissioners and funders.

A number of recommendations emerge from the study. In investing in active travel, priority should be given to: 'whole system'-type intervention approaches; identifying appropriate combinations of measures that 'fit' locally, based on evidence of need and likelihood of impact; encouraging local agencies to promote active transport as part of their efforts to increase physical activity; enabling consistent, long-term funding streams; and enabling funding streams that draw on wide-ranging cross-departmental support.

The search find also gathered little evidence on cost-effectiveness of interventions. This signals a gap in intervention studies whereby inclusion of evaluation of cost-effectiveness of the intervention could help provide added insight into value for money and wider policy goal objectives such as carbon reduction. It was of note that it was the larger programmes – whole town and city approaches, funded by Government, that at least included BCR calculations.

2. INTRODUCTION

Increasing levels of physical activity is central to improving public health in England. Sport England has an aspiration for an active nation where everyone can take part in sport or activity, regardless of age, background or ability. Active travel for transport (such as walking or cycling to work or to the shops) is widely viewed as having the potential to make a major contribution to this vision for a more active nation.

This review of the evidence base on the link between active travel for transport and physical activity is intended to provide Sport England with an authoritative and accessible account of how, and how best, active travel interventions and investment can contribute to increasing and sustaining levels of physical activity.

The evidence base on the connection between active travel and physical activity is extensive, wide-ranging in terms of the interventions reviewed, exhibits variable degrees of rigour, and can be interpreted in different ways. In particular, the volume of available material has grown considerably in recent years (and should be expected to continue to grow in coming years). A further aspect is that some of the key pieces of literature are not formally published in academic journals, but are published as 'grey' literature, which may or may not have been subject to 'informal' peer-review processes.

Sport England commissioned Sustrans, working in partnership with Professor Adrian Davis and Dr Nick Cavill to undertake a review of evidence on the impact of active travel interventions on physical activity. The objective of this review is to help support Sport England and other stakeholders to bring about change through better investment decisions, informed influencing and advocacy tactics, and enhanced partnerships and project design at a local and national level.

Sport England also asked that the review should inform several specific opportunities for active travel to support work with certain audience or places:

- Reducing the number of people who do less than 30 minutes of moderate physical activity per week including the subset who achieve the duration but not at the intensity required to benefit health
- Increasing physical activity among people from lower socio-economic groups, and other less active groups such as older people, disabled people, ethnic minorities and women
- Achieving transformational change in identified urban areas including in selected Sport England local delivery pilot areas

It has not been possible to draw firm inference from the evidence on all of these aspects. In some cases we have identified evidence gaps that need to be addressed.

We approached the task by reconciling a complex sampling strategy and high evidence quality thresholds with a sample drawn from wide and 'non-traditional' sources (i.e. beyond academic journal publications) and a wide-reaching engagement exercise involving both academic experts in physical activity and public health, and practitioners working in the health and transport sectors. The evidence is distilled in an accessible and digestible form. In the following sections we describe the context for the study, the methodological

approaches applied, the results of the review, and the findings and implications from the evidence.

3. THE CURRENT AND POTENTIAL CONTRIBUTION OF ACTIVE TRAVEL TO LEVELS OF PHYSICAL ACTIVITY

Introduction

There is very strong evidence that physical activity benefits many aspects of physical and mental health and well-being. National recommendations from the Chief Medical Officers of the UK emphasise the importance of regular activity of at least moderate intensity and identify walking and cycling as activities that can be integrated into everyday life: *"For most people, the easiest and most acceptable forms of physical activity are those that can be incorporated into everyday life. Examples include walking or cycling instead of travelling by car, bus or train."* [19]

In this section we review available evidence on the current contribution of active travel for transport to levels of physical activity in England (and relevant examples from elsewhere in the UK) and its potential to increase these levels. This will set a context for the findings of the substantive review of evidence that follows on the effectiveness of active travel interventions in increasing physical activity levels.

The current contribution of active travel for transport to levels of physical activity

The National Travel Survey (NTS) shows that 343 trip stages were made by foot per person per year in 2017, and that 206 miles were walked per person per year in 2017. Nearly all (97%) local authorities had at least 60% of their adult population walking at least once a week. The equivalent figures for cycling are 17 cycling trips per person per year and 60 miles cycled per person per year in 2017. Fewer than 20% of people cycled at least once per week in the vast majority of local authority areas (96%) [20]. As NTS shows, in 2017, cyclists made on average 332 trips per year (about 6 trips a week) and travelled around 1,144 miles per year, up from 687 miles on average in 2002. So the NTS shows that while the number of cyclists has stayed stable, those in the sample have generally been making more cycling trips and travelling further.

Analysis of the Active Lives Survey reported by the Department of Transport [21] states that more adults were dependent on walking rather than cycling to stay active, with 10% dependent on walking for leisure and 6.5% on walking for travel. With much lower prevalence, 1.2% of adults were dependent on cycling for leisure to be active and 0.8% were dependent on cycling for travel to be active.

'Dependent' means that 'if you removed the impact of that activity, an active individual would no longer be considered active because they are not physically active for enough time'. So, using this rather strict definition, 7.3% of all adults are dependent on active travel (walking and cycling) to meet the physical activity guidelines.

Stewart et al [22] analysed Sport England's Active People Survey to assess the likelihood of meeting UK physical activity guidelines in those who reported utility cycling (i.e. cycling for transport) compared with those who did not. They found adjusted odds ratio for meeting physical activity guidelines in favour of utility cyclists 4.08 (95% CI 3.88–4.29). In other words, people who did some utility cycling were 4 times more likely to be classed as active. They concluded that utility cycling can make a significant contribution to levels of physical activity.

The Health Survey for England [23] is one of the most comprehensive assessments of physical activity in England. It is the basis for NHS statistics on physical activity. Although it does not discriminate between walking and cycling for pleasure/exercise and for transport purposes, it does show that walking is an important contributor to physical activity: 47% of men and 39% of women reported walking of at least moderate intensity for 10 minutes or more on at least one day in the past four weeks. The difference between men and women was most pronounced in those aged 16 to 34 years. The mean number of days in the last four weeks on which they walked was higher for men than for women (8.6 and 7.4 days respectively).

A meta-analysis of the contribution of walking to and from school to individual and population level physical activity estimates that it contributes 23% of MVPA on schooldays in primary school age children, and 36% of MVPA on schooldays in high school pupils. [24] Walking to and from school makes a meaningful contribution to individual school day MVPA for active commuters (in western countries). However, since schooldays represent only around half of all days, and prevalence of walking to school is low in many countries, the contribution of walking to school to population MVPA is probably low.

Analysis of the Active Lives Children Survey [25] shows the extent of contribution that 'walking to get to school and other places' makes to the overall physical activity of children. But it also shows a marked decrease in the proportion of 'walking to get to school and other places' as children get older, from 73% participation among years 1 and 2 (aged 5-7 years), to 26% participation among pupils in years 9 to 11 (aged 13-16 years).

This data makes clear the extent of the contribution that active travel for transport, walking in particular, and to a lesser extent cycling, makes to physical activity. The potential contributions are considered in the following section.

The potential contribution of active travel to total physical activity

Data from the National Travel Survey shows that 81% of journeys under one mile are walked, dropping to under 30% for journeys under 2 miles. For cycling for journeys under 2 miles less than 3% are cycled, dropping to just over 2% of journeys between 3 and 5 miles. [20] This implies a large potential for increasing walking and cycling.

Studies have modelled the impact of increased walking on physical activity and health, and the associated costs. In England, if one in ten adults (aged 40–60 years) achieved 10 min of brisk walking per day, it would save £310 million per year [26]. Another study estimated that the potential effect of increased walking and cycling in urban England and Wales would lead to savings of roughly £17 billion (in 2010 prices) for the NHS, after adjustment for an increased risk of road traffic injuries [27].

It is of interest to consider the intensity of walking, as brisk walking offers greater health benefits. Researchers have estimated that 1.5 million men (from 13.4 million corresponding to 11.6%) and 3.9 million women (from 13.6 million corresponding to 28.6%) in England aged 25–64 years would benefit from regularly walking at 3 mph. [28]

Shephard noted that when engaged in level walking, the intensity of effort may be adequate for cardiovascular benefit in older adults, but in fit young workers, it is necessary to either increase the pace or choose a hilly route in order to induce cardio-respiratory benefit. [29]

It is worth mentioning here the Propensity to Cycle Tool (PCT) [30]. This is an online, interactive planning support system that was initially developed to explore and map cycling potential across England (see www.pct.bike). Based on origin-destination data it models cycling levels at area, desire line, route and route network levels, for current levels of cycling, and for scenario-based 'cycling futures.' Four scenarios are presented, including 'Go Dutch' and 'Ebikes,' which explore what would happen if English people had the same propensity to cycle as Dutch people and the potential impact of electric cycles on cycling uptake. The cost effectiveness of investment depends not only on the number of additional trips cycled, but on wider impacts such as health and carbon benefits. The PCT reports these at area, desire line, and route level for each scenario. The PCT is open source, facilitating the creation of scenarios and deployment in new contexts. We conclude that the PCT illustrates the potential of online tools to inform transport decisions and raises the wider issue of how models should be used in transport planning.

There is a clear consensus among the listed sources that there is considerable potential for walking and cycling to make a greater contribution to overall levels of physical activity, both through increasing the amount of activity and increasing the intensity of activity. The following section considers patterns of physical activity from active travel for different parts of society.

The contribution of active travel to total physical activity among different parts of society

Analysis of the Active Lives Survey data shows the extent to which active travel contributes to overall physical activity. Among that part of the population who are physically active (achieving 150 minutes of physical activity per week), nearly 11% (roughly 3m adults) are dependent upon walking for travel to achieve those levels of physical activity (that is to say that these people may do other activity, but for less than 150 minutes – therefore we infer that they are completely or partially dependent upon walking for travel to achieve the minimum threshold).

There are marked differences (statistically significant) between different groups in the extent to which they are reliant on walking for travel to achieve recommended levels of activity:

- Socio-economic status – 8% of NS SEC 1-2 (higher income groups) who achieve threshold levels of physical activity are dependent on walking to achieve sufficient physical activity, compared with 10% of NS SEC 3-5 (middle income groups) and 16% of NS SEC 6-8 (lower income groups)

- Gender – 12% of females who achieve threshold levels of physical activity are dependent on walking to achieve these levels, compared with 9% of males
- Health impairment – 16% of disabled people who achieve threshold levels of physical activity are dependent on walking to achieve these levels, compared with 10% of people with no disability
- Older people – 17% of those aged over 85 years and who achieve threshold levels of physical activity are dependent on walking to achieve these levels, compared with other age groups (other age groups range from 7% to 13%)
- Ethnic groups – people from South Asian, Black and Other ethnic groups who achieve threshold levels of physical activity are more dependent on walking to achieve these levels relative to other ethnic groups

The equivalent analysis can be conducted for cycling. Among that part of the population who are physically active (achieving 150 minutes of physical activity per week), 1.3% (roughly 354,000 adults) are dependent on cycling for travel to achieve those levels of overall physical activity (that is to say that these people may do other activity, but for less than 150 minutes – therefore we infer that they are completely or partially dependent upon cycling for travel to achieve the minimum threshold). Males are more likely to be reliant on cycling for travel to achieve their physical activity levels than females (1.8% vs 0.7%) and there are differences between some age groups, with those aged 35-44 the most likely to rely on cycling for travel to be classed as active.

More widely, some studies of active travel for transport and physical activity distinguish people from lower socio-economic groups. However, there is a lack of studies addressing these issues which distinguish between other sectors of society, such as older people, disabled people, ethnic minorities, women and LGBTQ+ groups. For example, researchers addressing the health benefits of cycling have noted that the wider impact of active transport policies on health and inequalities across Europe must be explored. [31]

Researchers addressing active travel differences according to levels of deprivation (least to most) did find differences in levels of active travel remain between socio-economic groups. [11] Yet, while most health inequalities are largely unfavourable to the most deprived groups in the population, in the case of active travel in Scotland the researchers found that they run in the opposite direction. That is to say that those living in the most deprived areas are the most likely to report participation in active travel. We can reasonably infer that the same holds true for England, principally because of higher levels of walking in the lowest socio-economic group quintiles.

Earlier research by Bostock found that 'no access to a car', among low income mothers, was not only an indicator of low socio-economic status, but was also an indicator of higher levels of walking as a mode of transport. [32] Similarly, Adams, drawing on the UK Time Use Survey of 2005, reported that being sufficiently active through active travel was greater in the young and those without access to a car or van. [33] Additionally, higher levels of active travel were associated with being unemployed, being in a low socio-economic groups, and leaving full-time education at an older age.

Stewart et al noted for cycling that intuitively, those on a lower income have relatively more to gain from utilitarian cycling, even if only from a financial perspective. The unadjusted

odds ratio indicated significantly more utilitarian cycling in the lower socio-economic groups, but this disappeared after adjusting for confounding factors. This shows that there may be barriers to cycling for this group that appear to over-ride the financial case in favour of cycle use. [22] Cycling in England is predominantly undertaken by white, affluent males [34], signifying that its potential to reduce inequalities is not being realised.

There has been some focus on older people, socio-economic position and walking for transport. [35] Average minutes walked for transport are reported to decline for most socio-economic groups, however, the declines were reported to be steeper for the retired and members of low-income households.

The limited evidence of differential patterns of physical activity from active travel for different sections of society belies the fact that these differences may well exist, and that it may be possible to exploit them to improve population health.

The signals from underpinning analysis and research on the overall contributions and potential contributions to physical activity from active travel form a platform for the questions addressed by this study. The following section sets out these questions, and details the approach used to investigate the evidence in relation to each of them.

4. REVIEW METHODS

In this section we set out the methods we used to conduct the review. This includes our formulation of the research questions, the criteria we used to identify relevant evidence, our search strategies for peer-reviewed and grey literature and the search number outcomes.

Introduction

In this review, the authors set out to address a number of questions of specific interest to Sport England, based on the latest research knowledge. There are a number of ways to review scientific literature, from expert assessments based on knowledge of the literature, through to full systematic reviews or meta-analyses, where a great deal of effort is put into finding all available literature, and scrutinising it according to published analytical frameworks. This review lies somewhere between these two extremes: it was not thought necessary to conduct an academic systematic review to answer the research questions, but it was however important to be as rigorous as possible within the time available. We made sure to include both published and unpublished 'grey' literature, as previous experience has shown us that a lot of transport evaluations are published as reports on websites rather than in scientific journals. We also included advice from some key academic advisors in the health and transport sector (see acknowledgements section) to review the papers identified, and to suggest any additional relevant reports. In addition, we conducted two webinars with invited practitioners and academics, to sense-check the findings and also check for missing studies. As a result, we are confident that this report gives a solid overview of the available research knowledge in this area.

Research Questions

This review set out to answer four research questions.

1. What is the potential and actual contribution of active travel to physical activity participation? (This includes % inactive, active and distribution in the population)
2. What interventions are effective in increasing active travel for physical activity?
3. What interventions are cost-effective in increasing active travel for physical activity?
4. What are the characteristics of effective and cost-effective interventions? (Such characteristics might include messaging, engagement, delivery format, specific physical or environmental changes and the relative balance of capital investment (infrastructure) and revenue investment (interventions)

Inclusion criteria

We set out below the criteria we used to determine whether evidence was to be included in the review.

Definition of Active Travel

For the purpose of this study, Active travel is defined as primarily walking and cycling (though some other minor modes of travel that include physical activity such as scooter-riding would have been be included). These must be for the purpose of transport (getting from place to place) and not for recreation or fitness.

Definition of 'intervention'

We included any type of action or change that may have led to a change in walking or cycling, even if an unintended outcome.

Intensity

All walking and cycling are included in this definition of active travel (i.e. there is no intensity cut-off, so slow walking/cycling are included if for transport).

Outcomes

Studies must report a measured change in walking for transport, cycling for transport, or both. Studies reporting a measure of physical activity can only be included if it is demonstrated that this is largely due to the contribution of walking and/or cycling for transport.

This focus on outcomes data means that broader transport interventions (such as road speed reduction programmes) could be included if they had measured walking or cycling as an outcome.

Target audiences/populations included in interventions

Adults and children aged 5 and over.

Study design

Experimental and quasi-experimental studies (i.e. studies with some form of control or comparison group). This criterion was included to make sure we could have confidence that any measured changes in cycling or walking were due to the impact of the intervention itself and not due to any confounding factors (such as weather). In active travel interventions this tends to mean that the impact of an intervention in one area (i.e. a town or a school) is compared to a similar area that did not receive the intervention.

Publication dates

We focused the search initially on reviews of the literature conducted since 2000 (to focus the review on the most up-to-date findings). As there had been seminal systematic reviews conducted on walking in 2007 [11] and cycling in 2010 [5] we then searched for any primary studies since those dates to update these reviews.

Geography

We searched the global literature for papers published in English.

Search strategy for peer-reviewed literature

We searched PUBMED using the following title search terms:

- Cycling OR bicycling AND review
- Walking AND review
- Active transport OR active transportation OR commuting AND review

We searched three transport-focused search engines (TRID, ICE Virtual, TRB) and one generic search engine (PsychInfo). We used the title search terms: 'walking' OR 'cycling' AND 'review'.

Primary studies

For walking we used a recent high quality systematic review that had been conducted using very similar criteria [36] and extracted the studies that met our more limited inclusion criteria. For cycling no such review was available so we conducted a search of Pubmed using the 'Bicycling' MESH terms; and dates 2011 – present; and 'intervention'.

Search strategy for grey literature

'Grey' literature refers to anything that is published and available but has not been through a peer-review process. The search approach is different to that used for peer reviewed searches. We searched for this type of literature using a range of approaches. This included searching Google Scholar; Sustrans' own extensive set of reports; our own personal libraries, as well as those known to other members of the team; and by 'snowballing i.e. making contact with others in the field who could recommend grey literature reports which might meet our inclusion criteria. We used the broad search terms: 'walking, cycling, active travel' and used the most appropriate term for each search tool.

We searched websites such as the ELTIS platform for mobility management http://www.eltis.org/; EPOMM http://www.epomm.eu/ for case studies as well as EC-funded programmes such as PASTA http://www.pastaproject.eu/home/ and the WHO Transport webpages http://www.euro.who.int/en/health-topics/environment-and-health/Transport-and-health/publications.

Inclusion criteria

We used the following criteria to establish inclusion of evidence:

- Studies and reports from 2008 to current,
- English language,
- Minimum of pre and post intervention data for changes in levels of active travel
- Analysis of results with some form of control or comparison group

Theory into practice workshops

As part of our overall approach we organised workshops with active travel practitioners, most working in transport planning in local and combined authorities. The purpose of the workshops was to test that we had covered the known evidence and to seek advice on the most practical ways of presenting and making the most of the findings of the review. We will take the comments and observations made in the workshops forward with Sport England in devising a strategy for dissemination of the review findings.

We are grateful to all those who took part in supporting the work of the review in this way. Participants are listed in appendix 4.

5. RESULTS OF LITERATURE SEARCHES, AND DATA EXTRACTION

Peer-reviewed literature

Reviews: Cycling

We found 79 reviews of cycling interventions. These were screened for relevance and 6 full papers were retrieved. After reading these papers, 4 review papers were included in the review.

Reviews: walking

We found 226 reviews. These were screened for relevance and 9 full papers were retrieved. After reading these papers 4 review papers were included in the review.

Reviews: active transport

We found 22 references. These were screened for relevance and 4 full papers were retrieved. Additional papers were found through expert search. After reading these papers 5 review papers were included in the review.

Transport search engines

We found 655 references as follows:

- TRID = 481 references
- ICE Virtual = 127 references
- TRB = 20 references
- PsychInfo = 27 references

Primary studies

We found 2 studies on walking and 7 on cycling.

Finally, the expert consultation process revealed one additional paper [16].

In total 68 peer-reviewed studies were included, from 12 reviews and 9 primary studies.

Grey literature

We found 93 studies/reports of which 16 met the inclusion criteria. In addition, several hundred other sources were identified but excluded at an early stage.

