Active Travel England

Active Travel Portfolio Research and Evaluation Programme

Evidence assessment: The Impacts of Interventions to Enable Adult Cycling

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Sheffield Hallam University, NatCen and Mosodi Ltd

ACTIVE TRAVEL PORTFOLIO RESEARCH AND EVALUATION PROGRAMME

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Executive Summary

About this Evidence Assessment

Sheffield Hallam University, NatCen, and Mosodi Ltd were commissioned by the Department for Transport (DfT) and Active Travel England (ATE) to carry out an evidence assessment focused on Enabling Adult Cycling. Whilst active travel evidence and policy often refers to cycling and walking, a broader and more inclusive definition refers to any travel that is powered, partially or fully, by the sustained physical exertion of the traveller (Cook et al., 2022). As such, the definition of walking also includes wheeling (use of wheelchairs and other wheeled mobility aids such as mobility scooters and rollators) as well as the use of a variety of other modes such as skateboards and kick scooters. In recent years, active travel has received increasing recognition for its potential to help facilitate a range of environmental, public health and economic policy outcomes (Hirst, 2020).

In England, the government has an ambition to make walking, wheeling and cycling the natural choice for shorter journeys or as part of a longer journey. The government's original Cycling and Walking Investment Strategy (CWIS) published in 2017 set out specific, measurable aims and provided the financial resources to help achieve them.

The second cycling and walking investment strategy[1] (CWIS2), published in 2022 and updated in March 2023, aims, by 2025, to increase the percentage of short journeys in towns and cities that are walked or cycled to 46%; increase walking activity to an average of one walking stage per person per day; double cycling activity to 1.6 billion journey stages; and increase the percentage of children aged 5 to 10 who usually walk to school to 55%. The latter is set out as a specific target. Over the longer term, the strategy is that half of all short journeys in towns and cities will be walked or cycled by 2030, and that England will have a 'world-class' cycling and walking network by 2040. CWIS2 also introduced a more inclusive definition of active travel to include wheeling.

To support the implementation of projects that deliver its active travel aims, the Government has made an investment projected to be £3.6 billion from 2021 to 2025, and established ATE. ATE's role is to administer the funding whilst working with local authorities to ensure the delivery of high-quality active travel infrastructure for walking, wheeling and cycling, provide tools to deliver ambitious active travel programmes, and support children and other people to cycle.

1 ATE & Department for Transport (2023). The second cycling and walking investment strategy (CWIS2), 10 March 2023.

The need for evidence on cycling interventions

CWIS2 reaffirms the government's commitment to making walking, wheeling, and cycling the natural first choice for many short journeys in the UK. Achieving this will require change on a number of levels.

Increasing the accessibility of cycling requires improvements to the public realm, including redesigning towns, cities, and neighbourhoods so cycle journeys are seen as a more attractive and safe option. Infrastructure improvements need to be made alongside interventions which support behaviour change, to encourage an increase in both cyclists and cycle journeys. At the start of this evidence assessment, a range of sub-themes were identified by ATE and wider stakeholders, including areas such as equipment, facilities, cycle training. These areas help to provide a broad overview of the evidence base on how to adult cycling is enabled through interventions.

Although the evidence base was limited and inconclusive in some areas (see section 5), there are some interesting findings that can be used to inform the design and implementation of future interventions and policies aimed at encouraging and incentivising adult cycling.

Structure of this report

The findings of this evidence assessment have been organised into two chapters: interventions to enable behaviour change and infrastructure interventions to create enabling environments. Both play a role in supporting the update of cycling amongst adults.

Methodology

The report presents findings from 28 studies that were selected following a process of systematic searching, screening, prioritising, and evidence extraction. The evidence reviewed predominantly comprises review studies or evaluation papers that either assessed a specific intervention in depth or synthesised evidence on a range of interventions. Supplementing this are a small number of relevant reports from government and other non-academic sources.

It is important to note that the scope of the evidence assessment was limited. Therefore, more extensive and systematic research into the evidence base would be required to produce exhaustive findings.