In total 16 grey-literature studies were included, from 93 studies and reports.

Data extraction

Appendix 1 below sets out the detailed data contained within each review, extracted from the reviews or primary studies according to key criteria.

It is important to note that when considering reviews, it was found that a number of individual studies contained within each review did not meet the inclusion criteria for this review. For example, a review may have looked at cycling studies, of which only a proportion dealt with cycling for transport. For this reason, it was decided to present the results from each individual study contained within each review, rather than the review-level findings. This allows the current review to be much more detailed and offer more nuanced findings. This is also the case for the grey literature where we report the detail of five cases within one report, in order to be able to describe more clearly the differing interventions.

The tables also present quality and external validity scores for each study. These use a version of the type of scale used by NICE in literature reviews, rating 1-3 for the following:

Quality: the extent to which the study has been designed or conducted in such a way as to minimise the risk of bias. This was a subjective judgement on behalf of the authors, combining assessments of study design and quality of methods. A 1-3 rating was given (with three the highest).

External validity: the extent to which the results of a study can be generalized to other situations and to other people. This was also a subjective judgement on behalf of the authors, combining assessments of the extent to which a study could be taken out of the research context and applied in a real-life setting; and the specific applicability to the UK setting. A 1-3 rating was given (with three the highest).

6. EVIDENCE FOR THE EFFECTIVENESS OF ACTIVE TRAVEL INTERVENTIONS

This part of the report considers the evidence available on the effectiveness of active travel interventions in general and of particular types of intervention.

Summary of impacts for all types of intervention

In total 84 studies met the review inclusion criteria (see Appendix 1). These were classified according to types of intervention:

- 35 studies on schools-based interventions, of which 26 reported increases in cycling and/or walking and 9 which reported no impact
- 19 studies on city and town wide interventions, of which 14 reported increases in cycling and/or walking and 5 reported no impact
- 16 studies on building or improving local routes or networks, of which 11 reported increases in cycling and/or walking, four reported no impact and one reported a decrease in cycling
- 7 studies on inter-personal interventions, of which 6 reported increases in cycling and/or walking and 1 reported no impact
- 4 studies on support at workplace or other institutions of which 2 reported increases in cycling and/or walking and 2 reported a negative impact or lack of impact on levels of active commuting
- 3 studies on social marketing including marketing of infrastructure of which 2 reported increases in cycling and/or walking and on reported a decrease in cycling in the intervention area

Summary of positive impact by interventions aimed to increase cycling or walking

Cycling: 41 of the 60 interventions which included cycling reported increases in cycling while 16 were unable to demonstrate an increase compared to the control. Three studies reported declines in cycling.

Walking: 36 of 50 interventions reported increases in walking, while a further 13 were unable to demonstrate an increase in walking. One study reported declines in walking post intervention.

The effectiveness of whole city or whole town-based interventions

Seven peer-reviewed studies looked at interventions that were conducted across towns and cities to modify the built environment, supported in many cases by marketing and behaviour change initiatives. These were all shown to increase cycling compared to controls, and two studies increased walking.

The impact of the interventions varied in scale: from very small 1% change in cycling use across twelve towns in the UK through to a 30% increase in active modes in two New

Zealand cities. However, it is important to note that while some of the reported changes may seem small in absolute terms, the changes are likely to be important as they demonstrate change at scale, as they led to changes measured across the whole population.

This was supported by the grey literature, although the findings were slightly more equivocal. Of the 12 studies that looked at whole city/town-wide interventions to increase cycling, 8 were shown to increase cycling compared to controls. Four studies addressing cycling found no increase when assessed against control areas, but in 3 of these studies this may have been because further data was needed and over a longer time period.

Automatic count data provides a robust measure of change in levels of cycling as it comes from devices that count the number of passing bicycles. In the English Cycle Demonstration Towns (CDTs), automatic count data showed there was an overall increase of 29% for cycling in the six CDTs in 5 and a half years (with a range of between 6% and 59% for individual towns); and an overall increase of 24% for the 12 Cycle City & Towns (CCT) over three years (with a range of between 9% and 62% for individual towns). Evidence for the outcomes of the English Cycle City Ambition (CCA) programme shows cycle flows on specific intervention routes have risen significantly. For example, in Leeds the range of increase in cycling on cycle superhighways was reported as being between 31 and 46%.

Between 2012 and 2016 the canal towpaths network in Birmingham was improved. The volume of cycling on the towpaths increased by 128%, compared to just 24% in a control group of six routes which did not receive improvements.

On the Pink Pedalway in Norwich, cycle volumes increased by 29% between 2014 and 2016, compared with an increase of 16% for the comparison group of routes without improvements. However, the change on the Pink Pedalway was entirely driven by the increase at the count site with the largest flows (Cow Drive), which is at the eastern end of the Pink Pedalway near the University of East Anglia. The Pink Pedalway is an eight-mile cross-city route between the University of East Anglia to the west of the city and Thorpe St. Andrew to the east of the city, via the city centre. The entire route is either separate from traffic or on roads with speed limits at, or below, 20mph.

In the Bristol area, cycling increased by 52% between 2011 and 2015. Interventions were largely a mix of on and off-road provision. Most on-highway cycle lanes were not grade segregated from motor traffic.

In the Sustainable Travel Towns (STT) (operating between 2004-09 in Peterborough, Darlington and Worcester/ Redditch) cycle trips per head across the three towns increased by 26-30%. In Darlington (also a CDT), cycling showed a very dramatic increase during the STT period, with growth of between 50 and 100%. Walking also increased substantially although the increase was less dramatic. Between 2008-09 and 2013, both the higher cycling and higher walking levels were maintained, with some indications that a further period of cycling growth might be starting.

In Peterborough automatic counter data (both overall and for individual routes) suggest relatively substantial increases in cycling between 2012 and 2013, which may mark the

beginning of an upward trend. Walking increased by at least 18% during the STT period and manual counts suggest that increases were either maintained or augmented during 2013.

In Worcester automatic cycle count data shows cycling increased by 16% during the STT period. Data to 2012 suggest that there was further, substantial growth since 2012, although the number of cycle counters from which this conclusion is drawn is limited, and any increases are likely to vary across the city between different routes. According to household survey data, walking also increased during the STT period, and data from the 2010 household survey suggested that the higher walking levels may have been maintained, with the number of walk trips per person per year increasing from 255 in 2004, to 284 in 2008 and 287 in 2010, an overall increase of 13%.

The Local Sustainable Transport Fund (LSTF) for cycling and walking infrastructure funded a wide range of improvements to infrastructure across the country. This was evaluated with a meta-analysis based on data from the Active People Survey which showed that the proportion of adults cycling in the previous month increased slightly in the large projects over the course of the funded period, and this trend was more favourable than the background national trend. There was no evidence that the amount of cycling done by cyclists (as measured by the number of days cycled in the previous month) changed in the large projects over the funded period, either in absolute terms or relative to the national comparator group. This suggests that any increase in cycling in the large projects may have been driven by widening participation, rather than encouraging existing cyclists to cycle more.

Three studies from the grey literature examined town-wide walking programmes. One study covering the STT programme found increased levels of walking compared to controls. The two other studies addressed the same programme – the LSTF – and did not find increased walking compared to controls. The LSTF involved 7 large projects delivering many interventions intended to increase walking and 4 projects which delivered some interventions. The meta-analysis was inconclusive, reporting that there was limited data on changes in overall levels of walking which could be attributed to LSTF interventions. In some cases this was due to insufficient data and in others because the data available shows variations from year to year and from one town or area to another. On an area-wide basis there are external influences which may affect the level of walking, so it is not yet possible to ascertain whether the changes are attributable to the LSTF. However, one large project, Nottingham, showed an increase in walking relative to the comparator group between 2012 and 2014/15 that was statistically significant.

Evidence for the effectiveness of individual elements of the schemes was of variable quality. Some of the stronger evidence included:

- Barnsley, Doncaster, Rotherham and Sheffield Combined Authority: Three months after participating in walking promotional initiatives, 62% of the 567 respondents reported walking more than when they first joined the programme, with an average increase of 81 minutes per week, while 14% reported driving less.
- CENTRO (a collection of councils in the West Midlands, who worked together on major region-wide issues such as strategic transport and economic planning): 64% of

car owners and 50% of non-drivers reported walking more after personal travel planning on two corridors.

- Merseyside: surveys of over 700 people using traffic-free routes found that almost half of respondents said the route had encouraged them to walk or cycle more.
- Reading: a 'Beat the Streets' scheme (in which participants compete to visit the most checkpoints as part of a game or competition) found that four-fifths of participants said that it helped them to walk or cycle more.
- Manchester: surveys of 1,750 people at sites where routes had been improved for walking or cycling found that 70% said the presence of the route had increased their level of physical activity.

It is worth noting that in many cases these studies report objective measures of numbers of people walking and cycling – often taken from traffic counts or surveys. While on one hand this type of data is much stronger than the type of self-reported data often found in physical activity surveys, it is not able to discriminate between types of journeys or existing physical activity levels of walkers or cyclists. For example additional cycle journeys measured on a route may be being taken by existing cyclists, leading to minimal health benefits. However, additional walking and cycling in general is likely to be associated with increased total physical activity [13 15].

NATURE OF EFFECTIVE CITY AND TOWN WIDE INTERVENTIONS

The studies in this section all describe multi-faceted attempts to increase cycling (and to a lesser extent walking) at town or city level. This tends to revolve around investment in the physical infrastructure for cycling: building bike lanes and associated facilities such as advanced stop lines and dedicated crossings. In most cases the new infrastructure is associated with a publicity programme to encourage people to take up cycling.

In the UK Cycling Demonstration Towns [2] [3] and Cycling Cities and Towns project expenditure was a mix of capital and revenue. The ratio of capital to revenue expenditure over the two phases of the CDT programme was 4:1. The ratio was 2.5:1 for the CCT programme.

Construction of segregated and unsegregated cycle routes was common to most of the locations. 35.14 kilometres of traffic-free cycle lanes were added or improved and 18 kilometres of on road cycle lanes added or improved. Infrastructure comprised almost 70% of the budget spend. As part of the original programme for the initial six towns, a total of 129 schools (approximately 46% of all schools) were offered the intensive support of a 'Bike It' officer. Bike It teaches riding skills and bicycle maintenance, mainly in primary schools.

The Leeds-Bradford cycle superhighway [7] is a 23km route stretching from Leeds to Bradford in the west, and to Seacroft in the east and was developed as an element of the Cycle City Ambition (CCA). Improvements include cycle lanes which are physically segregated from the carriageway by raised strips or kerbs; bus stop islands / bypasses (more than four per km); and upgraded road crossings (toucans, zebras and cycle phases at existing signals). The scheme was built in two phases. Phase 1, the 14km segregated route between Bradford and Leeds city centres, was completed in June 2016. As part of this, 16km of the Leeds-Liverpool canal towpath was refurbished. Phase 2 between Leeds and Seacroft was completed by the end of 2016.

As noted above, in Birmingham, between 2012 and 2016 [7], infrastructure was focused on improvements to the network of canal towpaths. In CCA Phase 1 Birmingham resurfaced 52km of routes on eight canal towpath cycle routes, created or improved 18km of cycle routes across green space, signed 11 routes along quieter roads, implemented 20mph zones across 41 square km of roads, and distributed 4,750 bikes in disadvantaged communities.

As part of the CCA Phase 1 In Norwich a 9.2km mixed strategic 'pedalway' route was upgraded, created a contraflow route into the city centre, implemented 20mph zones in an area covering 10,800 households and created or improved cycle parking at four 'hub' locations, including the hospital and university [7].

In Oxford a five-arm roundabout on a main approach to Oxford city centre was remodelled [7]. The scheme included reducing the width of each entry point arm; widening pedestrian islands and upgrading six un-signalised pedestrian crossings; lowering kerbs; and narrowing the roundabout.

In Bristol, schemes delivered included a new signalised pedestrian and cycle crossing of a motorway slip road, a remodelled ring-road junction including a single fast crossing of six traffic lanes for cyclists, and a refurbished pedestrian and cyclist bridge [7].

A few of the LSTF Large Projects made significant public realm improvements such as Telford's redesign of part of town centre Box Road as shared space. Other interventions included 20mph zones, [17] pedestrian route improvements, and behaviour change measures such as led walks.

The analysis did not identify a clear pattern of which factors determine the extent of impact, but obvious factors that differed between the towns included the nature and extent of delivery (including the capital and revenue split), the target groups, the profile and extent of support for the initiatives that were introduced, changes in political support at different stages of the programme, baseline levels of cycling and baseline levels of car dependence, amongst other factors.

The effectiveness of interventions to build or improve local routes or networks

Fifteen studies analysed the impact of modifying the environment to support cycling or walking. These ranged from small studies looking at one path, through to wider-scale 'complete streets' interventions. In general the evidence supports the effectiveness of these types of intervention: 10 of the 15 studies (66%) showed positive impacts compared to controls, with 4 having no impact and one a negative impact.

There was a wide range of impacts among the 10 studies reporting positive findings. One reported an unquantified increase in walking and cycling among those who lived near to trails compared to those living further away. Others reported a 97% increase in levels of cycling at one point on a new bike trail in Sydney and an average increase in active travel of 41 minutes per week in a scheme in London.

NATURE OF EFFECTIVE INTERVENTIONS TO BUILD OR IMPROVE LOCAL ROUTES OR NETWORKS
The majority of the interventions in this category were small and relatively isolated changes to the infrastructure for cycling, such as building a new bike path [6] or adding in one bike lane to an existing road [8]. Many of these were in the USA, where town -wide cycle promotion seems relatively rare. Exceptions to this were investment in whole neighbourhoods in Holland [10]; a 'complete streets' approach in the USA [14] (a transport policy and design approach that requires streets to be planned, designed, operated, and maintained to enable safe, convenient and comfortable travel and access for users of all ages and abilities regardless of their mode of transport); and the 'mini-Holland' programme in three London boroughs [16] (where infrastructure changes include redesigned town centres, with cycle hubs at tube and rail stations; measures to reduce and calm motor traffic in residential areas; and physically protected cycle lanes along main roads. Many schemes also aimed to improve the walking environment and public realm quality).

The effectiveness of social marketing interventions

Two studies that evaluated the marketing of a new trail were positive for cycling, while one UK study showed that a publicity campaign was associated with declines in cycling. The reported increases in cycling were relatively modest: e.g. use of cycle paths increased by 5% in one Sydney programme; and in another the average increase in time spent cycling was around 11 minutes per week.

NATURE OF EFFECTIVE SOCIAL MARKETING INTERVENTIONS
These studies focused on the effectiveness of marketing of new cycle infrastructure, in one case through using the transtheoretical model of behaviour change [6] (a model based on an assessment of an individual's readiness to act on a new healthier behaviour, and provides strategies, or processes of change to guide the individual); in another using a promotional campaign [12].

The effectiveness of workplace and other institution-based interventions

There is conflicting evidence for the impact of cycling and walking programmes coordinated by employers and other institutions. One workplace study showed a very positive impact on rates of walking to work (with walking to work increasing by an average of 64 minutes per

person per week) but no impact on cycling, and one study showed a positive effect on cycling. Studies of telecommuting and carshare programmes had a negative impact on cycling.

NATURE OF EFFECTIVE WORKPLACE OF OTHER INSTITUTION BASED INTERVENTIONS
The intervention covered by the first of the studies involved making a pack entitled "Walk in to Work Out" available, having been pre-tested on a local population [1]. It contained a booklet with written interactive materials based on the transtheoretical model of behaviour change, with educational, and practical information and issued at the place of work. This included information on choosing routes, maintaining personal safety, shower and safe cycle storage information, and useful contacts. The pack also included an activity diary in the form of a wall chart, a workplace map, distances from local stations, local cycle retailers and outdoor shops, contacts for relevant organisations, local maps, and reflective safety accessories. The intervention was effective for walking but not cycling. The second study covered the workplace intervention '*Bike to Work: cyclists are rewarded'*, which the Flemish Cycling Union implemented in Flanders between May 2011 and March 2012 [9]. An internet-based program promoted commuter cycling to all employees in twelve small and middle-sized companies. During the initial implementation the Union charged a participation fee. As this discouraged participation the fee was removed. The intervention consisted of three major components: (1) two cycling contests, (2) an online loyalty programme based on earning 'cycling points' and (3) the dissemination of information. To encourage potential cyclists to start cycling to work the first cycling contest took place during summer (months June-July 2011). To encourage employees to continue to cycle to work the second cycling contest took place during winter (October-November 2011). To participate, employees had to sign up as a team of at least five members. Each team was challenged to cycle half of the commuter trips by bike. Afterwards, of all teams that had met the challenge, three were randomly selected to receive a prize (e.g. GPS, rain coat, backpack). The loyalty program aimed to motivate cyclists throughout the year. Employees had to register on the website in order to track each cycling trip on their personal score

The effectiveness of interpersonal interventions.

Evidence in this category is overwhelmingly dominated by the personalised travel planning studies conducted under the 'Travelsmart' initiative. These have been shown to be almost universally positive for walking and cycling. This was supported by the same or similar studies found in the grey literature.

These individualised marketing campaigns reported net increases in cycling trip frequency ranging up to 21 trips per person per year. Another study among obese women found much higher levels of bicycle commuting among the target audience compared to the control (29% vs 8%). Evidence from St. Albans reported growth in trips by most sustainable and active travel modes, with relative increases in walking (6%), cycling (36%) and public transport trips (31%). There was a relative increase of 20% in daily exposure to active forms of travel (i.e. time spent participating in walking and cycling as modes of transport, plus access/egress to public transport and parked cars). The project achieved relative increases in walking (4%) and public transport use (12%).

NATURE OF EFFECTIVE INTERPERSONAL INTERVENTIONS
The TravelSmart intervention involves three key phases each based on personal contact with the households in a target area [5] [11]. The process involves dialogue which motivates people to consider and review their travel behaviour in the context of their lifestyles. People who are interested in changing are supported and encouraged, but the choice is always left to the individual. In Peterborough this personalised travel planning intervention was conducted in one relatively wealthy area and one deprived area. A total of 6,204 personalised TravelSmart packages were hand-delivered to participating households (including 666 containing only rewards for regular users). In Hemel Hempstead a total of 10,173 incentives and items of travel information were made to households.

The effectiveness of school-based interventions

There is a large literature on school travel interventions. We found 32 studies in the peer-reviewed literature. These are overwhelmingly positive for both cycling and walking, although the impacts are often small-scale because of the limited reach of the intervention (i.e. most involve a relatively small number of schools and/or pupils).

Many of the evaluations reported unquantified increases in walking and cycling to school compared to controls. Reported changes included an increase in days walked or cycled to school per week; an increase in the number of children walking to school; an increase in time spent walking ranging from 2 to 69 minutes per week; and an increase in number of children commuting actively. Two 'grey' studies addressed school travel, one addressing both walking and cycling, and one just walking. Both studies reported increases in walking. The study including cycling also reported increases in cycle use. Both studies employed promotional and/or behaviour and skills training. Both studies were small scale and evaluated over a short time period.

NATURE OF EFFECTIVE SCHOOL BASED INTERVENTIONS
The school interventions were in a number of categories: **Safe Routes to Schools;** including changes to the environment (such as new crossings) combined with educational and motivational activities. **Walking school buses;** where children are walked to school in groups accompanied by a teacher parent or volunteer **General active travel promotion** including resources for students, teachers and parents; combined with promotional activities. **Beat the Street:** one study reported on this technology-based promotion in which people are encouraged to log their walks to school by swiping a post near the school and collecting points to enter a competition. **Cycle training;** where students are taught to ride a bike safely **Active travel days** where promotional activity is focused on a single day A good example comes from a UK study [4], conducted in North Tyneside (FEAT 1st), council staff and other Sustrans staff and volunteers delivered activities including bike skills and maintenance sessions, on-road cycle training and education to raise awareness of the need for physical activity in each school one afternoon a week. The Sustrans FEAT 1st officer and North Tyneside school travel advisor also led family-orientated walks and bike rides at weekends and evenings as well as half-term activities including a mountain bike ride.