Key findings

This report has attempted to answer the following research question:

- **RQ1.** How do the following factors enable adult cycling?
  - Cycle training (in all forms e.g. confidence building, proficiency, coaching).
  - Cycling infrastructure.
  - Cycling equipment, facilities, and security.
  - Influencing and incentivisation.

In relation to this research question, the key findings of the evidence assessment are summarised below. Key findings were also synthesised in the Key Findings Tables at the end of this section.

Interventions to enable behaviour change

- **E-cycles.** E-cycle usage and e-cycle loan schemes were found to be successful in increasing both the use and purchase of e-cycles, replacing some journeys that would otherwise be made by car. Several pilot projects reported success in terms of widening access to e-cycles and attracting interest from underrepresented groups , for example women and younger people. The evidence suggests that there is a certain level of 'readiness' (including confidence and physical ability) needed to switch to making some journeys by e-cycle, which supports the rationale for delivering training and confidence building sessions as part of bike loan schemes.
- **Cycle share.** The evidence highlights that cycle share schemes can positively influence a population's propensity to cycle. However, important enabling factors must be in place to ensure a positive experience, such as appropriate infrastructure, and easy access to affordable, high-quality bikes for hire.
- **Cycle parking and maintenance.** Evidence suggests that bicycle parking supply, and the quality of this supply, are determinants of cycling for both current and potential cyclists, and that higher quality facilities are important for increasing personal security and safety. Free of charge or subsidised cycle maintenance could potentially increase cycle usage.
- **Incentivisation.** Financial rewards specifically have been shown to- be effective in promoting active travel, such as cycling for commuting purposes. Less effective has been gamification (gamifying travel by incorporating games or challenges) elements to encourage cycling. However, the use of gamification in transportation is an emerging field and there is no strong empirical evidence of impact due to this.
- **Cycle training.** Several studies highlighted positive impacts resulting from cycle training interventions, although the overall evidence base was somewhat limited. The included evidence highlights successes in engaging both new and returning cyclists and attracting women to take part in training programmes. The data analysed showed a reported increase in confidence and an increase in cycling trips (both leisure and commuting) as a result of participation in cycle training.
- **Workplace interventions.** The workplace evidence reviewed as part of this assessment often brought together a myriad of factors (such as equipment, facilities, training, and support) needed to influence employee behaviour. All the studies noted the importance of infrastructure in addition to behavioural change strategies in enabling adult cycling. Evidence suggested that supportive policies and programmes at the organisational and community levels, including workplace cycling initiatives and community cycling events, can increase the number of people cycling as a regular activity. The workplace schemes reviewed reported positive findings in relation to increased cycling levels.
- **Promotional and social campaigns.** The evidence included examples highlighting the success of promotional campaigns to communicate the positive benefits of cycling. Promotion of cycling as an everyday activity, rather than just a sport, is important to increase participation. Social support and encouragement from peers, family, and friends can positively influence individuals' decision to cycle.

Infrastructure interventions to create enabling environments

New infrastructure. The interaction between different elements of the built environment, urban planning, and its influence on behaviour was the focus of several selected studies.[2] Evidence suggests that cycling is unlikely to become a mainstream mode of transport without high quality infrastructure. Improvements to infrastructure and interventions to advance the urban environment can positively encourage cycling behaviour, with the provision of new bicycle infrastructure found to be strongly associated with increased levels of physical activity in the studies reviewed.

Segregated, quality infrastructure. Quality cycling infrastructure, such as protected cycle lanes and clearly marked cycle-specific facilities, improve safety, and encourage cycling participation. Cycling collision rates are relatively low, and fatalities are rare events, especially in countries with high levels of cycling infrastructure and clearly marked cycle-specific facilities.

Key determinants of and barriers to participation in active travel

This section summarises the key determinants and barriers to participation in active travel, influenced by behaviour-based interventions and enabling environments. The presence or absence of the following factors can either encourage or hinder participation:

- E-cycle loan schemes, which can successfully increase both the use and purchase of e-cycles, particularly among individuals with existing health conditions.
- Cycle share schemes, though effective, depend on several conditions (e.g., appropriate cycling infrastructure, ease of use, cost, and quality).
- Improving the quality and reducing the cost of parking, especially in terms of enhancing security, is crucial for both current and potential cyclists.
- Incentives, especially financial rewards.
- Cycle training schemes aimed at the general population and disabled individuals.
- Workplace cycling interventions, such as providing good cycle parking facilities, changing showers and lockers, purchasing assistance, cycle repairs, training, targets and awards, and bike ‘buddies’.
- Promotional campaigns that present cycling as an everyday activity rather than just a sport.
- Encouragement from friends and family.
- High-quality infrastructure, including traffic-free cycling routes and cycle facilities.