7. KEY FINDINGS AND GAPS IN EVIDENCE

In this section we set out the key findings of the review and the key gaps in the evidence on the effectiveness of active travel interventions in increasing physical activity.

Key findings

There is substantial robust evidence for the positive impact of interventions to increase active travel

The review has shown there is substantial robust evidence for the positive impact of interventions to support active travel. It found there were 84 studies in which the impact of an intervention was sufficiently robustly evaluated (by comparing the intervention impact with a control or counterfactual) to be covered by the review. Of these 84 studies, over two thirds (61) found interventions had led to increased levels of active travel. The remaining studies either did not show increases in the intervention group compared to the control, or showed mixed results (e.g. with some increases and some decreases in active travel such as in a multi-site or city and town-wide intervention).

The evidence of the positive impact covers a number of different types of intervention

The review found the types of interventions to increase active travel covered by robust evidence fell into six main categories:

- multi-faceted attempts to increase cycling (and to a lesser extent walking) at town or city level, involving both improvement of physical infrastructure and other methods to encourage active travel;
- new or improved local routes or networks;
- schools based programmes
- workplace programmes
- inter-personal initiatives to encourage behaviour change and transport mode shift to active travel;
- initiatives to market existing or new active travel routes.

The majority of studies covering each of these types of intervention showed a positive impact on levels of active travel.

The comparative effectiveness of individual types of intervention cannot be equated solely with the comparative volume of its review evidence. Volume is a function of the popularity of the different type of intervention and its ease of evaluation. For example, the single largest group of studies examined school-based interventions. This type of intervention is both popular because it is comparatively simple to implement and also easier to evaluate with readily available pupil participants in a school setting. It is therefore important to assess both the volume and strength of evidence for each intervention type.

The evidence of the positive impact was strongest for town or city-wide interventions

The review found the evidence for positive impact was greatest for town and city-wide interventions. All the peer reviewed studies addressing whole town or city-wide interventions showed that these interventions increased levels of cycling compared to controls. Two peer reviewed studies addressed walking and cycling interventions and reported increases in both. For example, levels of cycling increased between 26-30% in terms of cycle trips per head across the three towns that took part in the English Sustainable Travel Towns programme.

The evidence shows that city and town wide programmes were able to demonstrate change at the population level (i.e. using population-based surveys) rather than only among isolated target audiences. This is a significant success as a key element of a public health approach to population health is to stimulate positive health changes at the population level, rather than interventions targeted only at small population sub-groups [37].

It is very challenging to isolate the factors that contributed to the success of these city or town-wide programmes. It seems likely that a very important factor was the scale of investment: these programmes were funded at a level that enabled significant changes to be made to the physical (and perhaps social) environment for walking and cycling. This in turn enabled the potential synergistic effect of a wide range of interventions encouraging and supporting active travel together across a city or town. This might also combine with the 'network effect': the effect of the availability of a network of routes rather than just isolated corridors, such as a road from a suburb to the city centre. The phrase 'whole system' was not popular at the time many of these projects were funded, but it does sum up well how these interventions worked across the whole system, combining infrastructural and social marketing approaches, with efforts being made to coordinate actions from a wide variety of agencies.

There was also evidence for the positive impact of other types of intervention

The review also found evidence for the positive impact of walking and cycling interventions that were not town or city-wide. Building or improving individual routes or networks – including along single corridors, or more integrated pedestrian and cycle improvements – were reported to increase walking or cycling in most cases, and people living within 500 metres of routes were more likely to use them in most cases.

There is also strong evidence of the impact of interventions supported by individual institutions, such as those to promote walking (and to a lesser extent, cycling) to schools. As such interventions have the potential to develop active travel habits that may be continued into adult life, this seems a potentially important area for investment. A wide range of approaches have been shown to be effective, including new infrastructure; walking buses, crossings, bicycle parking; education; cycle training; pavements; and motivational programmes. However, it seems likely that local circumstances might dictate the approaches that are likely to be most appropriate for any one school.

The evidence for the effectiveness of individualized marketing was also strong, demonstrating that once people have stated their desire to change travel behaviour, they

can be encouraged to change through the provision of relatively simple information. This was frequently carried out face-to-face and with information specifically tailored to the individual.

Walking is the physical activity which has greater prevalence among the population compared to cycling, which remains a minority activity. But taken as a whole there was less evidence on the impact of interventions on walking compared to cycling. This is likely to be due to two main factors. Firstly, cycling interventions are more easily identifiable than walking interventions that are often part of broader changes to the public realm. And secondly, cycling is more easily measured than walking.

The evidence of the positive impact of workplace interventions was more equivocal

The evidence for the effectiveness of workplace-based interventions was slightly more equivocal, with two out of four evaluations showing some positive changes in cycling or walking, but one of these coming from the strongest research design – a randomized controlled trial. The two successful interventions focused directly on promoting walking and cycling to work, whereas the unsuccessful ones measured the impacts of car share and telecommuting campaigns. It is also worth considering that there are likely to be many evaluations of workplace interventions that have been conducted, but as they did not use control groups they were not included in this review.

Gaps in the evidence

The review deliberately only included those studies with some form of control or comparison group to increase the confidence that the changes reported are due to the intervention itself and not some confounding factor. This ensures any conclusions are based on robust evidence.

However, the use of controlled evaluation designs is not generally common in the transport sector (compared to public health) and so this inevitably leads to the exclusion of a large body of literature. This includes for example studies of innovative or new approaches that have not been established long enough to justify the additional investment in a controlled evaluation design. This meant that for example evidence on the effectiveness of financial incentive schemes (such as bike to work programmes) was not covered.

Another significant limitation of the evidence covered by the review was the lack of detail on the nature of the interventions covered including their context and implementation process as well as other factors that might provide insights into the relative effectiveness of different types of intervention or the different factors that account for the relative effectiveness of different implementations of the same intervention type.

Lower socio-economic groups and active travel

It is important to reflect on the evidence for the effectiveness of interventions to increase active travel among low socio-economic groups. The literature is relatively limited compared to most other areas focusing on active travel, implying a need for further

research in this area. This does not necessarily mean specific new studies, but in many cases analysing the data using socio-economic status as a variable, and reporting levels of active travel by socio-economic status. In many studies it appears likely that this information is collected, but not used in the final analysis.

We set out below some of the key gaps in robust evidence on aspects of effectiveness as a result of these limitations:

Settings

The studies covered by the review almost exclusively cover interventions in urban areas. This is not surprising given the vast majority of active travel interventions are aimed at urban areas. This may be where there is most scope to have impact in increasing levels of active travel. However, there is almost no evidence addressing rural areas and how to increase active travel in low density settlements. Despite the high levels of urbanisation in England there is still a need to consider how active travel can play an increased role in total physical activity time among the significant minority of the population living outside of urban areas.

At the general level, evidence does show the critical influence of distance on modal choice [38]. A key aspect of promoting active travel will be ensuring that facilities are available within walkable distance. This combines with travel culture to influence active travel patterns. The suburbs created in the last 30 or 40 years exhibit high levels of car dependence and low levels of active travel, while some of the older or more mixed-age neighbourhoods are less car dependent and have high levels of active travel.

Funding, packaging and sequencing

Given that funding may allow for a mix of behaviour change interventions and infrastructure there will be a significant time-lag for infrastructure to be selected, designed and built. In the meanwhile, local authorities are left with the need to implement shorter-term behaviour change programmes without the benefit of infrastructure unless significant programmes of infrastructure programmes have been implemented in the past. This has been a major advantage for continental European countries such as The Netherlands, Germany, and Scandinavian countries where each new intervention largely adds to existing portfolio of infrastructure programmes.

The inter-relationship between behaviour change interventions and infrastructure remains an important question both because the balance of investment between the two may be optimised in terms of percentage share of spend on each and the ‘added value’ of multiple interventions working together to generate a network effect of interventions which increases active travel use.

Most of the interventions lasted no more than 12 months and often less. This creates a challenge in terms of confidence that changes can be sustained in the long-term. In general, behaviour change interventions often lead to a declining effect over time, as people revert to old behaviours, in the absence of additional interventions. However, there are likely to be far greater rates of decay for purely behaviour change interventions than infrastructure

interventions which provide longer-lasting support to behaviour change. Commissioners of interventions and evaluations should consider longer-term programmes, together with follow-up periods of at least 3 years to better understand intervention effectiveness.

Beneficiaries

The study designs covered by the review did not allow for the provision of evidence on the nature of the beneficiaries of increased active travel.

We do not know whether the increased levels of active travel benefited a wide population or rather benefited those already active who simply increased their total physical activity time through active travel. Latent class analysis and other techniques addressing active travel may be able to identify clustering of health behaviours among pre-existing healthier groups or whether increases in active travel by intervention types are dispersed more evenly across populations. However, there is good evidence that increases in active travel lead to increases in physical activity overall [13 15].

The lack of robust detailed evidence in this area also covers the take-up of active travel across various sub-groups within the population. There remains little evidence on the take up of walking and cycling among ethnic minorities. We understand that similar recently commissioned studies addressing active travel have also reported a lack of robust evidence and/or a lack of research focus addressing the travel behaviours of various population sub-groups including the disabled and low socio-economic groups.

Value for Money

The studies reviewed included very little reference to value for money or cost-effectiveness. Whilst the evaluations covered the outputs and outcomes achieved as a result of an intervention, there was little consideration of their overall cost, the cost benefit ratio or the cost per output. Few of the evaluations benchmarked the effectiveness of different intervention types which might have included the relative costs or relative cost-benefit ratios. Cost-effectiveness is an important consideration within local authorities where funding outside of specifically funded programmes is limited. The evaluations of both the Sustainable Travel Towns and the Local Sustainable Transport Fund (LSTF) had Benefit-to-Cost ratio (BCR) calculations undertaken. For the Sustainable Travel Towns this was 4.5:1. For the LSTF projects, at the programme level (i.e. including all costs and benefits for all 11 Large Projects apart from Telford), the best mid-point estimate BCR is 5.2-6.1. At the programme level, the analysis carried out for the initial Cycle Demonstration Towns noted that the investment in the programme provided good value for money at 2:59:1.

8. RECOMMENDATIONS

For investing in effective active travel interventions

1. Given the evidence that whole town or city-wide programmes, delivered at scale, appear to provide the most effective intervention to increase active travel at a population scale, priority should be given to this type of 'whole system' intervention.

2. However, investment should not be confined to whole town or city-wide programmes. Investment should also be considered in other approaches that have been shown to be effective, including building and connecting active travel networks; implementing school-based active travel interventions; social and individualised marketing programmes; and programmes in workplaces.

3. The evidence from the UK literature shows that active travel intervention funding has been dominated by short-term stop-start projects rather than consistent long-term funding. Active travel would benefit from a continuous 'bottom line' in spending for sustainable transport interventions at levels which enable both infrastructure and behaviour change programme to run with certainty of future continued funding for those interventions evaluated and known to be effective.

4. It is clear from the report that active travel interventions have great potential to increase population levels of physical activity. Local agencies should therefore be encouraged to promote active transport as part of their efforts to increase physical activity. It is difficult to discern from the evidence presented, but almost without exception the most effective interventions have been delivered by local authorities (public health, sport and leisure, and transport departments, sometimes working in partnership) and other similar bodies. Sports bodies, such as County Sports Partnerships, may also be integral to effective local delivery partnerships.

5. Many of the most effective interventions come from funding streams from central government. Although it is not a derivative of the evidence reviewed in this study, it may be that 'central' support aids impact. Further, the fact that cycling and walking deliver such a wide range of co-benefits, addressing many of the pressing environmental, health and congestion and other economic challenges, suggest that wide-ranging cross-departmental support may be appropriate.

For improving knowledge on the effectiveness of different approaches

6. Active travel funding should require that interventions are robustly evaluated. Evaluation specifications should wherever possible require:

    a. the inclusion of counterfactual evidence using control groups
    b. the provision of impact data for at least 3 years following the intervention
    c. the provision of demographic and physical activity profiles for the beneficiaries
    d. the provision of economic evaluation and value for money assessment

7. Future funded research programmes should develop and implement evaluation approaches to better understand:

    a. the degree of synergetic or added value which may result from whole town or city-wide interventions and the most effective means of achieving those synergies
    b. the relative cost benefit ratios and the overall value for money of different approaches and interventions types
    c. the best ways of achieving increased active travel amongst those most likely to benefit, and amongst less active or hard to reach groups such as lower socio-economic groups, older people, disabled people, ethnic minorities and women
    d. the full public health impact of active travel interventions through longitudinal studies examining whether a shift towards active travel is associated with an increase in physical activity.

Appendix 1: SYNTHESIS OF REVIEW RESULTS BY INTERVENTION TYPE

- = negative impact; 0 = no or uncertain impact; += positive impact

	Synthesis of results from the peer-reviewed and grey literature	Cycling - 0 +	Walking - 0 +
CITY AND TOWN-WIDE ENVIRONMENTAL INTERVENTIONS			
Peer-reviewed literature			
1	A study of 12 town-wide interventions in the UK [2] found cycling to work in the intervention towns increased by 0.69 percentage points with larger differences in differences compared with the unfunded comparison group (1.02 percentage points) and the national comparator (1.23 percentage points). "Although seemingly small in effect, the size of the sample population in the 12 towns (1 266 337 in the 2011 census) indicates that the absolute percentage change in cycle commuting (0.97%) may have a large public health significance."	+	
2	Sloman et al [39] evaluated the activities in the UK's Cycling Demonstration Town programme, including media campaigns, personalized travel planning, cycle repair and cycle training services, and improvements to cycle infrastructure. They found an increase in cycling ≥30 mins once a month or more of 2.7% compared to control areas.	+	
3	A study of environmental interventions in three UK cities/towns [40], found at the 2-year follow-up, 18% of people who knew about the project reported transport cycling compared with 7% of the full sample.	+	
4	Wilmink and Hartman [10] evaluated the extension and improvement of the cycle network in the Netherlands and compared to a control area of the city. They found a 2 percentage point increase in the proportion of trips made by bike, and an increase in frequency and distance cycled per person.	+	
5	Troelsen et al [41 42] evaluated the multi-faceted activities in Odense, named as Denmark's cycling city, and compared to comparison control areas. They found a 3.4 percentage point increase in the proportion of trips made by bike, and an increase in frequency and distance cycled per person.	+	
6	Norwood et al 2014 [43] aimed to evaluate the Smarter Choices, Smarter Places programme in Scotland, intended to encourage uptake of walking, cycling and the use of public transport. The results suggest that the initiative impacted positively on the likelihood of physical activity participation and meeting the recommended physical activity guidelines. Individuals in the intervention areas were on average 6% more likely to meet the physical activity guidelines compared to individuals in the non-intervention areas.	+	+
7	Keall et al 2015 **[44]** aimed to analyse the changes in walking and cycling in two New Zealand cities that accompanied public investment in infrastructure married with programmes to encourage active travel. Relative to the control cities, the odds of trips being by active modes (walking or cycling) increased by 37% (95% CI 8% to 73%) in the intervention cities between baseline and postintervention. The net proportion of trips made by active modes increased by about 30%.	+	+
Grey literature			
8	Sloman, L. et al 2017 [7]. Part of a study of 8 town/city-wide interventions in England funded through the Cycle City Ambition Fund. In Birmingham the focus was on the upgrading of the canal tow-path network. A maximum of 48 Automatic Cycle Counters (ACCs) have enabled examination of indexed change in cycling volumes at the city-wide level within the Birmingham City metropolitan district limits. Between 2010 and 2016, city-wide volumes of cycling increased steadily year-on-year with an indexed increase of 32% between the baseline year of 2012 and 2016. The effect on cycling volumes is being monitored by eight comparison ACCs. Between 2012 and 2016, indexed cycling volume increased on the canal towpaths by 128%, whereas cycling volumes for a comparison group of six ACCs increased by 24%, giving a difference-in-difference increase of +104%. In all cases, the timing of increases in cycling on the canal towpaths coincides with the timing of completion of CCA infrastructure works. Limited post intervention evaluation period. Active People Survey also used for control.	+	
9	Sloman, L. et al 2017 [7]. Part of a study of 8 town/city-wide interventions in England funded through the Cycle City Ambition Fund. A group of ten Automatic Cycle Counters (ACCs) in Norwich form the basis for a city-wide analysis of levels of cycling. ACCs suggest that cycling is increasing in Norwich over time, with an increase of 46% between 2012 and 2016. Specific highway route infrastructure interventions. Active People Survey also used for control.	+	
10	Sloman, L. et al 2017 [7]. Part of a study of 8 town/city-wide interventions in England funded through the Cycle City Ambition Fund. A group of six Automatic Cycle Counters (ACCs) counters located in Oxford form the basis of a 'city-wide' analysis of levels of cycling. These ACCs suggest that cycling is increasing in Oxford over time, with an increase of 13% between the baseline year of 2012 and 2016. Specific highway route infrastructure interventions. Active People Survey also used for control.	0	
11	Sloman, L. et al 2017 [7]. Part of a study of 8 town/city-wide interventions in England funded through the Cycle City Ambition Fund. Data from 17 Automatic Cycle Counters (ACCs) has been made available for the purpose of analysis for Bristol. Continuity of ACC data between 2010 and 2016, from which change in cycling volumes can be calculated, varies considerably. Specific highway route infrastructure interventions. In 2010 and 2011, 13 ACCs have suitable data. During 2012 only six ACCs collected usable data. Although 14	0	