2 The third report in this suite of evidence assessments - Early consideration of active travel via planning – also reports on evidence related to this in terms of the impact that planning policy and site-level development management and design considerations can have on active travel outcomes.

Conclusions, limitations and suggestions for further research

This report provides valuable insights into enabling adult cycling through various interventions and infrastructure improvements. However, the evidence assessment has also highlighted gaps and limitations in the evidence base.

Generalisability of research findings, a lack of longitudinal evidence, limited insight on inclusion and diversity, and understanding of the importance of collaboration between stakeholders and joined up working were all flagged as research gaps.

This evidence assessment clearly underscores the need for improvements to infrastructure and behavioural change interventions delivered in tandem to improve perceptions of safety, accessibility, and confidence to encourage more people to cycle more often.

Key Findings Tables

This section provides summary tables on the key findings from the evidence assessment.

Table 1: Interventions to enable behaviour change

Key evidence	Source/method/sample/country
Equipment, facilities, and cycle maintenance / service interventions	
A UK shared electric cycle programme found that e-cycles attracted a wider demographic of cyclist. There was a high representation of women amongst the riders, a group who are otherwise difficult to reach: 45% of e-cycles riders were female, compared to only 25% for personal bicycles (National Travel Survey 2015) – suggesting that e-cycles can contribute to normalising cycling for females, to a greater extent than traditional bikes.	Carplus Bikeplus (2016) Mixed methods including survey data (535 responses), interviews and GPS tracking. UK
13% of regular riders through the shared e-cycle scheme proceeded to purchase an e-bike and a further 17% purchased a standard bike through a shared e-cycle scheme (Bikeplus, 2016).	Carplus Bikeplus (2016) Mixed methods including survey data (535 responses), interviews and GPS tracking. UK
There is reported potential for e-cycle use to transform personal transportation towards a mode that is eco-friendly, age-friendly, barrier-free, healthy, and cost-effective. An e-cycle scoping review (from 107 selected articles) highlighted that the use of e-cycles has the potential to reduce our reliance on personal cars for short distance trips.	Jenkins et al. (2022) Scoping review of 107 studies. Global
The review concluded that accidents, violations, and injuries are similar when comparing e- cycles to traditional bicycle users. Jenkins' states that this challenges the perception that cycling at higher speeds from riding e-cycles would lead to more harm and suggests that e- cycles do not require additional regulation.	Jenkins et al. (2022) Scoping review of 107 studies. Global
A significant portion of shared e-bike riders, approximately one in three, reported feeling more confident while cycling, indicating that the electric assist feature is crucial for overcoming challenges such as hills (33% tackled hills they wouldn't have otherwise tackled) and maintaining pace with traffic. This suggests that e-bikes can effectively lower barriers to entry for new cyclists.	Carplus Bikeplus (2016) Mixed methods including survey data (535 responses), interviews and GPS tracking. UK
The positive contribution of e-bikes to health and well-being was demonstrated by the ability of e-bikes to attract people back or into cycling and lead to people cycling for longer (travel times and distances – with average cycles increasing from three to five miles) providing physical activity benefits. The survey results show those using the e-bike regularly reported that when using an e-bike, 58% feel happier and 41% feel healthier.	Carplus Bikeplus (2016) Mixed methods including survey data (535 responses), interviews and GPS tracking. UK
Road user intercept surveys (RUIS) conducted across England (and six international studies) were used to calculate a weighted mean of typical marginal cycling diversion factors. Compared to the existing TAG value of 11%, a significantly higher estimate of 24% for the car to cycle diversion factor was calculated – more than double the previous TAG estimate (for every 100 new cycle trips, 24 are estimated to come from car travel).	Clark & Parkin (2022) Rapid Evidence Assessment: 26 sources – 20 UK, 6 international sources UK

Key evidence	Source/method/sample/country
Equipment, facilities, and cycle maintenance / service interventions	
E-cycles need to be treated separately in economic assessments of the benefits associated with cycling interventions since the user and usage profiles of e-cycles are different to the user and usage profiles of conventional cycles. This is because e-cycles have longer ranges, require lower levels of physical exertion and are a new technology. Whilst it is too early in the adoption of e-cycles to reach clear evidence based recommendations on the 'diversion factors' (i.e., propensity to switch mode) that should be incorporated in economic appraisals, international evidence suggests that car to e-cycle diversion factors can be expected to be higher than car to conventional cycle diversion factors – examples of car to e-cycle diversion factors were found to range between 25% to 46%, with an indicative mean value of 40%. These are, however, related to the acquisition of an e- cycle by an individual rather than measured outcomes from specific interventions, and so cannot be considered to be 'marginal diversion factors.'	Clark & Parkin (2022) Rapid Evidence Assessment: 26 sources – 20 UK, 6 international sources UK

Key evidence	Source/method/sample/country
Cycle share schemes	
Bike sharing can influence a population's inclination to cycle. The extent to which people can benefit from bike sharing depends on the spatial distribution and density of the bikes, the quality of the bikes, the cost of hire and the ease of use, and accessibility of the online platforms through which the hire is made. In particular, the quality, perceived usability and comfort of the bikes can be a limiting factor, with a poor-quality experience potentially forming a major barrier towards future cycling e.g. if people don't find the hire bikes easy to ride (within the study they are described in a number of negative ways 'clunky, heavy, slow, tiring, uncomfortable, not efficient, not pleasurable', and the authors suggest this may put people off cycling in the future.	Sherriff et al. (2020) Mixed methods including surveys and interviews, n=2,270 (survey), n=17 (interviews). UK
Concerns over personal safety, especially for females, can limit bike share scheme usage. Survey data on the evaluation of Manchester's MoBikes scheme found that 40% of female users had safety concerns when cycling in traffic, compared to 30% of males. For non- users, this difference was more pronounced - 34% of male and 61% of female 'deciders' and 28% of male and 57% of female 'avoiders' cited safety issues as a concern.[3]	Sherriff et al. (2020) Mixed methods including surveys and interviews, n=2,270 (survey), n=17 (interviews). UK
Bike share operators should consider the social and physical geography of cities, including current infrastructure and practice, rather than assuming that a 'one size fits all' approach is adequate. Engaging with existing bodies, including transport authorities and local authorities, plus potential users, is crucial to co-design bike share systems that work for the local population.	Sherriff et al. (2020) Mixed methods including surveys and interviews, n=2,270 (survey), n=17 (interviews). UK
Bike share systems can help to maintain 'healthy habits' amongst the population, including physical activity engagement. 'Better infrastructure, technology and appropriate policies' can favour the use of these systems. However, this Spanish systematic review (of 33 papers) also highlighted the "favourable climatic conditions" and suggested that Spain is one of the countries with the most potential to encourage engagement in outdoor physical activity.	Sanmiguel-Rodríguez & Arufe Giráldez (2021) Literature review of 33 papers. Spain

3 'Deciders' were those that hadn't used bike share in the past 12 months but might in the next year. 'Avoiders' were those that hadn't used bike share in the past 12 months and were 'not at all likely to' in the next year.