	ACCs have sufficient data for 2015, there is a large gap in data availability for 2013 and 2014, meaning no conclusions regarding cycling volume in Bristol can be drawn from this time period. Active People Survey also used for control.		
12	Sloman, L. et al 2017 [7]. Part of a study of 8 town/city-wide interventions in England funded through the Cycle City Ambition Fund. A group of eight Automatic Cycle Counters (ACCs) located in the Leeds City metropolitan district form the basis of our citywide analysis of levels of cycling. These ACCs suggest that cycling may be increasing over time. This trend is mostly driven by a single ACC on a canal towpath, and if this counter is excluded, the trend from 2014-2016 is essentially flat. However, manual count data on a city centre cordon is suggestive of a rising trend in cycling volumes. Active People Survey also used for control.	**0**	
13	Cavill, N. et al 2009 [45]. Cycling Demonstration Towns (CDTs) 2006-09. A comprehensive town-wide approach to promoting cycling. it included secondary analysis of the Active People Survey (2005/6 and 2007/8); and ICM surveys commissioned by Cycling England conducted in the CDTs in 2006 and 2009. The proportion of respondents cycling once a month in local authorities with a CDT increased by 3.3% between 2006 and 2008. In all the towns combined, there was a significant increase in the proportion of people doing any cycling in the last year (from 24.3% in 2006 to 27.7% in 2009).	**+**	
14	Sloman et al 2009 [3]. Cycling Demonstration Towns (CDTs) 2006-09. A comprehensive town-wide approach to promoting cycling. Using data from automatic cycle counters, the interim result for the mean increase in cycling levels across all six towns was 27%, relative to a 2005 baseline (before the beginning of the investment programme) and including data up until March 2009**.** Active People Survey data enabled comparison of numbers of occasional and regular cyclists between local authorities with Cycling Demonstration Towns and other local authority areas; and second, data on cycle trip stages and trip distances in medium sized towns, from the National Travel Survey. Note that likely that the Active People Survey underestimates levels of change.	**+**	
15	Sloman et al, 2018 [17]. 7 Large Projects that had implemented many cycling interventions showed some indications of increases in cycling since the start of the LSTF programme, measured either by automatic counts or manual cordon counts. Also use of Active People Survey. Among participants in Active People Survey, proportion of adults who had cycled in past month increased slightly in Large Projects between 2010-12 and 2013-15 (from 14.1% to 14.5%, p=0.04 for difference i.e. a 96% chance the difference was 'real' and not simply a result of random variability). By contrast, proportion of cyclists in national comparator group decreased from 16.0% to 15.4%, meaning that the change in the Large Projects was more favourable than the background national trend.	**+**	
16	Sloman et al, 2018 [17]. Information from Outcomes Reports reported in Interim Meta-analysis in 2015 and Final Meta-analysis in 2017 assessing the impact of the Local Sustainable Transport Fund in 12 large projects. Projects delivered many interventions intended to increase walking, and 4 delivered some interventions. A few Large Projects made significant public realm improvements. Modal share in six Large Projects showed mixed evidence. Using a three-year rolling average, three Large Projects showed an increase in walking between 2009-11 and the most recent period (either 2013-15 or 2014-16), while three showed a decrease.		**0**
17	Sloman, L. et al, 2017 [17]. Meta-analysis of outcomes of investment in the 12 Local Sustainable Transport Fund. Whole town and individual focused interventions compared to national trends. There was no evidence that the amount of cycling done by cyclists (number of days cycled in the past month) changed in the Large Projects over the funded period. The limited data on changes in overall levels of walking which can be attributed to LSTF interventions do not point to a clear conclusion.	**0**	**0**
18	Cairns, S., Jones, M., 2016 [46]. Evaluation of the Sustainable travel towns programme - Peterborough, Darlington, Worcester (& Redditch). Whole town and individual focused interventions compared to national trends. Cycling increases achieved by the end of the STT period – estimated as being a 26-30% increase in cycle trips per head across the three towns taken together - were broadly sustained. Walking also increased substantially (by least 18%), albeit that the relative increase over time was less dramatic. Data from the 2010 household survey suggested that the higher walking levels may have been maintained, with the number of walk trips per person per year increasing from 255 in 2004, to 284 in 2008 and 287 in 2010, an overall increase of 13%.	**+**	**+**
19	Sloman L, Cope A, Kennedy A, Crawford F, Cavill N and Parkin J. 2017 [47] The focus of the programme was on encouraging more cycling for short 'everyday' urban trips – that is, those trips which when made by car contribute disproportionately to congestion. Cycling trips increased across both programmes overall, and also individually in all 18 towns and cities, by different amounts. From automatic count data, there was an overall increase of 29% for the six CDTs in 5.5 years (range across towns: 6% - 59%); and an overall increase of 24% for the 12 CCTs over three years (range across towns: 9% - 62%).	**+**	
BUILDING OR IMPROVE LOCAL ROUTES OR NETWORKS			
Peer-reviewed literature			
20	Titze et al [48] found that people who agreed that there were bicycle "tracks" along their route and possible shortcuts were about twice as likely to bicycle as those who did not	**+**	
21	Krizek et al [49] found that people living within 400 meters of a bike lane were more likely to bicycle than those living further away.	**+**	
22	Clark et al evaluated a trail intervention in Nevada. USA [61]. This included 6 community trails which included a marketing campaign promoting trail use and the addition of way-finding and incremental distance signage to selected trails. They reported Increases in mean users per hour were found for both the intervention and control trails (increased by 31%, $p < 0.01$ and 35%, $p < 0.01$, respectively). Increases did not vary between the treatment groups ($Z = 0.9892$, $p = 0.32$).	**0**	**0**

23	Veitch [50] evaluated park improvements in Melbourne Australia. The intervention involved the establishment of a fenced leash-free area for dogs, an all-abilities playground, a 365 m walking track, a barbecue area, landscaping, and fencing to prevent motor vehicle access to the park. They found a significant difference in change in number of people observed walking (increased from 155 to 369 in intervention park and decreased from 75 to 51 in control park, F = 11.70, p < 0.0005).		**+**
24	West [51] evaluated 1.93 miles of greenway developed and added to an existing greenway in North Carolina USA. They found no significant differences between the experimental and control groups for any outcome variables including walking (all p > 0.975).		**0**
25	Pazin et al. [52] evaluated a new avenue, parking lots, and an on-road walking and cycling route (2.3 km long) along the seashore. They found a general increase of walking and a higher weekly volume of walking at follow-up among residents up to 500m from the new route compared to those living further away.		**+**
26	Parker et al [53] evaluated a A 1-mile bike lane which was striped on both sides of the road and 5ft (1.52 m) wide in New Orleans USA. They found the number of cyclists increased on intervention streets but decreased on adjacent side streets.	**+**	
27	Dill [53] evaluated Bicycle boulevard installation in eight street segments (0.9–4.2 miles long) in Portland. Oregon. They found A significant decrease in number of minutes biked was observed in the intervention neighbourhood (where biking occurred for at least 10 min.)	**-**	
28	Fitzhugh [54] evaluated the retrofitting of a neighbourhood with an 8-ft-wide and 2.9-mile-long asphalt urban greenway/trail to connect the pedestrian infrastructure with nearby retail establishments and schools. They found Changes in neighbourhood level walking (p < 0.001) and cycling (p = 0.038) were greater in the experimental neighbourhood than the control neighbourhood. There was no difference over time for the experimental neighbourhood for active transport to school, or for the difference in change in active transport to school between the experimental and control neighbourhoods (p = 0.2061).	**+**	**+**
29	Gustat [54] evaluated path and playground interventions in New Orleans USA. They reported no difference in walking for transportation or leisure between control and intervention		**0**
30	Lott [55] evaluated the installation of bicycle lanes on both sides of a street in California. Control streets had existing bicycle lanes, but no description of these provided. Significant increases in cyclists were observed in the intervention street compared with the control street, for adults aged 25 years and older only (x2 = 3.20, p = 0.08).	**+**	
31	Repeated cross sectional household studies in Delft (Netherlands) evaluated the effects of improving and extending cycle route networks. Households in the intervention suburb reported a 3% increase after three years in the share of all trips made by bike, with no change in the shares for walking or car use; in the control area, the frequency of car trips increased and the frequency of bike trips did not change. [56]	**+**	
32	Panter et al [57] reported the impact of a new guided bus service and new walking and cycle routes on the residents from the environs of Cambridge, UK. They reported a non-significant increase in mean walking for commuting for residents who increased walking (mean 73.4 (SD 66.6), RR 0.90 (0.69 to 1.19)) with a graded exposure to busway.		**0**
33	Rissel et al. [58] evaluated A new 2.4 km bi-directional separated bicycle path in inner Sydney. They found the number of cyclists increased with 23% and 97% at two points at the trail, compared to 3% in the whole city at follow-up. Weekly frequency of cycling did not change over time at follow-up I. Participants in the intervention group reported a higher frequency of cycling compared with the control group, at follow-up II.	**+**	
34	Brown et al 2016 [14] aimed to investigate whether complete streets increase active transport. Near-Time 2 residents were more likely to engage in complete street transit walking trips (35%, adjusted) and non-transit walking trips (50%) than the other 3 groups (24% to 25% and 13% to 36%, respectively). Bicycling was less prevalent, with only 1 of 3 contrasts significant (10% of Near-Time 2 residents had complete street bicycle trips compared with 5% of Far-Time 1 residents). Living near the complete street intervention supported more pedestrian use and possibly bicycling, suggesting complete streets are also public health interventions	**0**	**+**
35	Aldred et al [16] evaluated the impacts of the still in progress 'mini-Hollands programme', which seeks to transform local environments for walking and cycling, in three Outer London boroughs. They found those in high-dose areas were 24% more likely to have done any past-week cycling at follow-up, compared to those living in non mini-Holland areas (95% CI, 2% to 52%). The mid-point estimate for increase in active travel (walking plus cycling) time for the same group was an additional 41.0 min (95% CI 7.0, 75.0 min	**+**	**+**
	SOCIAL MARKETING (INCLUDING MARKETING OF INFRASTRUCTURE)		
36	Rissel et al [6] used a controlled cohort design to evaluate the social marketing of cycle infrastructure based on the transtheoretical model of behaviour change. They found an increase in use of cycle paths (+5%) and number of bicycles counted (+7.9%) but they noted a decrease in prevalence of cycling in the past year (-0.5%).	**+**	
37	In Maidstone (England), a controlled repeated cross-sectional study of households on trunk route corridors showed that two years after a publicity campaign on sustainable transport, the only significant change was a decrease in cycling trips in the intervention area (P < 0.05) [59].	**-**	
38	Merom et al 2003 [12] aimed to assess the impact of a local promotional campaign around a newly constructed Rail Trail. Trail usage was higher among bike-owners than pedestrians (8.9 vs 3.3%, P = 0.014) and was moderated by proximity to the Trail. Inner cyclists increased mean cycling time by 0.19 h (SD = 1.5) while outer cyclists decreased cycling time (-0.24 h, SD = 1.6). Mean daily bike counts in the monitored areas increased significantly after the Trail launch (OR = 1.35, P = 0.0001, and OR = 1.23, P = 0.0004).	**+**	
	WORKPLACE AND OTHER INSTITUTIONS		
39	A RCT of Workplace; self-help pack including maps, activity diary, safety accessories [1] found no effect on commuter cycling but doubled rates of walking to work, increasing walking by an average of 64 minutes per week	**0**	**+**

40	Dubuy et al 2013 [9] aimed to evaluate the dissemination efforts of a bike to work programme. Employees aware of the program had a significantly more positive attitude towards cycling and reported significantly more commuter cycling than those unaware of the program (both $p < 0.001$). Participation was mainly because of health and environmental considerations.	+	
41	A controlled repeated cross sectional study of the City CarShare club in San Francisco (USA) found the share of journeys made by car increased by a greater proportion than the combined walking and cycling mode share did (17.0% and 3.7%, respectively) [60]	0	0
42	A controlled retrospective study of commuters registered with neighbourhood telecommuting centres in California (USA) found a negative shift of 0.2% on telecommuting days compared with normal commuting days, with a 24% decrease in reported distance travelled on foot or by bike. [61]	-	-
	INTERPERSONAL INTERVENTIONS		
	Peer-reviewed literature		
43	Yang et al's review [5] describes results from **sixteen separate evaluations** of individualized marketing campaigns run and evaluated by the same social marketing agency. These are based around individualised marketing (IndiMark): provision of tailored information, advice, and incentives to encourage change in travel behaviour in interested households. In these studies, individualised marketing was associated with modest but generally consistent net increases in cycling trip frequency (range from 0 to +21 trips per person per year; median +8).	+	
44	Ogilvie et al [11] describes results from **thirteen separate studies** of individualized marketing campaigns run and evaluated by the same social marketing agency. These are based around individualised marketing (IndiMark): provision of tailored information, advice, and incentives to encourage change in travel behaviour in interested households. These studies consistently reported a net increase in the proportion of trips made on foot (usually measured in the local population as a whole) and an increase in time spent walking in those studies that reported this outcome.		+
45	RCT of support programme (awareness raising, countering and helping relationships) among obese women in Sweden [62] found mean proportion of intervention group participants (n=60) commuting with a bicycle at least once a week during months 2– 18 was 29.4% compared with 8% in the control group.	+	
46	Bernstein et al 2017 [5] aimed to test the efficacy of a bicycling intervention targeting inactive, low-income, overweight adults on reducing perceived barriers to bicycling, increasing physical activity, and improving health. Barriers to bicycling declined significantly among intervention group participants at 12 weeks with some declines persisting to 20 weeks. Bicycling for leisure or non-work transportation increased significantly more in the intervention than control group from baseline to 12 weeks but this difference attenuated by 20 weeks	+	
47	Diniz 2015 [63] aimed to assess the effectiveness of an educational intervention on active commuting by bicycle. The proportion of participants that used bicycles to commute to work (IG) increased significantly from baseline (45.3%) to the final interventional period (47.5%). No difference was found between the CG and the IG group after the interventional period	0	
	Grey literature		
48	SocialData/Sustrans, 2013 [64] . Two residential areas of a small city (St. Albans). Random selection from 12,000 households. Personalised TravelSmart packages were hand-delivered to participating households after conversations with a TravelSmart trained presentative about their lifestyle. Growth in trips by most sustainable and active travel modes, with relative increases in walking (6%), cycling (36%) and public transport trips (31%). Control area.	+	+
49	SocialData/Sustrans, 2014 [65]. Separate samples were drawn from the ITM target population of 18,000, randomly allocated across the town, and from the Harpenden control group. Increases in walking (4%) and public transport use (12%). No changes in cycling levels. The project also resulted in a 16% relative increase in average daily exposure to physically active forms of travel.	0	+
	SCHOOLS		
	Peer-reviewed literature		
50	Groesz [66] used a RCT design to evaluate a Safe Routes to School programme including educational and motivational activities by teachers. This found no significant difference in the mean number of days cycled to school after 5 months	0	
51	MacDonald 2013 [67] evaluated a US Safe routes to School program with education, environmental changes (sidewalks, crossings, covered bike parking) Using a controlled before and after study. The approach used education only and education plus environmental changes compared with comparison schools and reported positive increases in the proportion of children reporting walking trips to school of between 5% (education only) and 20% (education plus environmental changes) per school.		+
52	Hoelscher et al. 2016 [68] evaluated Safe Routes to School, a comprehensive, federally-funded programme in the USA. They reported that Infrastructure and non-infrastructure schools had significantly higher rates of AST in the morning ($p = 0.024$ and 0.013 respectively) and non-infrastructure schools had significantly higher overall AST relative to control schools ($p = 0.036$). However, differences between groups attenuated over time.	+	+

53	McDonald et al. 2013 [68] evaluated Safe Routes to School, a comprehensive, federally-funded program in the US designed to increase AST through non-infrastructure and infrastructure strategies in Oregon, USA. They found Education + encouragement were associated with increases in walking and biking by 2 and 5 percentage points respectively. Augmenting education programs with engineering improvements and was associated with increases in walking and biking of 5-20 percentage points.	+	+
54	McDonald et al. 2014 [67] conducted a separate evaluation of the same programme as above in Florida, Oregon, Texas, and District of Columbia, USA. They found that relative to control schools, each year of participation in SRTS was =associated with a 1.1% increase in AST (p = 0.002; d = 0.019). Engineering improvements led to a 3.3 percentage point increase in walking and biking (p = 0.031; d = 0.12), while education + encouragement interventions led to a 0.9 percentage point increase per year (p = 0.025; d = 0.15).	+	+
55	Boarnet et el [69] [70]evaluated SRTS projects in cities in California. There was a greater increase in walking among those who passed the SRTS project (P < 0.01) after sidewalk improvements and traffic control projects (primarily traffic signals). Children who passed completed SRTS projects were more likely to show increases in walking or bicycling to school than were children who would not pass by projects (15% vs. 4%; P < 0.01).	+	+
56	Jordan et al [71] evaluated The Gold Medal Schools program which aims to establish policy and environmental supports for students and staff. SRTS interventions included Walk your Child to School Day. They found children at experimental schools walked or biked to school more often than control children (P < 0.001), both at pre and post-test. While children in both conditions increased the days per week they walked or biked to school between pre- and post-test, the change was only significant at control schools (P < 0.001).	0	0
57	Heelan et al[72] used a quasi-experimental design to evaluate a walking school bus (WSB) in 2 intervention schools and one control school in Nebraska. They found that the intervention had a positive impact: 36.2% of children from WSB schools actively commuted at least 50%of the time compared with 26.2% of control school. Also, frequent walkers across all schools did 25% more physical activity and gained 58% less body fat compared with passive commuters.		+
58	Mendoza et al [73] used a controlled, quasi-experimental trial with cross-sectional assessments. There was 1 intervention school with a WSB program with parent volunteers and a part-time coordinator and 2 control schools. They found significantly higher proportions of students walked to school at the intervention school than control schools by 1month into the intervention and remained so by 6- and 12-month follow-up.		+
59	Mendoza et al [74] conducted a cluster RCT of waking school buses among 4 intervention and 4 control schools. They found Intervention schools increased active commuting (AT) from time 1 to time 2, whereas control schools decreased AT. Intervention children increased the daily MVPA from 46 to 48 minutes, whereas control children decreased MVPA from 46 to 41 minutes. The WSB children achieved 7minutes/day more MVPA than control children.		+
60	Sirad et al [75] used a RCT design to evaluate a small pilot study of walking school buses aimed at car commuters. They found Intervention children significantly increased their physical activity and percentage of MVPA before school compared to control school children. This difference was even greater during general commute time (45minutes before school) where there was no change for controls but intervention children added an average of 14minutes of MVPA.		+
61	Sayers et al. 2012 [76] evaluated the Walking School Bus, which aimed to increase AST by having children walking in adult-supervised groups in Columbia, USA. They found the percentage of time spent in MVPA did not differ between WSB participants and controls (all $p \geq 0.17$). d = −0.32. The age-related gradient in MVPA was attenuated in WSB participants.		0
62	Mendoza et al. 2011 [74] evaluated the Walking School Bus, which aimed to increase AST by having children walking in adult-supervised groups in Texas, USA. They found intervention children increased their weekly percent AST from 23.8% ± 9.2% at baseline to 54.0% ± 9.2% at follow-up, whereas control children decreased their weekly percent AST from 40.2% ± 8.9% to 32.6% ± 8.9% (p < .0001; d = 0.40).		+
63	McMinn et al [77] conducted a controlled trial to evaluate a school-based active travel project delivered through teacher handbooks and pupil packs. They found step count increased in the intervention compared to control group		+
64	Wen et al [78] conducted a cluster RCT in Australia of a multicomponent active travel to school promotion, including resources for students, schools and parents. They found walking to school increased in the intervention compared to control group		+
65	McKee [79] evaluated an active commuting pack in primary schools in Scotland and found an increase in walking of 69 minutes per week compared to the control school		+
66	Rowland [80] evaluated school travel initiatives delivered by a school travel coordinator in primary schools in England. The study found no significant differences		0
67	The TAPESTRY project in (Hertfordshire [81] evaluated the activities of Walk to school week in primary schools and found no impact on walking		0
68	Christiansen et al. 2014 [82] evaluated a comprehensive school-based intervention to improve non-curricular PA through changes of the physical and school environment supported by educational activities in Denmark. They reported that the prevalence of AST increased from 87.8% to 88.8% in the experimental group and from 84.3% to 85.3% in the control group with no difference between groups (p = 0.30; d = 0.13).	0	0
69	Coombes et al. 2016 [83] evaluated a technology-based intervention (Beat the Street) which aimed to increase AST via incentive-motivated approaches in the United Kingdom. They reported that at 7-week follow-up there was no difference in AST between groups. At 20-week follow-up there was a 10% increase in AST in the intervention group and 7% decrease in control group (p = 0.056)	+	+

70	Crawford & Garrard, 2013 [84] evaluated The Ride2School Program, which consisted mostly of promotional activities with some infrastructure changes in Victoria, Australia. They reported that AST increased significantly in the inner suburban pilot school and the outer suburban control school. Hands-up surveys show that AST increased in the inner suburban pilot school and no changes were found in the other schools	+	+
71	Gutierrez et al. 2014 [85] evaluated the implementation of crossing guards & AST awareness campaign in Miami, USA. They reported that the number of pedestrian and cyclists did not change following the addition of crossing guards ($p > 0.05$;$d = 0.03$).	0	0
72	McMinn et al. 2012 [77] evaluated Travelling Green, a 6-week school-based intervention aimed to increase AST via teacher lesson plans and student packs in Glasgow, Scotland. They reported that the intervention group had smaller decreases in mean steps (−47 vs. -205) and seconds of MVPA (−33 vs. -85) during the morning trip. There were contrasting results on the afternoon trip for steps (−222 vs. -120) and MVPA (−125 vs. -59). $d < 0.1$ for changes in steps and MVPA during the school trip.		+
73	Østergaard et al. 2015 [86] evaluated Safe and Secure Cycling to school, which aimed to increase cycling behaviors through a multicomponent cycling promotion programme in Denmark. They found the change in the number of cycling trips to/from school were not significant (B = 0.15 trips; 95% CI = −0.25; 0.54). d = 0.02.	0	
74	Villa-González et al. 2016 [87] evaluated an intervention that aimed to increase AST through changing children safety perceptions and attitudes in Spain. They found an increase in the frequency of active trips in intervention schools (0.6 ± 0.2) relative to control schools (−0.4 ± 0.3) [p = 0.019; d = 0.40]. When examining travel modes separately, significant changes were only observed for walking.		+
75	Xu et al. 2015 [88] evaluated a multicomponent lifestyle childhood obesity prevention program aimed to enhance lifestyle behaviors in China. They found participants in schools were more likely to change their travel mode to walking or cycling to school (OR = 2.24, 95% CI = 1.47-3.40; d = 0.45) relative to those in the control schools	+	+
76	Ducheyne et al. 2014 [89] evaluated cycling training, which aimed to increase cycling skills and encourage uptake of cycling in Belgium. They reported that changes in weekly time spent cycling did not differ between intervention and control group ($F = 1.9$; $p > 0.05$)	0	
77	Goodman et al. 2016 [85] evaluated Bikeability, a national cycle training programme for children and adults in the UK. They reported that children attending schools that had offered Bikeability were not more likely to cycle at least once a week (OR = 0.99; 95% CI = 0.89-1.10) and to cycle to school (OR = 0.73; 95% CI = 0.41-1.29). Children who received Bikeability training were more likely to cycle at least once a week (OR = 1.26; 95% CI = 1.16-1.37).	+	
78	Johnson et al. 2016 [90] evaluated Bikeability, a national cycle training program for children and adults in England. They reported that Students who received Bikeability were more likely to cycle to school (OR = 2.25; 95% CI = 1.83-3.52). d = 0.45. In one arm of the study they found Students who received Bikeability did not report more cycling in general while in another they found Students who received Bikeability were more likely to report cycling ≥30 min in the past week	+	
79	McKee et al [79] conducted a controlled trial to evaluate a school-based active travel project delivered through teacher handbooks and pupil packs. They found distance walked increased in the intervention compared to control group		+
80	Buckley et al. 2013 [91] evaluated an active school travel (AST) day in Idaho, USA. They found an increase in AST sustained at 2-week follow-up relative to the control school ($\chi2 = 11.6$; $p = 0.009$	+	+
81	Bungum et al. 2014 [82] evaluated an AST day in Las Vegas, USA. They found an increase in the mode share of AST by 7.4 percentage points on the day of the event. AST was then significantly higher than in the control school ($\chi2 = 27.2$; $p < .001$; $d = 0.29$). AST dropped to baseline rates at 1-week assessment	+	+
82	Bungum et al [82] evaluated a promotional 'Nevada Moves Day' comparing school travel with a control school. They found number of walkers increased in the intervention compared to control group		+
	Grey literature		
83	Healey, M., Gilmour. P. 2016. [92] Ride or Walk to School Program consisted of behavioural, riding skills, and educational interventions for Year 5 and 6 pupils in Canada. When compared to non-RWTS schools: Children attending a RWTS school were more likely to use active travel at least once a week. in RWTS-schools an average of 67% of students use active travel at least once a week, as compared to 44% in non-RWTS schools. Children attending a RWTS school were more likely to use active travel as their usual mode of travel4; 51% of RWTS school students used active travel as their usual mode of transport (5 or more trips a week to or from school), compared to 30% in non-RWTS schools. Incomplete data over time.	+	+
84	Sustrans, 2011 [4]. Intervention to promote walking to school in Year 5. As well as monitoring the impact of the project within the intervention school, surveys were conducted at a control school of similar size and location. Through intensive engagement with pupils over a twelve-week period, the FEAT 1st pilot achieved an active mode increase by 22.4 percentage points, from 53.6% before FEAT 1st to 76.0% at the end of the twelve-week intervention while the control remained at a stable level. Limitations as a 12 week intervention.		+

Appendix 2: SUMMARY OF FINDINGS OF REVIEWS AND PRIMARY STUDIES IN SCOPE

REVIEWS

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results
Author Stewart et al 2015[93] **Aim** To identify interventions that will increase commuter cycling.	**Quality score** 2 **External validity score** 2	**Country of study:** Global Setting: all settings **Location**: variety **Sample characteristics:** literature on Commuter cycling 12 studies from 6 countries (6 from the UK, 2 from Australia, 1 each from Sweden, Ireland, New Zealand and the USA) included. Controlled studies include: 2 RCTs 2 whole-city approaches with control groups (quasi-experimental)	**How allocated to intervention and control** Controlled and uncontrolled pre-post studies included **Characteristics of intervention: what was delivered to whom and how?** Interventions varied from interpersonal to environmental	**Outcome**: 'changes in commuter cycling' indicators, including frequency of cycling, change in workforce commuting mode, change in commuting population transport mode, use of infrastructure by defined populations and population modal shift **follow-up**: various **analysis**: various	**Results for all outcomes** RCT of Workplace; self-help pack including maps, activity diary, safety accessories [1]found no effect on commuter cycling RCT of support programme (awareness raising, countering and helping relationships) among obese women in Sweden [62] found mean proportion of intervention group participants (n=60) commuting with a bicycle at least once a week during months 2– 18 was 29.4% compared with 8% in the control group. A study of 12 town-wide interventions in the UK [2] found cycling to work in the intervention towns increased by 0.69 percentage points with larger differences in differences compared with the unfunded comparison group (1.02 percentage points) and the national comparator (1.23 percentage points). "*Although seemingly small in effect, the size of the sample population in the 12 towns (1 266 337 in the 2011 census) indicates that the absolute percentage change in cycle commuting (0.97%) may have a large public health significance."* A study of environmental interventions in three UK cities/towns [40], found at the 2-year follow-up, 18% of people who knew about the project reported transport cycling compared with 7% of the full sample.
Author Pucher et al, 2010 [94] **Aim** To assess existing research on the effects of various interventions on levels of bicycling. Interventions	**Quality score 1** **External validity score 1**	**Country of study** International **Setting** all settings **Location** global **Sample characteristics** All study types included including case studies 139 studies. Study methodologies varied considerably in type and	**How allocated to intervention and control** varied **Characteristics of intervention: what was delivered to whom and how?** All types including infrastructure programs and policies	**Outcomes** any measure of cycling **Follow-up periods** **Method of analysis including ITT** narrative	**Results for all outcomes** One Austrian study found that people who agreed that there were bicycle "tracks" along their route and possible shortcuts were about twice as likely to bicycle as those who did not [48] One study [49] found that people living within 400 meters of a bike lane were more likely to bicycle than those living further away.

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results
		quality, with few using any type of control			
Author, Year Yang et al 2010 [5] **Aim:** systematic review To determine what interventions are effective in promoting cycling	**Quality score 2** **External validity score 2**	**Country of study** UK (international literature) **Setting** all settings including city-wide promotions **Location** principally Europe and Australia **Sample characteristics** Review included controlled evaluations. 25 studies from seven countries were included, of which 21 included evaluations of active travel	**How allocated to intervention and control** All included studies were controlled before and after or RCTs **Characteristics of intervention: what was delivered to whom and how?** Various	**Outcomes** all cycling **Follow-up periods** various **Method of analysis including ITT** All controlled studies generally looking at increase in prevalence of cycling compared to control	**Results for all outcomes** Groesz [66] used a RCT design to evaluate a Safe Routes to School programme including educational and motivational activities by teachers. This found no significant difference in the mean number of days cycled to school after 5 months Wilmink and Hartman [10] evaluated the extension and improvement of the cycle network in the Netherlands and compared to a control area of the city. They found a 2 percentage point increase in the proportion of trips made by bike, and an increase in frequency and distance cycled per person. Troelsen et al [41 42] evaluated the multi-faceted activities in Odense, named as Denmark's cycling city, and compared to comparison control areas. They found a 3.4 percentage point increase in the proportion of trips made by bike, and an increase in frequency and distance cycled per person. Sloman et al [39] evaluated the activities in the UK's Cycling Demonstration Town programme, including media campaigns, personalized travel planning, cycle repair and cycle training services, and improvements to cycle infrastructure. They found an increase in cycling $\geq$ 30 mins once a month or more of 2.7% compared to control areas. Rissel et al [6] used a controlled cohort design to evaluate the social marketing of cycle infrastructure based on the transtheoretical model of behaviour change. They found an increase in use of cycle paths (+5%) and number of bicycles counted (+7.9%) but they noted a decrease in prevalence of cycling in the past year (-0.5%). Yang et al's review describes results from **sixteen separate evaluations** of individualized marketing campaigns run and evaluated by the same social marketing agency. These are based around individualised marketing (IndiMark): provision of tailored information, advice, and incentives to encourage change in travel behaviour in interested households. In these studies, individualised marketing was associated with modest but generally consistent net increases in cycling trip frequency (range from 0 to +21 trips per person per year; median +8).
Author, Year Ogilvie et al 2004	**Quality score 2**	**Country of study** UK, based on international literature	**How allocated to intervention and control**	**Outcomes** **Follow-up periods**	**Results for all outcomes**

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results
[95] Aim To assess what interventions are effective in promoting a population shift from using cars towards walking and cycling and to assess the health effects of such interventions	**External validity score 2**	**Setting** various **Location** various **Sample characteristics** 22 studies were included, of which 4 were controlled studies not included in other reviews	varied **Characteristics of intervention: what was delivered to whom and how?** Various	**Method of analysis including ITT**	This review contains many studies described above. Unique additional studies: In Maidstone (England), a controlled repeated cross sectional study of households on trunk route corridors showed that two years after a publicity campaign on sustainable transport, the only significant change was a decrease in cycling trips in the intervention area ($P < 0.05$) [59]. Repeated cross sectional household studies in Delft (Netherlands) evaluated the effects of improving and extending cycle route networks. Households in the intervention suburb reported a 3% increase after three years in the share of all trips made by bike, with no change in the shares for walking or car use; in the control area, the frequency of car trips increased and the frequency of bike trips did not change. [56] A controlled repeated cross sectional study of the City CarShare club in San Francisco (USA) found the share of journeys made by car increased by a greater proportion than the combined walking and cycling mode share did (17.0% and 3.7%, respectively) [60] A controlled retrospective study of commuters registered with neighbourhood telecommuting centres in California (USA) found a negative shift of 0.2% on telecommuting days compared with normal commuting days, with a 24% decrease in reported distance travelled on foot or by bike. [61]
Author, **Year** Smith et al 2015 [96] **Aim** to evaluate the impact of walking school buses on young people's travel to school	**Quality score 2** **External validity score 2**	**Country of study** USA **Setting** schools **Location** Community **Sample characteristics** 12 studies were identified of which 4 had some form of control group	**How allocated to intervention and control** varied **Characteristics of intervention: what was delivered to whom and how?** Walking school buses are organised group walks to school, organised by parents and volunteers.	**Outcomes** **Follow-up periods** **Method of analysis including ITT** Various	Results for all outcomes Heelan et al[72] used a quasi-experimental design to evaluate a walking school bus (WSB) in 2 intervention schools and one control school in Nebraska. They found that the intervention had a positive impact: 36.2%of children from WSB schools actively commuted at least 50%of the time compared with 26.2% of control school. Also, frequent walkers across all schools did 25% more physical activity and gained 58% less body fat compared with passive commuters. Mendoza et al [73] used a controlled, quasi-experimental trial with cross-sectional assessments. There was 1 intervention school with a WSB program with parent volunteers and a part-time coordinator and 2 control schools. They found significantly higher proportions of students walked to school at the intervention school than control schools by 1month into the intervention and remained so by 6- and 12-month follow-up. Mendoza et al [74] conducted a cluster RCT of waking school buses among 4 intervention and 4 control schools. They found Intervention schools increased active commuting (AT) from time 1 to time 2, whereas control schools decreased AT. Intervention children increased the daily MVPA from 46 to 48 minutes, whereas control children decreased MVPA from 46 to 41 minutes. The WSB children achieved 7minutes/day more MVPA than control children.

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results
					Sirad et al [75] used a RCT design to evaluate a small pilot study of walking school buses aimed at car commuters. They found Intervention children significantly increased their physical activity and percentage of MVPA before school compared to control school children. This difference was even greater during general commute time (45minutes before school) where there was no change for controls but intervention children added an average of 14minutes of MVPA.
Author, Year Carlin et al 2016 [97] **Aim** conduct a systematic review of interventions aimed at promoting increased levels of walking among children and adolescents	**Quality score 2** **External validity score 2**	**Country of study** Ireland (international evidence) **Setting** primary schools **Location** **Sample characteristics** 12 studies were included of which 4 met the inclusion criteria (excluded studies were either not school travel or had been covered above)	**How allocated to intervention and control** varied **Characteristics of intervention: what was delivered to whom and how?** Most interventions were educational/ promotional initiatives focused on walking to school	**Outcomes** **Various** **Follow-up periods** **Various** **Method of analysis including ITT** Various	**Results for all outcomes** McKee et al [79] conducted a controlled trial to evaluate a school-based active travel project delivered through teacher handbooks and pupil packs. They found distance walked increased in the intervention compared to control group McMinn et al [77] conducted a controlled trial to evaluate a school-based active travel project delivered through teacher handbooks and pupil packs. They found step count increased in the intervention compared to control group Bungum et al [82] evaluated a promotional 'Nevada Moves Day' comparing school travel with a control school. They found number of walkers increased in the intervention compared to control group Wen et al [78] conducted a cluster RCT in Australia of a multicomponent active travel to school promotion, including resources for students, schools and parents. They found walking to school increased in the intervention compared to control group
Author, Year Foster et al 2018 [36] **Aim** systematically reviewed the effectiveness of population approaches to promote walking among individuals and populations	**Quality score 3** **External validity score 3**	**Country of study** UK (international evidence) **Setting** various **Location** **Sample characteristics** 12 studies, all of which used a controlled design. Many studies rejected due to a) not transport walking or b) already covered above. New unique studies reported here.	**How allocated to intervention and control** varied **Characteristics of intervention: what was delivered to whom and how?** School promotional programmes and environmental change	**Outcomes** **Various** **Follow-up periods** **Various** **Method of analysis including ITT** Various	**Results for all outcomes** MacDonald 2013 [67] evaluated a US Safe routes to School program with education, environmental changes (sidewalks, crossings, covered bike parking) Using a controlled before and after study. The approach used education only and education plus environmental changes compared with comparison schools and reported positive increases in the proportion of children reporting walking trips to school of between 5% (education only) and 20% (education plus environmental changes) per school. Panter et al [57] reported the impact of a new guided bus service and new walking and cycle routes on the residents from the environs of Cambridge, UK. They reported a non-significant increase in mean walking for commuting for residents who increased walking (mean 73.4 (SD 66.6), RR 0.90 (0.69 to 1.19)) with a graded exposure to busway.

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results
Author, Ogilvie et al 2007 [11] **Aim** To assess the effects of interventions to promote walking in individuals and populations.	**Quality score 3** **External validity score 3**	**Country of study** UK with international literature **Setting** **Location** **Sample characteristics** 48 studies included, of whch 17 meet our inclusion criteria and have not been covered above	**How allocated to intervention and control** varied **Characteristics of intervention: what was delivered to whom and how?** Varied	**Outcomes** **Various** **Follow-up periods** **Various** **Method of analysis including ITT** Varied	**Results for all outcomes** Ogilvie et al [11] describes results from **thirteen separate studies** of individualized marketing campaigns run and evaluated by the same social marketing agency. These are based around individualised marketing (IndiMark): provision of tailored information, advice, and incentives to encourage change in travel behaviour in interested households. These studies consistently reported a net increase in the proportion of trips made on foot (usually measured in the local population as a whole) and an increase in time spent walking in those studies that reported this outcome. Mutrie reported a RCT of a workplace programme including a self-help pack including maps, activity diary, safety accessories [1]. This found an increase in walking of 64 minutes per week McKee [79] evaluated an active commuting pack in primary schools in Scotland and found an increase in walking of 69 minutes per week compared to the control school Rowland [80] evaluated school travel initiatives delivered by a school travel coordinator in primary schools in England. The study found no significant differences The TAPESTRY project in (Hertfordshire [81] evaluated the activities of Walk to school week in primary schools and found no impact on walking
Author: Larouche et al 2018 [98] Aim: review the effectiveness of interventions in increasing Active school travel	**Quality score 3** **External validity score 3**	**Country of study** Canadian study of global literature **Setting** schools **Location** various **Sample characteristics** 27 studies of which 18 met our criteria	**How allocated to intervention and control** varied **Characteristics of intervention: what was delivered to whom and how?** Varied	**Outcomes** **Various** **Follow-up periods** **Various** **Method of analysis including ITT** Varied	**Results for all outcomes** Buckley et al. 2013 [91] evaluated an active school travel (AST) day in Idaho, USA. They found an increase in AST sustained at 2-week follow-up relative to the control school ($\chi2 = 11.6$; $p = 0.009$ Bungum et al. 2014 [82] evaluated an AST day in Las Vegas, USA. They found an increase in the mode share of AST by 7.4 percentage points on the day of the event. AST was then significantly higher than in the control school ($\chi2 = 27.2$; $p < .001$; $d = 0.29$). AST dropped to baseline rates at 1-week assessment Christiansen et al. 2014 [99] evaluated a comprehensive school-based intervention to improve non-curricular PA through changes of the physical and school environment supported by educational activities in Denmark. They reported that the prevalence of AST increased from 87.8% to 88.8% in the experimental group and from 84.3% to 85.3% in the control group with no difference between groups ($p = 0.30$; $d = 0.13$). Coombes et al. 2016 [83] evaluated a technology-based intervention (Beat the Street) which aimed to increase AST via incentive-motivated approaches in the United Kingdom. They reported that at 7-week follow-up there was no difference in AST between groups. At 20-week

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results
					follow-up there was a 10% increase in AST in the intervention group and 7% decrease in control group (p = 0.056) Crawford & Garrard, 2013 [84] evaluated The Ride2School Program, which consisted mostly of promotional activities with some infrastructure changes in Victoria, Australia. They reported that AST increased significantly in the inner suburban pilot school and the outer suburban control school. Hands-up surveys show that AST increased in the inner suburban pilot school and no changes were found in the other schools Ducheyne et al. 2014 [89] evaluated cycling training, which aimed to increase cycling skills and encourage uptake of cycling in Belgium. They reported that changes in weekly time spent cycling did not differ between intervention and control group (F = 1.9; p > 0.05) Goodman et al. 2016 [85] evaluated Bikeability, a national cycle training programme for children and adults in the UK. They reported that children attending schools that had offered Bikeability were not more likely to cycle at least once a week (OR = 0.99; 95% CI = 0.89-1.10) and to cycle to school (OR = 0.73; 95% CI = 0.41-1.29). Children who received Bikeability training were more likely to cycle at least once a week (OR = 1.26; 95% CI = 1.16-1.37). Gutierrez et al. 2014 [100] evaluated the implementation of crossing guards & AST awareness campaign in Miami, USA. They reported that the number of pedestrian and cyclists did not change following the addition of crossing guards (p > 0.05;d = 0.03). Hoelscher et al. 2016 [68] evaluated Safe Routes to School, a comprehensive, federally-funded programme in the USA. They reported that Infrastructure and noninfrastructure schools had significantly higher rates of AST in the morning (p = 0.024 and 0.013 respectively) and non-infrastructure schools had significantly higher overall AST relative to control schools (p = 0.036). However, differences between groups attenuated over time. Johnson et al. 2016 [90] evaluated Bikeability, a national cycle training program for children and adults in England. They reported that Students who received Bikeability were more likely to cycle to school (OR = 2.25; 95% CI = 1.83-3.52). d = 0.45. In one arm of the study they found Students who received Bikeability did not report more cycling in general while in another they found Students who received Bikeability were more likely to report cycling ≥30 min in the past week. McDonald et al. 2013 [67] evaluated Safe Routes to School, a comprehensive, federally-funded program in the US designed to increase AST through non-infrastructure and infrastructure strategies in Oregon, USA. They found Education + encouragement were associated with increases in walking and biking by 2 and 5 percentage points respectively. Augmenting education programs with engineering improvements was associated with increases in walking and biking of 5-20 percentage points.