Key evidence	Source/method/sample/country
Parking and maintenance	
A positive relationship was found between bicycle parking supply and cycling levels or the stated likelihood to cycle to access public transport. A systematic review of evidence which synthesised 94 studies also found that bicycle parking supply and quality are determinants of cycling. Conversely, a lack of bicycle parking and/or inadequate bicycle parking discourages cycling.	Heinen & Buehler (2019) Systematic review of 94 papers. Global
Charging for cycle parking reduces the likelihood of using a cycle parking facility, and many cyclists resort to locking their bicycles to street furniture due to a local imbalance between supply and demand. One of the 94 studies within the systematic review of evidence, Geurs et al. 2016, found that free bicycle parking would result in an 11% greater likelihood of cycling to a railway station (vs. having to pay for parking), whilst another (Mrkajic, Vukelic, & Mihajlov, 2015) monitored parking behaviour before and after the installation of higher- quality parking spaces and reported that occupancy rose from 30-40% to 68%.	Heinen & Buehler (2019) Systematic review of 94 papers. Global
The 'Fix Your Bike' voucher scheme was effective in attracting people who did little or no cycling: over a third of those applying (35%) said they had cycled less than once a week in the previous year, including 6% who said that they never cycled, whilst only around one third of respondents would have had the work done on their bike anyway without the voucher The scheme provided 400,000 £50 vouchers to members of the public to support cycle repair or servicing. which showed positive additionality. Vouchers on their own did not need to be the sole cause of change, but they were a catalyst/ enabling factor to overcoming financial barriers, improving equipment, and providing a reason / confidence to go into bike shops.	Cairns et al. (2023) Evaluation report based on mixed methods including surveys and interviews. n=45,785 (public survey), n=250 (business survey), n=20 (interviews) UK

Key evidence	Source/method/sample/country
Influencing and incentivisation interventions	
Reducing the effort required from individuals to receive incentives (direct receipt of an incentive by email, rather than having to apply) may lead to increased use of vouchers / incentives, however increasing the value of the incentives beyond a certain level did not lead to further increases in use. The incentives included a £50 sports goods retail voucher, free cycle service, subsidised e-cycle hire scheme, bus tickets, and a reduced household annual management charge.	Garrott et al. (2023) Mixed methods including surveys and interviews, n=99. UK
Incentives were useful in helping to initiate new leisure travel or to subsidise existing leisure travel, but there was little evidence to suggest they initiated commuting behaviours.	Garrott et al. (2023) Mixed methods including surveys and interviews, n=99. UK
Commuter cycling can be increased with the use of incentives (both financial and non- financial) using a smartphone app, with financial rewards were more effective than non- financial (i.e. smart gamification). The smart gamification comprised of an app which included points, badges, leader boards, and challenges.	Máca et al. (2020) Randomised control trial, n=482. Czech Republic
Survey respondents highlighted that the provision of better cycling infrastructure (57%), financial incentives for the purchase of new bikes (54%), and showers and dressing rooms at work (51%) would increase their likelihood of engaging in frequent commuter cycling.	Máca et al. (2020) Randomised control trial, n=482. Czech Republic
Due to new and developing approaches being used, the potential of smartphones to incentivise sustainable travel has still not been fully explored.	Máca et al. (2020) Randomised control trial, n=482. Czech Republic
Within a systematic review of gamification, some studies highlighted that providing a small amount of money as a reward for users who ride bicycles to work (or school) every day can effectively encourage people to significantly increase the frequency of cycling.	Wang et al. (2022) Systematic review of 30 papers. China

Key evidence	Source/method/sample/country
Cycle training interventions	
One of the key factors to increasing cycling for people with disabilities is to provide appropriate cycling training. Safety concerns are a key deterrent to cycling for such individuals and training is one possible intervention to address this.	Berent et al. (2021) Mixed methods including interviews and cross-sectional surveys, n=132 (surveys), n=17 (interviews). UK
To increase engagement with cycling by disabled people, the most important measure identified was to improve awareness of cycling amongst disabled people and reduce the perceived barriers to participation in training opportunities of both disabled participants as well as their parents and carers. This was a finding from a UK study which investigated the delivery of cycling activity and training sessions for disabled people.	Berent et al. (2021) Mixed methods including interviews and cross-sectional surveys, n=132 (surveys), n=17 (interviews). UK
A UK study highlighted that safety concerns are a key deterrent to cycling for disabled individuals. The study recommended that the presence of traffic safety education within an inclusive cycling curriculum could make a significant difference in building confidence to cycle independently, although two thirds of surveyed cycling instructors believe that traffic safety education should not be a part of cycling activity session for people with disabilities.	Berent et al. (2021) Mixed methods including interviews and cross-sectional surveys, n=132 (surveys), n=17 (interviews). UK
A UK cycle training programme observed statistically significant increases in cycling (overall and commuting). The mean number of days spent cycling for at least 30 minutes increased by three days, from 1.2 to 4.2 days, and the mean number of days cycled to work in the last 7 days increased from 0.66 to 1.33 days three months afterwards (significant difference (z=3.027, p=0.002; confidence interval 95%). The volume of cycling increased by 43.1 minutes per week, from 12.7 to 55.9mins. The sample was a cohort of 471 participants: 82% female, 80% 'inactive' with 80% not meeting PA guidelines, 46% bike owners, 70% 'un-confident'.	Johnson & Margolis (2013) Longitudinal survey, n=471. UK
Cycle training was far more likely to attract women than men. The cycle training had a large positive impact on cycling confidence levels and was successful in encouraging participation from new or returning cyclists, rather than existing cyclists wishing to 'top up' their skills. Road safety concerns are repeatedly noted as a major barrier to cycling in UK urban areas, therefore the study suggested that the increase in confidence may assist in reducing this barrier.	Johnson & Margolis (2013) Longitudinal survey, n=471. UK