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results
					McDonald et al. 2014 [43] conducted a separate evaluation of the same programme as above in Florida, Oregon, Texas, and District of Columbia, USA. They found that relative to control schools, each year of participation in SRTS was associated with a 1.1% increase in AST (p = 0.002; d = 0.019). Engineering improvements led to a 3.3 percentage point increase in walking and biking (p = 0.031; d = 0.12), while education + encouragement interventions led to a 0.9 percentage point increase per year (p = 0.025; d = 0.15). McMinn et al. 2012 [77] evaluated Travelling Green, a 6-week school-based intervention aimed to increase AST via teacher lesson plans and student packs in Glasgow, Scotland. They reported that the intervention group had smaller decreases in mean steps (−47 vs. -205) and seconds of MVPA (−33 vs. -85) during the morning trip. There were contrasting results on the afternoon trip for steps (−222 vs. -120) and MVPA (−125 vs. -59). d < 0.1 for changes in steps and MVPA during the school trip. Mendoza et al. 2011 [74] evaluated the Walking School Bus, which aimed to increase AST by having children walking in adult-supervised groups inTexas, USA. They found intervention children increased their weekly percent AST from 23.8% ± 9.2% at baseline to 54.0% ± 9.2% at follow-up, whereas control children decreased their weekly percent AST from 40.2% ± 8.9% to 32.6% ± 8.9% (p < .0001; d = 0.40). Østergaard et al. 2015 [86] evaluated Safe and Secure Cycling to school, which aimed to increase cycling behaviors through a multicomponent cycling promotion programme in Denmark. They found the change in the number of cycling trips to/from school were not significant (B = 0.15 trips; 95% CI = −0.25; 0.54). d = 0.02. Sayers et al. 2012 [76] evaluated the Walking School Bus, which aimed to increase AST by having children walking in adult-supervised groups in Columbia, USA. They found the percentage of time spent in MVPA did not differ between WSB participants and controls (all p ≥ 0.17). d = −0.32. The age-related gradient in MVPA was attenuated in WSB participants. Villa-González et al. 2016 [87] evaluated an intervention that aimed to increase AST through changing children safety perceptions and attitudes in Spain. They found an increase in the frequency of active trips in intervention schools (0.6 ± 0.2) relative to control schools (−0.4 ± 0.3) [p = 0.019; d = 0.40]. When examining travel modes separately, significant changes were only observed for walking. Xu et al. 2015 [88] evaluated a multicomponent lifestyle childhood obesity prevention program aimed to enhance lifestyle behaviors in China. They found participants in schools were more likely to change their travel mode to walking or cycling to school (OR = 2.24, 95% CI = 1.47-3.40; d = 0.45) relative to those in the control schools

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results
Author: Chillon et al 2011 [101] **Aim** review intervention studies related to active school transportation	**Quality score 3** **External validity score 3**	**Country of study** primarily USA but some UK studies **Setting** school **Location** **Sample characteristics** 14 studies of which 2 met our inclusion criteria and were not already covered above	**How allocated to intervention and control** Mainly cluster controls i.e control schools **Characteristics of intervention: what was delivered to whom and how?** **Safe routes to schools**	**Outcomes** **Various** **Follow-up periods** **Method of analysis including ITT** **Various** Various	**Results for all outcomes** Boarnet et el [70] [69] evaluated SRTS projects in cities in California. There was a greater increase in walking among those who passed the SRTS project (P < 0.01) after sidewalk improvements and traffic control projects (primarily traffic signals). Children who passed completed SRTS projects were more likely to show increases in walking or bicycling to school than were children who would not pass by projects (15% vs. 4%; P < 0.01). Jordan et al [71] evaluated the Gold Medal Schools program which aims to establish policy and environmental supports for students and staff. SRTS interventions included Walk your Child to School Day. They found children at experimental schools walked or biked to school more often than control children (P < 0.001), both at pre and post-test. While children in both conditions increased the days per week they walked or biked to school between pre- and post-test, the change was only significant at control schools (P < 0.001).
Author: Smith et al 2015 [96] Aim: review studies that focused on walking school buses.	**Quality score 2** **External validity score 2**	**Country of study** International **Setting:** school **Location: various** **Sample characteristics** Twelve WSB studies involving a total of 9169 children were reviewed. However the studies that included as control group had already been covered above	**How allocated to intervention and control** Various **Characteristics of intervention: what was delivered to whom and how?** Walking school bus	**Outcomes** **Various** **Follow-up periods** **Various** **Method of analysis including ITT** Various	**Results for all outcomes** All included studies covered above
Author: Smith et al 2017 [102] **Aim**: to identify which environmental interventions	**Quality score 2** **External validity score 2**	**Country of study USA** **Setting community** **Location** **Sample characteristics**	**How allocated to intervention and control** Control areas **Characteristics of intervention: what was**	**Outcomes** **Various** **Follow-up periods** **Various**	**Results for all outcomes** Clark et al evaluated a trail intervention in Nevada. USA [61]. This included 6 community trails which included a marketing campaign promoting trail use and the addition of way-finding and incremental distance signage to selected trails. They reported Increases in mean users per hour were found for both the intervention and control trails (increased by 31%, p < 0.01 and 35%, p < 0.01, respectively). Increases did not vary between the treatment groups (Z = 0.9892, p = 0.32).

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results
increase physical activity in residents at the local level		7 studies found that satisfy inclusion criteria	**delivered to whom and how?** Environmental changes	**Method of analysis including ITT** Various	Dill [103]] evaluated Bicycle boulevard installation in eight street segments (0.9–4.2 miles long) in Portland. Oregon. They found A significant decrease in number of minutes biked was observed in the intervention neighbourhood (where biking occurred for at least 10 min. Fitzhugh [54] evaluated the retrofitting of a neighbourhood with an 8-ft-wide and 2.9-mile-long asphalt urban greenway/trail to connect the pedestrian infrastructure with nearby retail establishments and schools. They found Changes in neighbourhood level walking ($p < 0.001$) and cycling ($p = 0.038$) were greater in the experimental neighbourhood than the control neighbourhood. There was no difference over time for the experimental neighbourhood for active transport to school, or for the difference in change in active transport to school between the experimental and control neighbourhoods ($p = 0.2061$). Gustat [55] evaluated path and playground interventions in New Orleans USA. They reported no difference in walking for transportation or leisure between control and intervention Lott [8] evaluated the installation of bicycle lanes on both sides of a street in California. Control streets had existing bicycle lanes, but no description of these provided. Significant increases in cyclists were observed in the intervention street compared with the control street, for adults aged 25 years and older only ($x2 = 3.20$, $p = 0.08$). Veitch [50] evaluated park improvements in Melbourne Australia. The intervention involved the establishment of a fenced leash-free area for dogs, an all-abilities playground, a 365 m walking track, a barbecue area, landscaping, and fencing to prevent motor vehicle access to the park. They found a significant difference in change in number of people observed walking (increased from 155 to 369 in intervention park and decreased from 75 to 51 in control park, $F = 11.70$, $p < 0.0005$). West [51] evaluated 1.93 miles of greenway developed and added to an existing greenway in North Carolina USA. They found No significant differences found between the experimental and control groups for any outcome Variables including walking (all $p > 0.975$).
Author: Stappers et al 2018 [104] **Aim**: examined the effect of built environment infrastructural changes (BEICs) on physical activity (PA),	**Quality score 2** **External validity score 2**	**Country of study:** Netherlands; global literature **Setting:** community **Location:** USA Brazil and Australia **Sample characteristics**	**How allocated to intervention and control** varied **Characteristics of intervention: what was delivered to whom and how?**	**Outcomes** **Various** **Follow-up periods** **Various** **Method of analysis including ITT**	**Results for all outcomes:** Parker et al [53] evaluated a A 1-mile bikelane which was striped on both sides of the road and 5ft (1.52 m) wide in New Orleans USA. They found the number of cyclists increased on intervention streets but decreased on adjacent side streets. Pazin et al. [52] evaluated a new avenue, parking lots, and an on-road walking and cycling route (2.3 km long) along the seashore. They found a general increase of walking and a higher weekly volume of walking at follow-up among residents up to 500m from the new route compared to those living further away.

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results
active transportation		Three studies found that satisfy criteria	Environmental changes	Various	Rissel et al. [58] evaluated A new 2.4 km bi-directional separated bicycle path in inner Sydney. They found the number of cyclists increased with 23% and 97% at two points at the trail, compared to 3% in the whole city at follow-up, Weekly frequency of cycling did not change over time at follow-up I. Participants in the intervention group reported a higher frequency of cycling compared with the control group, at follow-up II.

PRIMARY STUDIES

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
Author Bernstein et al 2017 [105] **Aim** tested the efficacy of a bicycling intervention targeting inactive, low-income, overweight adults on reducing perceived barriers to bicycling, increasing physical activity, and improving health	**Quality score** 2 **External validity score** 2	**Country of study** USA **Setting** community **Location** Milwaukee **Sample characteristics** low-income, overweight adults	**How allocated to intervention and control** Random **Characteristics of intervention: what was delivered to whom and how?** A certified bicycling instructor led a 12-week bicycling intervention	**Outcomes** biking-related attitudes, self-reported physical activity **Follow-up periods** Baseline, 12, 20 weeks **Method of analysis including ITT**	**Results for all outcomes** Barriers to bicycling declined significantly among ntervention group participants at 12 weeks with some declines persisting to 20 weeks. Bicycling for leisure or non-work transportation increased significantly more in the intervention than control group from baseline to 12 weeks but this difference attenuated by 20 weeks	
Author: Brown et al 2016 [14] **Aim**: to investigate whether complete streets increase active transport	**Quality score** 2 **External validity score** 2	**Country of study** USA **Setting** Community **Location** Salt Lake City Utah **Sample characteristics** Residents	**How allocated to intervention and control** Non-random; comparing people living near the streets with those further away **Characteristics of intervention: what was delivered to whom and how?** street intervention provided new light rail, bike lanes, and better sidewalks	**Outcomes** walking and cycling trips for transit **Follow-up periods** **Method of analysis including ITT**	**Results for all outcomes** Near-Time 2 residents were more likely to engage in complete street transit walking trips (35%, adjusted) and nontransit walking trips (50%) than the other 3 groups (24% to 25% and 13% to 36%, respectively). Bicycling was less prevalent, with only 1 of 3 contrasts significant (10% of Near-Time 2 residents had complete street bicycle trips compared with 5% of Far-Time 1 residents). Living near the complete street intervention supported more pedestrian use and possibly bicycling, suggesting complete streets are also public health interventions	**Limitations** **Evidence gaps** **Sources of funding**
Author, Keall et al 2015 [44]	**Quality score 2**	**Country of study** NZ **Setting** Urban	**How allocated to intervention and control**	**Outcomes** Trips and mode	**Results for all outcomes** Relative to the control cities, the odds of trips being by active modes (walking or cycling) increased by 37% (95% CI	**Limitations** **Evidence gaps**

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
Aim analyses the changes in walking and cycling in two New Zealand cities that accompanied public investment in infrastructure married with programmes to encourage active travel	**External validity score 1**	**Location** **Sample characteristics** Face to face survey of population	Matched cities **Characteristics of intervention: what was delivered to whom and how?** public investment in infrastructure married with programmes to encourage active travel	**Follow-up periods** One year **Method of analysis including ITT**	8% to 73%) in the intervention cities between baseline and postintervention. The net proportion of trips made by active modes increased by about 30%.	**Sources of funding**
Author, Diniz 2015 [63] **Aim** assess the effectiveness of an educational intervention on active commuting by bicycle	**Quality score 1** **External validity score 1**	**Country of study** Brazil **Setting** Santa Catarina state **Location** **Sample characteristics** workers from a metallurgical industry in	**How allocated to intervention and control** Not clear **Characteristics of intervention: what was delivered to whom and how?** activities for 6 months, including 23 meetings.	**Outcomes** Commute trips by bike **Follow-up periods** **Method of analysis including ITT** Intragroup analysis was performed 6 months after the intervention. Student's t-test, chi-square, and McNemar tests were used to analyze the data.	**Results for all outcomes** The proportion of participants that used bicycles to commute to work (IG) increased significantly from baseline (45.3%) to the final interventional period (47.5%). No difference was found between the CG and the IG group after the interventional period	**Limitations** **Evidence gaps** **Sources of funding**
Author Norwood et al 2014 [43] **Aim** evaluates the Smarter Choices, Smarter Places programme in Scotland, intended to encourage uptake of walking, cycling	**Quality score 2** **External validity score 3**	**Country of study** Scotland **Setting** Community **Location** Cities **Sample characteristics** Adult residents	**How allocated to intervention and control** **Characteristics of intervention: what was delivered to whom and how?** Smarter Choices, Smarter	**Outcomes** Active travel **Follow-up periods 4 years** **Method of analysis including ITT**	**Results for all outcomes** The results suggest that the initiative impacted positively on the likelihood of physical activity participation and meeting the recommended physical activity guidelines. Individuals in the intervention areas were on average 6% more likely to meet the physical activity guidelines compared to individuals in the non intervention areas	**Limitations** **Evidence gaps** **Sources of funding**

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
and the use of public transport			Places programme in Scotland, intended to encourage uptake of walking, cycling and the use of public transport as more active forms of travel			
Author, Dubuy et al 2013 [9] **Aim** evaluate the dissemination efforts of a bike to work programme	**Quality score 1** **External validity score 1**	**Country of study** Belgium **Setting** workplace **Location** **Sample characteristics** employees	**How allocated to intervention and control** Compared involved and non-involved companies **Characteristics of intervention: what was delivered to whom and how?** two cycling contests, an online loyalty program based on earning 'cycling points' and the dissemination of information through folders, newsletters, posters and a website	**Outcomes** Commuter cycling **Follow-up periods** Two months **Method of analysis including ITT**	**Results for all outcomes** Employees aware of the program had a significantly more positive attitude towards cycling and reported significantly more commuter cycling than those unaware of the program (both $p < 0.001$). Participation was mainly because of health and environmental considerations.	**Limitations** **Evidence gaps** **Sources of funding**
Author, Merom et al 2003 [12] **Aim:** assess the impact of a local promotional campaign around a newly constructed Rail Trail	**Quality score 2** **External validity score 2**	**Country of study** Aus **Setting** community **Location** Western Sydney **Sample characteristics** Residents	**How allocated to intervention and control** Proximity to trail **Characteristics of intervention: what was delivered to whom and how?** newly constructed Rail Trail	**Outcomes** Bike counts **Follow-up periods** **Method of analysis including ITT**	**Results for all outcomes** Trail usage was higher among bike-owners than pedestrians (8.9 vs 3.3%, P = 0.014) and was moderated by proximity to the Trail. Inner cyclists increased mean cycling time by 0.19 h (SD = 1.5) while outer cyclists decreased cycling time (-0.24 h, SD = 1.6). Mean daily bike counts in the monitored areas increased significantly after the Trail launch (OR = 1.35, P = 0.0001, and OR = 1.23, P = 0.0004).	**Limitations** **Evidence gaps** **Sources of funding**

Appendix 3: SUMMARY OF FINDING OF GREY LITERATURE IN SCOPE

Note: The first five of these studies are case studies within one report (reference 25). The separation of individual case studies was chosen in order to be able to describe more clearly the differing interventions between the five case study locations e.g. Case study 1 was confined to canal tow-paths which differs significantly from the other 4 intervention case studies. In addition, a further two of the studies are contained in another report single report (No.s 8-9 – reference 96) in order to identify clearly interventions addressing walking and cycling separately.

Study/review details	**Study design**	**Population and setting**	**Method of allocation to intervention and control**	**Outcomes and methods of analysis**	**Results**	**Notes**
Study/review details **No 1**	**Study design**	**Population and setting**	**Method of allocation to intervention and control**	**Outcomes and methods of analysis**	**Results**	**Notes**
Author: Sloman, L. et al, 2017 [7] **Aim:** The evaluation of the Cycle City Ambition (CCA) programme will involve 'internal comparisons' of intervention sites and non-intervention sites within each of the eight cities. For each city, automatic and manual cycle count data will be analysed for between one and three cycle infrastructure schemes, to assess to what extent they result in an increase in cycling.	Evaluation of the CCA Programme is rooted in internal comparisons within each city. Automatic and manual count data for between one and three of the most significant schemes is being analysed, to assess changes in cycling volume. Intervention cities were matched with local authorities with the nine 'most similar' English local authorities that did not receive CCA funding. For each intervention local authority, the 'most similar' local authority was identified using the National Statistics '2011 Area Classification for Local Authorities', which measures the similarity of	**Country of study: England** **Setting:** Birmingham **Location: 1 of** 8 **Sample characteristic:** Urban canal tow paths	**How allocated to intervention and control:** City-wide interventions **Characteristics of intervention: what was delivered to whom and how?** Within Birmingham, there has been a comprehensive upgrade of the canal towpath network.	**Outcomes:** Increases in cycling along intervention routes **Follow-up periods**: 6 years – 2010 to 2016 **Method of analysis including ITT:** 8 Automated Cycle Counts at intervention sites and 7 at control sites. Also Active People Survey.	**Results for all outcomes:** A maximum of 48 ACCs have enabled examination of indexed change in cycling volumes at the city-wide level within the Birmingham City metropolitan district limits. Between 2010 and 2016, city-wide volumes of cycling increased steadily year-on-year with an indexed increase of 32% between the baseline year of 2012 and 2016. The effect on cycling volumes is being monitored by eight ACCs. Between 2012 and 2016, indexed cycling volume increased on the canal towpaths by 128%, whereas cycling volumes for a comparison group of six ACCs increased by 24%, giving a difference-in-difference	**Limitations:** The CCA programme is at too early a stage for it to be possible to report large changes, and most of our findings simply provide a baseline against which the impact of CCA investment on levels of cycling in the cities and the demographic profile of cyclists will be measured in future reports. Our interim report in 2018 will look at changes in these metrics, and will also assemble evidence relating to growth or decay of effects cyclists'. **Evidence gaps:** **Source of funding:** DfT

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
	pairs of local authorities in terms of a range of demographic, socio-economic, employment and industry characteristics. **Quality score:** 2 **External validity score**: 3				increase of +104%. In all cases, the timing of increases in cycling on the canal towpaths coincides with the timing of completion of CCA infrastructure works.	
Study/review details No 2	**Study design**	**Population and setting**	**Method of allocation to intervention and control**	**Outcomes and methods of analysis**	**Results**	**Notes**
Author: Sloman, L. et al 2017 [7] **Aim:** The evaluation of the Cycle City Ambition (CCA) programme will involve 'internal comparisons' of intervention sites and non-intervention sites within each of the eight cities. For each city, automatic and manual cycle count data will be analysed for between one and three cycle infrastructure schemes, to assess to what extent they result in an increase in cycling.	Evaluation of the CCA Programme is rooted in internal comparisons within each city. Automatic and manual count data for between one and three of the most significant schemes is being analysed, to assess changes in cycling volume. Intervention cities were matched with local authorities with the nine 'most similar' English local authorities that did not receive CCA funding. For each intervention local authority, the 'most similar' local authority was identified using the National Statistics '2011 Area Classification for Local	**Country of study: England** **Setting:** Norwich **Location: 1 of** 8 **Sample characteristic:** Whole populations.	**How allocated to intervention and control:** City-wide interventions **Characteristics of intervention: what was delivered to whom and how?** Norfolk County Council's CCA programme is focussed on Norwich, where it is improving the 60-mile network of five radial and two orbital (inner and outer) 'pedalways'. The Pink Pedalway was improved	**Outcomes:** Increases in cycling along intervention route, Pink Pedalway, plus city-wide ACC counts **Follow-up periods**: 6 years – 2012 to 2016 **Method of analysis including ITT:** A group of ten ACCs in Norwich form the basis for a city-wide analysis of levels of cycling. Also Active People Survey.	**Results for all outcomes:** ACCs suggest that cycling is increasing in Norwich over time, with an increase of 46% between 2012 and 2016. There are five ACCs located on the scheme being evaluated, the Pink Pedalway. Cycle volumes on the Pink Pedalway increased by 29% between 2014 and 2016, while they only increased by 16% for the comparison group of ACCs. However, the change on the Pink Pedalway was entirely driven by the increase at the count site with the largest flows (Cow Drive), which is at the far end of the Pink Pedalway near the university. The trend for the remaining	**Limitations:** There are limited possibilities for a comparator group of ACCs, and since scheme ACCs have only been operational since 2014, trends can only be compared for a limited period. **Evidence gaps:** **Sources of funding:** DfT

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
	Authorities', which measures the similarity of pairs of local authorities in terms of a range of demographic, socio-economic, employment and industry characteristics. **Quality score:** 2 **External validity score**: 3		during CCA Phase 1, and the Blue and Yellow Pedalways are being improved during CCA Phase 2. The Pink Pedalway is an eight-mile cross-city route between the University of East Anglia to the west of the city and Thorpe St. Andrew to the east of the city, via the city centre. The entire route is either separate from traffic or on roads with speed limits at, or below, 20mph.		ACCs on the Pink Pedalway (+17%) was almost identical to the trend for the comparator group. .	
Study/review details **No 3**	**Study design**	**Population and setting**	**Method of allocation to intervention and control**	**Outcomes and methods of analysis**	**Results**	**Notes**
Author: Sloman, L. et al 2017 [7] **Aim:** The evaluation of the Cycle City Ambition (CCA) programme will involve 'internal comparisons' of intervention sites and non-intervention sites within each of the eight cities. For each	Evaluation of the CCA Programme is rooted in internal comparisons within each city. Automatic and manual count data for between one and three of the most significant schemes is being analysed, to assess changes in cycling volume. Intervention cities	**Country of study: England** **Setting:** Oxford **Location: 1 of** 8 **Sample characteristic:** Urban on and off	**How allocated to intervention and control:** City-wide interventions. **Characteristics of intervention: what was delivered to whom and how?**	**Outcomes:** Increases in cycling along intervention routes across city. **Follow-up periods**: 4 years – 2012 to 2016 **Method of analysis including ITT:**. ACC	**Results for all outcomes:** A group of six ACC counters located in Oxford form the basis of a 'city-wide' analysis of levels of cycling. These ACCs suggest that cycling is increasing in Oxford over time, with an increase of 13% between the baseline year of 2012 and 2016. Part of this	**Limitations:** **Evidence gaps:** Annual manual cordon count data is also suggestive of an increase adjacent to The Plain in 2015 and 2016, relative to the combined count for all other sites on the inner cordon. However, more data is again

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
city, automatic and manual cycle count data will be analysed for between one and three cycle infrastructure schemes, to assess to what extent they result in an increase in cycling.	were matched with local authorities with the nine 'most similar' English local authorities that did not receive CCA funding. For each intervention local authority, the 'most similar' local authority was identified using the National Statistics '2011 Area Classification for Local Authorities', which measures the similarity of pairs of local authorities in terms of a range of demographic, socio-economic, employment and industry characteristics. **Quality score:** 2 **External validity score**: 3	highway routes. The Plain is a busy five-arm roundabout with high bus flows and a history of cyclist casualties. CCA Phase 2 investment in Oxford is on riverside routes and access to Oxford city centre from these riverside routes.	The Plain is a busy five-arm roundabout with high bus flows and a history of cyclist casualties. CCA Phase 2 investment in Oxford is on riverside routes and access to Oxford city centre from these riverside routes.	data is available for seven sites. Five of these are close to or in the city centre. Four ACCs have data between 2012 and 2016. One has data from 2010 to 2016; one has data from 2013 to 2016; and one has data from January 2016 only, so cannot be included in analysis of change in annual cycling volumes. A six-point inner cordon manual count is conducted over one day (between 07:00 and 19:00) every year in May, and data is available for the years 2010-2016. The inner cordon count site on Magdalen Bridge is located 150m north of The Plain roundabout and the site on Folly Bridge is near the proposed CCA2 Thames Towpath scheme. Data is also available for a 12-point outer cordon count, which is up to	city-wide increase may be due to increased cycle volumes at two ACC sites on routes to The Plain roundabout, although more data is needed to confirm this. Other ACC sites show a mixture of increases and decreases between 2012 and 2016.	needed in future years to confirm this. **Sources of funding:** DfT

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
				20 minutes cycling from the city centre (the count location furthest from the city centre is around 5.5km). The count is conducted over one day (between 07:00 and 19:00) annually. The outer cordon counts do not provide evidence relevant to the CCA schemes but they are relevant to assessment of city-wide changes. Trends Also Active People Survey.		
Study/review details **No 4**	**Study design**	**Population and setting**	**Method of allocation to intervention and control**	**Outcomes and methods of analysis**	**Results**	**Notes**
Author: Sloman, L. et al 2017 [7] **Aim:** The evaluation of the Cycle City Ambition (CCA) programme will involve 'internal comparisons' of intervention sites and non-intervention sites within each	Evaluation of the CCA Programme is rooted in internal comparisons within each city. Automatic and manual count data for between one and three of the most significant schemes is being analysed, to assess changes in cycling	**Country of study: England** **Setting:** West of England **Location: 1 of** 8	**How allocated to intervention and control:** City-wide network largely concentration in Bristol. **Characteristics of intervention: what**	**Outcomes:** Increases in cycling along intervention routes across city. **Follow-up periods**: 6 years – 2010 to 2016	**Results for all outcomes:** A maximum of 17 ACCs are available for examination of indexed change in AUE at the city-wide level within Bristol. Between 2010 and 2012, ACC data shows a year-on-year increase in city-wide volumes of cycling. After 2012, there is	**Limitations:** There is one ACC located on the proposed E-W Quietway route, but no ACCs on either the Filwood or N-S Quietways. The ACC on the proposed E-W Quietway route shows a 6.4% increase in cycle AUE between 2015 and 2016. It has not been

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
of the eight cities. For each city, automatic and manual cycle count data will be analysed for between one and three cycle infrastructure schemes, to assess to what extent they result in an increase in cycling.	volume. Intervention cities were matched with local authorities with the nine 'most similar' English local authorities that did not receive CCA funding. For each intervention local authority, the 'most similar' local authority was identified using the National Statistics '2011 Area Classification for Local Authorities', which measures the similarity of pairs of local authorities in terms of a range of demographic, socio-economic, employment and industry characteristics. **Quality score: 2** **External validity score: 3**	**Sample characteristic:** Some unsegregated but segregated cycle paths are likely to run alongside Prince Street alongside Quay Street and Nelson Street alongside Fairfax Street itself and Broad Weir. In all, this is a distance of 1.5km, but in practice cyclists may be more likely to use short sections rather than using it end-to-end.	**was delivered to whom and how?** Bristol's North-South Quietway (so far Filwood Quietway) investment will consist of the construction of sections of segregated cycle path along a route between the north and south of the city centre, providing connection between several radial quietways.	**Method of analysis including ITT:** There are 33 ACCs in Bristol with data available during the study period. Of these, data from 17 ACCs has been made available for the purpose of this analysis. Continuity of ACC data between 2010 and 2016, from which change in cycling volumes can be calculated, varies considerably. In 2010 and 2011, 13 ACCs have suitable data. During 2012 only six ACCs collected usable data. Although 14 ACCs have sufficient data for 2015, there is a large gap in data availability for 2013 and 2014, meaning no conclusions regarding cycling volume in Bristol can be drawn from this time period. Also Active People Survey.	insufficient data to estimate change from ACCs with data in successive year-pairs, until 2015. Estimates have therefore been calculated between 2011 and 2015, and 2012 and 2015. Between the baseline year of 2011 (AUE index 100) and 2015, the citywide increase in cycling AUE is estimated at 52% (n=11). Between 2012 (AUE index 114) and 2015, the city-wide increase in cycling AUE is estimated at 84% (n=6).	possible to identify a comparison group of ACCs for this**,** and this means that it will only be possible to report a pre/post comparison. **Evidence gaps:** **Sources of funding:** DfT
Study/review details No 5	**Study design**	**Population and setting**	**Method of allocation to**	**Outcomes and methods of analysis**	**Results**	**Notes**

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
			intervention and control			
Author: Sloman, L. et al 2017 [7] **Aim:** The evaluation of the Cycle City Ambition (CCA) programme will involve 'internal comparisons' of intervention sites and non-intervention sites within each of the eight cities. For each city, automatic and manual cycle count data will be analysed for between one and three cycle infrastructure schemes, to assess to what extent they result in an increase in cycling.	Evaluation of the CCA Programme is rooted in internal comparisons within each city. Automatic and manual count data for between one and three of the most significant schemes is being analysed, to assess changes in cycling volume. Intervention cities were matched with local authorities with the nine 'most similar' English local authorities that did not receive CCA funding. For each intervention local authority, the 'most similar' local authority was identified using the National Statistics '2011 Area Classification for Local Authorities', which measures the similarity of pairs of local authorities in terms of a range of demographic, socio-economic, employment and industry characteristics. **Quality score:** 2 **External validity score**: 3	**Country of study: England** **Setting:** West Yorkshire **Location: 1 of** 8 **Sample characteristic:** whole populations	**How allocated to intervention and control:** Based on the location of cycling schemes undertaken in CCA Phase 1 and planned for CCA Phase 2, the Leeds City metropolitan district is the 'city-wide' unit of analysis. **Characteristics of intervention: what was delivered to whom and how?** The Leeds-Bradford cycle superhighway is a 23km route stretching from Leeds to Bradford to the west, and from Leeds to Seacroft to the east. Improvements include cycle lanes which are physically segregated from the carriageway by raised strips or kerbs; bus stop islands / bypasses	**Outcomes:** It appears that there has been a significant increase in cycle flows on the route of the cycle superhighway at Stanningley Road (75,300 in 2014; 98,600 in 2016; +31%) and at Armley Road (59,000 in 2014; 84,400 in 2016; +43%). These two sites are on the section of cycle superhighway west of Leeds, completed in June 2016. **Follow-up periods**: 3 years – 2014 to 2016 **Method of analysis including ITT:** Twenty automatic cycle counters (ACCs) have been installed across Leeds. The number of ACCs with sufficient data continuity over two successive years (100 days minimum in each year) for estimation of year-to-	**Results for all outcomes:** A group of eight ACCs located in the Leeds City metropolitan district form the basis of our citywide analysis of levels of cycling. These ACCs suggest that cycling may be increasing over time. This trend is mostly driven by a single ACC on a canal towpath, and if this counter is excluded, the trend from 2014-2016 is essentially flat. However, manual count data on a city centre cordon is suggestive of a rising trend in cycling volumes. Manual count data at five screenlines across the Cycle Superhighway was collected prior to the scheme, and the counts will be repeated in 2017. This will provide evidence on pre / post-scheme change in cycling volumes, and also on the extent to which any changes in cycling volumes are attributable to route diversion, as opposed to new trips.	**Limitations:** At this stage it is too early to tell whether the apparent increase in cycling on the section of the superhighway west of Leeds is real. The planned repeat of the screenline manual counts in spring 2017 should help confirm whether cycle flows have gone up. **Evidence gaps:** The cycle superhighway ACCs do not provide pre-intervention data. **Sources of funding:** DfT

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
			(more than four per km); and upgraded road crossings (toucans, zebras and cycle phases at existing signals). The scheme was built in two phases. Phase 1, the 14km segregated route between Bradford and Leeds city centres, was completed in June 2016. Phase 2 between Leeds and Seacroft was completed by the end of 2016.	year change in annual cycling volumes rose from one in 2010/11 to ten in 2015/16. Of the 20 ACCs across Leeds, two are located on the Leeds – Liverpool Canal towpath, nine on the Leeds – Bradford cycle superhighway, and nine away from CCA schemes. Also Active People Survey.		
Study/review details **No 6**	**Study design**	**Population and setting**	**Method of allocation to intervention and control**	**Outcomes and methods of analysis**	**Results**	**Notes**
Author: Cavill et al, 2009 [45] **Aim:** In the first three years of the CDT programme, there have been encouraging increases in cycling observed at a population level in the CDTs, that were not seen in other (non-CDT) towns. The CDTs have also seen	This report presents data from two surveys of cycling in the Cycling Demonstration Towns (CDTs): Secondary analysis of Sport England's Active People Survey (2005/6 and 2007/8); and ICM surveys commissioned by Cycling England conducted in the CDTs in 2006 and 2009.	**Country of study: England** **Setting:** Towns **Location:** Town-wide Aylesbury Brighton Darlington Derby	**How allocated to intervention and control:** Control is the Active People Survey comparison with non-participating towns **Characteristics of intervention: what was delivered to**	**Outcomes:** Increases in cycling were not observed in all other local authorities in England with no CDT or in a subset of local authorities with no CDT that were matched to the CDTs' demographic profile.	**Results for all outcomes:** The proportion of respondents cycling once a month in local authorities with a CDT increased by 3.3% between 2006 and 2008. This equates to approximately 26,000 people in the local authorities with a CDT who have increased their cycling since the CDT programme began. In all the	**Limitations:** 3 years length**.** Plus lack of descriptions on the range of interventions **Gaps**: **Sources of funding: DfT**

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
significant and important reductions in sedentary behaviour, that are likely to be associated with benefits to public health.	**Quality score:** 2 **External validity score**: 3	Exeter Lancaster **Sample characteristics:** Town-wide interventions	**whom and how?** A comprehensive town-wide approach to promoting cycling.	**Follow-up periods**: 3 years **Method of analysis including ITT:** The Active People Survey showed that between 2006 and 2008 there was an increase in cycling (for at least 30 minutes, once a month and three times a week) in local authorities with a CDT compared to local authorities without a CDT. And two surveys commissioned by Cycling England, conducted among random samples of the population of each CDT in 2006 (before programme activity began), and again in 2009.	towns combined, there was a significant increase in the proportion of people doing any cycling in the last year (from 24.3% in 2006 to 27.7% in 2009).	

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
Study/review details No 7	**Study design**	**Population and setting**	**Method of allocation to intervention and control**	**Outcomes and methods of analysis**	**Results**	**Notes**
Author: Sloman et al 2009 [3] **Aim:** The towns selected for funding were chosen from applications by 31 local authorities, on the basis of three principal characteristics: the ambition of their programme to increase short urban trips by bike; the commitment and involvement of senior members and officers; and the commitment by the local authority to match-fund the CE central grant.	Each town carried out quarterly manual counts of cyclists, for a partial cordon around the town centre (in the case of Lancaster with Morecambe, partial cordons around both town centres, and in the case of Exeter, additionally for a partial screenline using the River Exe). The average annual percentage change calculated using data from all the towns is 4%. Sport England Active People Survey, enabled comparison of numbers of occasional and regular cyclists between local authorities with Cycling Demonstration Towns and other local authority areas; and second, data on cycle trip stages and trip distances in medium sized towns, from the National Travel Survey **Quality score:** 2	**Country of study: England** **Setting:** **Location:** Aylesbury, Brighton & Hove, Darlington, Derby, Exeter and Lancaster with Morecambe. **Sample characteristics:** whole populations	**How allocated to intervention and control:** whole population and controls **Characteristics of intervention: what was delivered to whom and how?** Not covered.* see other CDTstudy DEF.	**Outcomes:** The increase in cycling behaviour for either occasional or regular cyclists in the Cycling Demonstration Town local authorities is not observed in the matched local authorities. **Follow-up periods**: 3 years **Method of analysis including ITT:** matched each of the Cycling Demonstration Town local authorities with the local authority that is considered most similar, using the National Statistics 2001 Area Classification.	**Results for all outcomes:** Using data from automatic cycle counters, the interim result for the mean increase in cycling levels across all six towns was 27%, relative to a 2005 baseline (before the beginning of the investment programme) and including data up until March 2009**.**	**Limitations:** likely that the Active People Survey underestimates levels of change **Evidence gaps**: **Sources of funding:** DfT

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
	External validity score: 3					
Study/review details No 8	**Study design**	**Population and setting**	**Method of allocation to intervention and control**	**Outcomes and methods of analysis**	**Results**	**Notes**
Author: Sloman, L. et al 2018 [106] **Aim:** The two core policy objectives of the programme were to support local economies, and to reduce carbon emissions. NB Reporting on cycling.	Information from Outcomes Reports reported in Interim Meta-analysis in 2015 and Final Meta-analysis in 2017; meta-analyses also involved extensive analysis of evidence from secondary datasets eg changes in traffic levels across country as control. Compared with the Active People Survey data. **Quality score:** 2 **External validity score**: 3	**Country of study:** England **Setting:** Urban and rural **Location:** 12 **Sample characteristics:** some whole populations, most focused on commute	**How allocated to intervention and control:** Bidding process by local authorities for funding. **Characteristics of intervention: what was delivered to whom and how?** 7 Large Projects delivered many interventions and five delivered some interventions. which included cycle routes; secure cycle parking; cycle training for adults and children; cycle maintenance courses and services; and cycle	**Outcomes:** Among participants in Active People Survey, proportion of adults who had cycled in past month increased slightly in Large Projects between 2010-12 and 2013-15 (from 14.1% to 14.5%, p=0.04 for difference i.e. a 96% chance the difference was 'real' and not simply a result of random variability). By contrast, proportion of cyclists in national comparator group decreased from 16.0% to 15.4%, meaning that the change in the Large Projects was more favourable than	**Results for all outcomes:** All 7 Large Projects that had implemented many cycling interventions showed some indications of increases in cycling since the start of the LSTF programme, measured either by automatic counts or manual cordon counts.	**Limitations:** impossible to identify impact of individual interventions for cycling. Lack of sufficient cycle counters but national comparator group. **Evidence gaps**: use of secondary data. **Sources of funding:** DfT

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
			hire (both short-term on-street hire schemes and longer term loan schemes). Cycling was also promoted by means of events, led rides, cycle challenges and other activities.	the background national trend. **Follow-up periods**: pre in 2010-12 and post 2013-15 **Method of analysis including ITT:** Pre-post and national comparator.		
Study/review details **No 9**	**Study design**	**Population and setting**	**Method of allocation to intervention and control**	**Outcomes and methods of analysis**	**Results**	**Notes**
Author: Sloman, L. et al 2018[106] **Aim:** The two core policy objectives of the programme were to support local economies, and to reduce carbon emissions. NB Reporting on walking.	Information from Outcomes Reports reported in Interim Meta-analysis in 2015 and Final Meta-analysis in 2017; meta-analyses also involved extensive analysis of evidence from secondary datasets eg changes in traffic levels across country as control. Compared with the Active People Survey data. **Quality score:** 2 national comparator group. **External validity score**: 3	**Country of study:** England **Setting:** Urban and rural **Location:** 12 **Sample characteristics:** some whole populations, most focused on commute	**How allocated to intervention and control:** Bidding process by local authorities for funding. **Characteristics of intervention: what was delivered to whom and how?** 7 Large Projects delivered many interventions intended to increase walking, and 4 delivered some interventions. A few Large Projects	**Outcomes:** Data from Active People Survey on the average number of days when adults had done any walking in the previous four weeks showed similar trends in the group of 12 Large Projects and in the comparator group, both before and during the course of the LSTF programme. However, one Large Project, Nottingham, showed an increase in walking relative to the comparator group	**Results for all outcomes:** Data from area-wide manual counts (and in one case a large-scale mode share survey) in six Large Projects showed mixed evidence. Using a three-year rolling average, three Large Projects showed an increase in walking between 2009-11 and the most recent period (either 2013-15 or 2014-16), while three showed a decrease.	**Limitations:** Variable quality of evidence with limited ability to identify specific interventions were effective. **Evidence gaps**: use of secondary data **Sources of funding: DfT** .