Key evidence	Source/method/sample/country
Workplace interventions	
A workplace intervention highlighted a series of barriers to cycling, this included: cost (the bike itself and associated equipment), a lack of facilities (both at work and home), non- supportive workplace culture for cycling (including not being able to wear appropriate clothes for cycling), a lack of social support (work colleagues, friends, family not interested/no role models or mentors), and a lack of knowledge (suitable cycle routes and planning skills), how to use local cycle-share and cycle-to-work schemes, and a lack of 'basic cycling knowledge including bike maintenance skills, such as changing inner tubes).	Connell et al. (2022) Mixed methods including interviews, focus groups, and longitudinal surveys, n=20,000 (surveys), n=6 workplaces (interviews/focus groups). UK
Principal barriers to cycling amongst those who had never cycled since childhood relate to feelings of safety and confidence. From a survey sample of 5,439 people who had never cycled, the two most prominent barriers were: 'The cycling (on-road) infrastructure does not make me feel safe' (53%) and 'not feeling confident riding on roads' (54%). This compares to 35% and 29% respectively for people who cycle at least weekly.	Connell et al. (2022) Mixed methods including interviews, focus groups, and longitudinal surveys, n=20,000 (surveys), n=6 workplaces (interviews/focus groups). UK

Key evidence	Source/method/sample/country
Workplace interventions	
A workplace intervention helped participants to increase their cycling by three rides per week, from 1.2 to 4.2 ($p < 0.001$), and by 43.1 min per week, from 12.7mins to 55.9mins ($p = 0.02$). The 68 participants reported increases in commuting journeys (31.4% of respondents), utility journeys (40.0%), and leisure cycling (57.1%), with an 63% overall increase in cycling. The intervention started with the identification of barriers (both at national level and local level via a mixed methods approach) which then shaped the design of an intervention covering six areas (education, persuasion, incentivisation, training, environmental restructuring, enablement). A cycle hire and cycle servicing scheme was then offered along with an extensive programme of training and behavioural change supported by Cycling Champions.	Connell et al. (2022) Mixed methods including interviews, focus groups, and longitudinal surveys, n=20,000 (surveys), n=6 workplaces (interviews/focus groups). UK