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
			made significant public realm improvements e.g, Telford's redesign of part of town centre Box Road as shared space. Other interventions included 20mph zones, pedestrian route improvements, and behaviour change measures such as led walks.	between 2012 and 2014/15 that was statistically significant. **Follow-up periods**: pre in 2010-12 and post 2013-15 **Method of analysis including ITT:** Pre-post and national comparator.		
Study/review details **No 10**	**Study design**	**Population and setting**	**Method of allocation to intervention and control**	**Outcomes and methods of analysis**	**Results**	**Notes**
Author: Sloman, L. et al 2017 [17] **Aim:** To assess the effects of the LSTF-programmes and the extent to which it had achieved the high level objectives – support the local economy and to reduce carbon emissions.	Meta-analysis **Quality score:** 2 **External validity score**: 3	**Country of study: England** **Setting:** Medium size towns **Location:** 12 towns and cities **Sample characteristics:** some whole town, some individual targeted interventions eg school journey	**How allocated to intervention and control:** Whole town and individual focused interventions compared to national trends **Characteristics of intervention: what was delivered to whom and how?** Local authority highways tams delivered and oversaw	**Outcomes:** All seven Large Projects that had implemented many cycling interventions showed some indications of increases in cycling since the start of the LSTF programme, measured either by automatic counts or manual cordon counts. Data from the Active People Survey on the average number of days when adults had	**Results for all outcomes:** Data from the Active People Survey provides some evidence that the proportion of adults cycling in the past month increased slightly in the Large Projects over the course of the funded period, and this trend was more favourable than the background national trend. There was no evidence that the amount of cycling done by cyclists (number of days cycled in the past month) changed in the Large Projects over the funded period, either in absolute terms or relative to	**Limitations:** cordon counts for cycling **Evidence gaps**: Detailed evaluation of specific interventions reported. **Sources of funding: DfT**

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
			interventions in a range of settings including some infrastructure but more behaviour change interventions.	done any walking in the previous four weeks showed similar trends in the group of 12 Large Projects and in the comparator group, both before and during the course of the LSTF programme. However, one Large Project, Nottingham, showed an increase in walking relative to the comparator group between 2012 and 2014/15 that was statistically significant. **Follow-up periods**: 2010-15 **Method of analysis including ITT:** whole towns and active travel changes	the national comparator group. This provides an indirect suggestion that any increase in cycling in the Large Projects may have been driven by widening participation in cycling, rather than encouraging existing cyclists to do more. The limited data on changes in overall levels of walking which can be attributed to LSTF interventions do not point to a clear conclusion, in some cases because there is insufficient data and in others because the data available shows variations from year to year and from one town or area to another. On an area-wide basis there are external influences which may affect the level of walking so it is not yet possible to ascertain whether the changes are attributable to the LSTF. However, attribution.	
Study/review details **No 11**	**Study design**	**Population and setting**	**Method of allocation to intervention and control**	**Outcomes and methods of analysis**	**Results**	**Notes**
Author: Healey, M., Gilmour. P. First Person Consulting.2016 [92] **Aim:** The Ride or Walk to School (RWTS) program was	For physical activity analysis: Baseline and yearly Year 6 student surveys (from participating schools) regarding active travel behaviour Baseline	**Country of study:** Australia **Setting:** Schools **Location:** Canberra	**How allocated to intervention and control:** RWTS schools and non-RWTS schools.	**Outcomes:** There is good evidence that there has been an increase in the rates of active travel within participating schools.	**Results for all outcomes:** An attributed increase in 84% of schools (n=25) as a result of the RWTS programme. Children attending a RWTS school are more likely to use	**Limitations:** incomplete data over time – for instance, a lack of follow-up data from parents or schools, missing or incomplete feedback sheets from components of

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
launched by ACT Health in 2012, with 11 pilot schools committing to RWTS for a three-year period (2013-2015). Ride or Walk to School (RWTS) is one of several supporting programs the ACT Government provides as part of the Healthy Weight Initiative which targets zero growth in overweight and obesity in the ACT. Provision of support in delivering the evaluation of the RWTS program for the grant-funded period between the start of 2013 and end of 2016. The purpose of the evaluation was to assess the appropriateness, effectiveness and sustainability of the RWTS program in terms of increasing active travel to school by children in the ACT.	parent surveys (from parents of children at participating schools); ACTPANS and General Health Survey results for population based measures of active travel (ie control) **Quality score:** 2 **External validity score**: 2	**Sample characteristics:** Year 5 and 6 pupils in RWTS participating schools.	**Characteristics of intervention: what was delivered to whom and how?** Range of behavioural interventions including: Personalised riding and walking maps; Safe Cycle teaching resource; National Ride 2 School Day; Active Kids Challenge - ride or walk weeks; Teacher training;	The increase in rates of active travel within participating schools is attributable to their involvement in the RWTS program. When compared to non-RWTS schools: Children attending a RWTS school were more likely to use active travel at least once a week. Children attending a RWTS school were more likely to use active travel as their usual mode of travel. Children attending a RWTS school were more likely to use active travel every day. **Follow-up periods**: 3 years **Method of analysis including ITT:** Pre-post with control for changes in active travel use	active travel at least once a week; in RWTS-schools an average of 67% of students use active travel at least once a week, as compared to 44% in non-RWTS schools. Children attending a RWTS school are more likely to use active travel as their usual mode of travel4; 51% of RWTS school students use active travel as their usual mode of transport (5 or more trips a week to or from school), compared to 30% in non-RWTS schools. Children attending a RWTS school are more likely to use active travel every day; 27% of RWTS school students use active travel every day, compared to 17% in non-RWTS schools.	RWTS; as schools self-selected (opted) into RWTS bias cannot be ruled out in results; data is largely self-reported/perception data. Moreover, for those that completed follow-up surveys there is likely some degree of self-selection bias; a lack of before and after comparison for control groups; population level data was not collected from all participating RWTS schools. That said, the population level data was random in terms of participation in the Program (i.e. they were chosen independent of RWTS). **Evidence gaps**: **Sources of funding:** Australian Capital Territory (ACT) Canberra
Study/review details No 12	**Study design**	**Population and setting**	**Method of allocation to intervention and control**	**Outcomes and methods of analysis**	**Results**	**Notes**

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
Author: Sustrans 2011 [4] **Aim:** The overarching aim of the pilot was to increase the number of pupils cycling and walking to school as well as increasing pupils' and their parents' overall levels of physical activity.	As well as monitoring the impact of the project within the intervention school, surveys were conducted at a control school of similar size and location. Baseline surveys show that both schools had similar travel to school behaviour prior to the FEAT 1st project. **Quality score:** 1 **External validity score**: 3	**Country of study: England** **Setting:** Schools **Location:** one school in North Tyneside (Wallsend Jubilee) **Sample characteristics:** delivered a practical programme of activities to year 5 pupils in one school over a twelve-week intervention.	**How allocated to intervention and control:** Pilot study. Selection of school not stated. **Characteristics of intervention: what was delivered to whom and how?** Sustrans' FEAT 1st officer, North Tyneside Council staff and other Sustrans staff and volunteers delivered activities in the school one afternoon a week including bike skills and maintenance sessions, on-road cycle training and education to raise awareness of the need for physical activity. The FEAT 1st officer and North Tyneside school travel advisor also led family-orientated walks and bike rides on weekends and evenings as well as half-term activities	**Outcomes:** results show that through intensive engagement with pupils over a twelve-week period, the FEAT 1st pilot has achieved very positive results, meeting the overall aim of the project to increase cycling and walking among pupils and to increase levels of physical activity. **Follow-up periods**: 12 weeks **Method of analysis including ITT:** Surveys including control school.	**Results for all outcomes:** At the intervention school, the percentage of pupils travelling to school by an active mode increased by 22.4 percentage points, from 53.6% before FEAT 1st to 76.0% at the end of the twelve-week intervention. Over the same period, at the control school, the percentage of pupils travelling to school by an active travel mode remained fairly constant with a slight decrease from 57.7% of pupils in the pre survey to 55.1% in the post survey	**Limitations:** 12 week intervention. 1 school so risk of selection bias Undertaken in spring. Self-report through survey and diaries. The sample size is small and there is no statistical significance within the data **Evidence gaps**: Long term impacts **Sources of funding:** North of Tyne NHS

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
			including a mountain bike ride.			
Study/review details No 13	**Study design**	**Population and setting**	**Method of allocation to intervention and control**	**Outcomes and methods of analysis**	**Results**	**Notes**
Author: SocialData/Sustrans 2013 [64] **Aim:** The project aimed to reduce levels of car use and encourage more environmentally-friendly forms of travel by promoting walking, cycling and use of public transport	Pre-post and control area **Quality score:** 2 **External validity score**: 3	**Country of study: England** **Setting:** St. Albans **Location:** two residential areas of a small city (11 Wards) **Sample characteristics:** in one relatively wealthy area and one deprived area	**How allocated to intervention and control:** Random selection from 12,000 households In St Albans. Separate samples were drawn from the ITM target population and from the Harpenden control group. **Characteristics of intervention:** The TravelSmart ITM process involves three key phases each based on personal contact with the households in the target area. The process involves dialogue which motivates people to consider and review their travel behaviour in	**Outcomes:** The project achieved healthy increases in walking, cycling and use of public transport, with relative reductions in car-as-driver trips of 12%, car-as passenger trips of 4%, and in car distance travelled for day-to-day trips of 18% (a net saving of 45.0 million car km per year across the target population). This level of behaviour change is in line with other UK TravelSmart projects. **Follow-up periods**: 12 months **Method of analysis including ITT:** A total of 6,204 personalised TravelSmart packages were hand-delivered to participating	**Results for all outcomes:** Growth in trips by most sustainable and active travel modes, with relative increases in walking (6%), cycling (36%) and public transport trips (31%); A relative increase of 20% in daily exposure to active forms of travel (i.e. time spent participating in walking and cycling as modes of transport, plus access/egress to public transport and parked cars);	**Limitations:** 1 year duration **Evidence gaps**: **Sources of funding:** LSTF (DfT)

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
			the context of their lifestyles. People who are interested in changing are supported and encouraged, but the choice is always left to the individual. This process enables people to make voluntary individual changes which add up to make a substantial difference to community-wide travel patterns.	households (including 666 containing only rewards for regular users). Socialdata contacted 726 households, or 37% of the 2,295 households with available telephone details that received information during the project.		
Study/review details **No 14**	**Study design**	**Population and setting**	**Method of allocation to intervention and control**	**Outcomes and methods of analysis**	**Results**	**Notes**
Author: SocialData/Sustrans 2014 [65]	Surveys were conducted before and after the ITM project to evaluate changes	**Country of study: England**	**How allocated to intervention and control:** Separate	**Outcomes:** There were however increases in walking	**Results for all outcomes:** The project achieved relative increases in walking (4%) and	**Limitations:** 1 year duration

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
Aim: To reduce levels of car use among the target population by promoting walking, cycling and use of public transport	in key mobility indicators over the project period. highway network). **Quality score:** 2 **External validity score**: 3	**Setting:** residential districts **Location:** Hemel Hempstead 13 Wards **Sample characteristics:** Random allocation across residential areas in the town	samples were drawn from the ITM target population and from the Harpenden control group. The target population was drawn from this area at random using a commercially available address database. This process provided the total target population of 18,000 households. **Characteristics of intervention: what was delivered to whom and how?** The TravelSmart ITM process involves three key phases each based on personal contact with the households in the target area. The process involves dialogue which motivates people to consider and review their travel behaviour in	and public transport use as modes of day-to-day travel. **Follow-up periods**: 12 months **Method of analysis including ITT:** In total, deliveries containing 96,690 rewards, incentives and items of travel information were made to a total of 10,173 households. For each household, the survey consists of a household questionnaire and an individual travel diary for each member, for a nominated day of the week. The survey sample includes households completing travel diaries for all seven days of the week.	public transport use (12%), as well as reductions in car-as-driver trips (2%) and car-as passenger trips (5%). In addition, a reduction in car distance travelled for day-to-day trips of 2% was observed (a net saving of 6 million car km per year across the target population). There was however no significant change in cycling levels. The project also resulted in a 16% relative increase in average daily exposure to physically active forms of travel.	**Evidence gaps**: **Sources of funding: LSTF** (DfT)

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
			the context of their lifestyles. People who are interested in changing are supported and encouraged, but the choice is always left to the individual. This process enables people to make voluntary individual changes which add up to make a substantial difference to community-wide travel patterns.			

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
Study/review details **No 15**	**Study design**	**Population and setting**	**Method of allocation to intervention and control**	**Outcomes and methods of analysis**	**Results**	**Notes**
Author: Cairns, S., Jones, M 2016 [46] **Aim:** An evaluation of the impacts of the STT project	Analysis of national data sets about local travel – in particular, Census data, National Road Traffic Estimates (NRTE) data and DfT figures on bus use. Comparison of trends in the towns with trends for English urban areas (excluding London), using comparable figures from the National Travel Survey, Census, NRTE data and DfT figures on bus use. **Quality score:** 2 **External validity score**: 3	**Country of study: England** **Setting:** Medium size towns **Location:** Peterborough, Darlington, Worcester (& Redditch) **Sample characteristics:** some whole town, some individual targeted interventions eg school journey	**How allocated to intervention and control:** Whole town and individual focused interventions compared to national trends **Characteristics of intervention: what was delivered to whom and how?** Darlington had a strong programme of walking and cycling promotion, which was conducted in partnership with substantial infrastructure improvements as part of the Cycling Demonstration Town (CDT) activity**.** Walking featured in general travel awareness, school and workplace activities, and	**Outcomes:** In all three towns, the active travel mode share for the school journey increased whilst, according to National Travel Survey data, the national trend was for a reduction. In Darlington, the cycling mode share rose to a peak of 7.5%, although this subsequently reduced, partly replaced by growth in both walking and scooter use. In Peterborough, the main increase was in walking, whilst Worcester experienced increases in the use of both modes. Increases in walking levels achieved during the STT period had subsequently been sustained at the higher levels that	**Results for all outcomes**: In Darlington, cycling showed a dramatic increase during the STT period, with growth of 50-100%. Walking also increased substantially, albeit that the relative increase over time was less dramatic. Between 2008/9 and 2013, both the higher cycling and walking levels were broadly maintained, with some indications that a further period of cycling growth might be starting. In Peterborough, although there was some increase in cycling levels between 2004 and 2005, it is unclear how cycling levels changed between then and 2013 compared with national trends. However, the automatic counter data suggest relatively substantial increases between 2012 and 2013, which may mark the beginning of an upward trend. Meanwhile, walking increased by least 18% during the STT period and manual counts seem to show that those increases were either	**Limitations:** Some data gaps in some years. **Evidence gaps**: **Sources of funding:** DfT .

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
			specifically in active travel promotions run by the Live Healthy public health team, including the give-away of 10,000 pedometers. In Worcester, cycling a variety of infrastructure improvements.	were achieved, with some indication in Darlington and Peterborough that walking levels were starting to rise again from 2012. Cycling increases achieved by the end of the STT period – estimated as being a 26-30% increase in cycle trips per head across the three towns taken together - were broadly sustained **Follow-up periods**: funded period 2004-09 **Method of analysis including ITT:** whole towns and active travel changes	maintained or augmented by 2013. In Worcester, cycling increased by 16% during the STT period, according to automatic cycle count data. Data to 2012 suggest that there was further, substantial growth since that time. According to household survey data, walking also increased during the STT period, and data from the 2010 household survey suggested that the higher walking levels may have been maintained, with the number of walk trips per person per year increasing from 255 in 2004, to 284 in 2008 and 287 in 2010, an overall increase of 13%.	
Study/review details **No. 16**	**Study design**	**Population and setting**	**Method of allocation to intervention and control**	**Outcomes and methods of analysis**	**Results**	**Notes**
Author: Sloman et al. 2017. [47] **Aim:** the focus of the programme was on encouraging more cycling for short 'everyday' urban trips –	Pre-post and controls with non-CDT/CCT towns. **Quality score:** 2 **External validity score**: 3	**Country of study: England** **Setting:** Towns and cities	**How allocated to intervention and control:** Bid to become a CDT/CCT. Some locations in the towns which	**Outcomes:** The annual rate of growth for the CDT and CCT programmes overall (5.3% and 8.0% respectively) is comparable to rates	**Results for all outcomes:** Cycling trips increased across both programmes overall, and also individually in all 18 towns and cities, by different amounts. From automatic count data, there was an	**Limitations:** Lack of specific intervention data **Evidence gaps**: Some data gaps e.g. lack of ACC data including for comparison towns.

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
that is, those trips which when made by car contribute disproportionately to congestion.		**Location:** Aylesbury, Brighton and Hove, Darlington, Derby, Exeter and Lancaster with Morecambe, all of which are medium-sized towns with populations of between 65,000 and 245,000 people. The Cycling City and Towns (CCT) programme involved one substantially larger city – Greater Bristol, with a population of 570,000 – and one significantly smaller town, Leighton Linslade, with a population of 38,000. The remaining ten towns were of medium size, with populations ranging from 75,000 to 240,000: these were Blackpool, Cambridge, Chester, Colchester, Shrewsbury, Southend,	were matched to the CDTs / CCTs have experienced increases in cycling which are of a similar order to those which occurred town-wide in the CDTs / CCTs themselves. This is perhaps to be expected, as we know that a number of the matched towns were themselves taking action to encourage cycling during the period in question **Characteristics of intervention: what was delivered to whom and how?** Not stated. Expenditure was a mix of capital and revenue, with the ratio being approximately 81% capital:19% revenue over the two phases of the CDT programme, and 72% capital:28%	of growth seen in international cities which have demonstrated sustained long-term commitment to cycling. Cycling trips increased in all six CDTs and 12 CCTs, and across the programme as a whole. This is evident in automatic cycle counts, which show overall increases of +29% for the CDT programme, and +24% for the CCT programme over a slightly shorter time period. This growth in cycling trips was widespread, rather than being confined to a few locations, so that, overall, seven in every 10 automatic cycle counters recorded increases compared to around a quarter recording decreases. Manual count data indicate that the growth in cycling trips	overall increase of 29% for the six CDTs in 5.5 years (range across towns: 6% - 59%); and an overall increase of 24% for the 12 CCTs over three years (range across towns: 9% - 62%) The measured increases in cycle activity may be associated with more people taking up cycling (rather than being solely due to existing cyclists making more trips by bike or travelling further), but the evidence currently available is not conclusive on this question. Evidence collected in the CDTs suggests that there was an increase in the proportion of adults who cycled once a week or more, from about 24% to about 27% in the first half of the programme (the proportion was static in the second half). In Bristol, other evidence shows that the proportion of adults who sometimes cycled for longer trips (over 30 minutes) may have increased from about 13% at the start of the programme to about 20%. There was also an increase in the proportion of secondary school pupils who reported that they usually cycled to	**Sources of funding:** DfT.

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
		Southport, Stoke-on-Trent, Woking and York. Taken together, the 18 towns and cities in the CDT and CCT programmes had a population of more than 2.5 million people. **Sample characteristics:** town/city-wide	revenue for the CCT programme. Between 2006 and 2011, there was an increase in the propensity to cycle amongst most age groups, with the exception of young people (16-24 year olds), whose propensity to cycle remained static at around 36-37%. The largest changes in behaviour appear to have come from people in the 'middle' and 'older' age groups (proportion of respondents reporting any cycling in a typical week in previous year increased from 31% to 34% for 25-34 year olds; from 33% to 37% for 35-44 year olds; from 25% to 30% for 45-54 year olds and from 15% to 19% for 55-64 year olds, comparing 2006 and 2011 results).	picked up by automatic counters was real, and not simply the result of a transfer of cycle activity from on-road locations to the off-road cycle paths where automatic counters are generally located. **Follow-up periods**: 5 years **Method of analysis including ITT:** Automated Cycle Counters, plus matched with non-participating towns. Active People Survey: In analysing the Active People Survey data, researchers compared the CDTs and CCTs with all other local authorities, and with a set of non-CDT/CCT local authorities matched by demographics, using the same ONS area classification as before. We looked at the proportion of respondents cycling	school, from about 4% to about 8% in the CCTs, with more modest but still positive changes in CDT secondary schools and both sets of primary schools. Evidence from the CDTs shows that the increased participation in cycling amongst adults was spread across most age groups, both genders, and most socioeconomic groups with the exception of group DE.	

Study/review details	Study design	Population and setting	Method of allocation to intervention and control	Outcomes and methods of analysis	Results	Notes
				for at least 30 minutes once or more per month, and also the (much smaller) proportion cycling for at least 30 minutes 12 times or more per month. Also, Annual Road Traffic Estimates of cycle traffic growth in non-metropolitan areas. During the period of the CDT / CCT programme, Annual Road Traffic Estimates suggest that on-road cycling levels may have been increasing somewhat, such that the background picture against which our observed trends in the CDTs / CCTs should be considered was not necessarily static.		

Appendix 4: CONTRIBUTORS TO THEORY INTO PRACTICE WORKSHOPS

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James Watmough, Sport England
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Becky Fuller, Urban Transport Group
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