Key evidence	Source/method/sample/country
Other social and behavioural interventions	
Promotion of cycling as an everyday activity (useful, enjoyable, social), rather than just a sport, is important to increase participation. Social support and encouragement from peers, family, and friends can positively influence individuals' decision to cycle. Additionally, convenience, location, environmental advantages, economic benefits, entertainment, and health benefits are key facilitators to encourage cycling.	Logan et al. (2023) Systematic review of 127 papers. UK
A study in the US showed that the creation of cycle lanes and bike share stations tends to occur in socio-economically advantaged regions, potentially excluding people of colour and those with low socio-economic status from environments that encourage walking and cycling.	Sadeghvaziri et al. (2023) Systematic review of 60 papers. US
Bike share interventions for minority and low-income groups need to consider addressing the following key barriers: safety concerns, equipment (lack of helmets specifically), location (lack of nearby stations), ease of access (difficulty renting/returning bikes), and weather conditions.	Sadeghvaziri et al. (2023) Systematic review of 60 papers. US
A promotional campaign in Denmark which highlighted the benefits of cycling led to a significant increase in cycling trips, with at least 21 million additional cycling trips conducted because of campaign activities.	Nielsen & Haustein (2019) Longitudinal survey, n=11,798. Denmark
A campaign's focus on the positive health effects of cycling and the various campaign activities, including local events, media promotions, and social media campaigns, helped to motivate people to cycle more frequently. In particular, the use of a smartphone app that provided personalised feedback and motivation and was found to be a contributing factor to the campaign's success.	Nielsen & Haustein (2019) Longitudinal survey, n=11,798. Denmark
Perceptions of safety are negatively affected by the fear of traffic-related injuries (the fear of being hit/run over by motorized traffic, high traffic volume/density, and traffic fast speed, in direct relationship with traffic fear of injury related to poor quality infrastructure, infrastructure maintenance, and the negative behaviour of drivers.	Campos Ferreira et al. (2022) Systematic review of 68 papers. Portugal
Concerns about crime, both personal safety and property security, are major factors influencing the security perception of pedestrians and cyclists.	Campos Ferreira et al. (2022) Systematic review of 68 papers. Portugal

Key evidence	Source/method/sample/country
Other social and behavioural interventions	
Four important conclusions were drawn from a Portuguese study investigating how to encourage cycling: • It is important to understand the determinants that influence the perceptions held by pedestrians and cyclists, which will help with defining and implementing transport policies. • Transport policies should explore the social and psychological aspects of all road users' interaction (and not just the importance of infrastructure design and maintenance). • All stakeholders including vulnerable road users should be involved in defining policy, and • There is a need to invest in educational programmes that raise road safety awareness.	Campos Ferreira et al. (2022) Systematic review of 68 papers. Portugal

Table 2: Infrastructure interventions to create enabling environments

Key evidence	Source/Method/ Sample/Country
Infrastructure and the urban environment	
Implementing policies that provide safe and connected walking and cycling infrastructures, whilst also supporting public transport, can increase overall physical activity levels.	Zukowska et al. (2022) Systematic review of 32 papers. Global
The single most effective measure to increase cycling and improve real and perceived cycling safety was judged by a panel of 28 experts (from research, professional practice, policy, and advocacy backgrounds) to be the provision of a basic level of safe, high-quality infrastructure. This included routes segregated from motor traffic, where traffic speeds and volumes necessitate, and low speed, shared streets elsewhere.	Adam et al. (2020) Delphi study of experts, n=28. New Zealand
Cycling is unlikely to become a mainstream mode of transport without an adequate network (good quality, completeness, and integration) of cycle lanes and paths, intersection treatments, and bicycle parking.	Adam et al. (2020) Delphi study of experts, n=28. New Zealand
Cycling infrastructure, such as protected bike lanes improve safety and encourage cycling participation.	Logan et al. (2023) Systematic review of 127 papers. UK
Cycling collision rates are very low in absolute terms, and fatalities are rare events, especially in countries with high levels of cycling infrastructure. The benefits of cycling substantially outweigh any increased collision risk. However, there is clear potential to reduce the collision risk associated with cycling further (e.g. through improving cycling infrastructure and providing physical separation between bicycles and motor vehicles).	Logan et al. (2023) Systematic review of 127 papers. UK
There was a positive association with the existence of cycling paths and infrastructure for both commuting cycling and general cycling rates, from a review of 39 empirical studies. These were the two most significant built environment factors which encouraged cycling behaviours.	Yang et al. (2019) Meta-analysis drawing on 39 studies. Global
Positive effects on physical activity from 'urban interventions' included improving cycling environments (increasing the availability, accessibility, and safety of routes), as well as initiatives for active travel.	Zhang et al. (2022) Systematic 'review of reviews' drawing on seven review papers. Netherlands
The key success factor to developing quality infrastructure for active travel is 'collaboration with other stakeholders'. This is necessary to help leverage funding and share resources. Other success factors include getting and keeping resources, taking advantage of opportunities, upskilling to support staff and communities, and dealing with policy and politics.	Lawlor et al. (2023) Systematic review of 35 papers. UK
A review considered what evidence was needed to convince decision makers to prioritise active travel. Economic evidence was reported to be the most persuasive. This was followed by health evidence, environmental evidence, and the need for public support. Political support was perceived as essential, with strategies to foster support including not de-prioritising cars and gaining funding from external sources.	Lawlor et al. (2023) Systematic review of 35 papers. UK
A sustained increase in active travel arose from greater provision of active travel promotion and infrastructure. Increases arising from an intervention (infrastructure development, promotion, and initiatives) were more prevalent and more immediate for those living closer to the infrastructure.	Keall et al. (2022) Longitudinal survey, n=2,500. New Zealand

Key evidence	Source/Method/ Sample/Country
Infrastructure and the urban environment	
The Cycle City Ambition (CCA) programme (14 schemes in eight cities) demonstrated: • Positive trends in cycling levels with increases between +4% and +79%). • In four cities, cycle mode share increased by between 0.2%-points and 5%-points, sometimes accompanied by a corresponding decrease in car mode share. • Reduced car use (one million trips switched from car to cycle across eight cities over five years), and improved health outcomes from physical activity increases. 53% of existing cyclists (95% confidence interval of 51-55%) and 80% (95% confidence interval of 51-55%) of new cyclists felt that the new infrastructure led them to be more physically active. • Contributions to addressing demographic inequalities in cycling participation (gender, age, ethnicity). For example, across the programme the proportion of new cyclists that were female was 42% (95% confidence interval of 37-47%) compared to 33% (95% confidence interval of 32-35%) for existing cyclists.	Sloman et al., 2020 Mixed methods including automatic and manual mode counts, secondary data, Route User Intercept Surveys, Surveys, n=3,796 (across 42 surveys). UK
The CCA report emphasizes the importance of high-quality cycle infrastructure, such as segregated cycle superhighways and traffic-free routes, which can significantly increase cycling volumes and improve the overall cycling experience. The findings underscore the need for continued investment in cycling infrastructure to sustain the benefits and promote a more active and environmentally friendly transport culture.	Sloman et al., 2020 Mixed methods including automatic and manual mode counts, secondary data, Route User Intercept Surveys, Surveys, n=3,796 (across 42 surveys). UK
The CCA report highlighted that scheme-level measurements showed that cycling levels may continue to build up for 3-5 years after a scheme is completed.	Sloman et al., 2020 Mixed methods including automatic and manual mode counts, secondary data, Route User Intercept Surveys, Surveys, n=3,796 (across 42 surveys). UK

Table 3: Enabling behaviour change interventions by feature

Feature/ design	Fix Your Bike	MoBike bike share	Cycle Nation Project (workplace)	Tower Hamlet Cycle training	Disability cycle training	Gamification incentives	RCT incentives	Health cycling campaign
Social support			✓	✓	✓	✓		✓
Apps/ social media		✓				✓		✓
Bike share		✓						
Bike loan			✓	✓	✓			
E-cycles								
Cycle training			✓	✓	✓			
Roadshows								
Maintenance	✓		✓					
Awareness raising/ promotion			✓		✓	✓	✓	✓
Behaviour change support			✓	✓	✓	✓	✓	✓

1. Introduction

1.1 Active travel policy context

Active travel can be defined as travel that is powered – either partially or fully – by the sustained physical exertion of the traveller. Whilst active travel evidence and policy often refers to cycling and walking, a broader and more inclusive definition refers to any travel that is powered, partially or fully, by the sustained physical exertion of the traveller (Cook et al., 2022). As such the definition also includes wheeling (wheelchair use as well as a variety of other modes such as skateboarding or scooting). In recent years, active travel has received increasing recognition for its potential to help facilitate a range of environmental, public health and economic policy outcomes (Hirst, 2020).

In England, the government has an ambition to make walking, wheeling and cycling the natural choice for shorter journeys or as part of a longer journey. The government's original Cycling and Walking Investment Strategy (CWIS) published in 2017 set out specific, measurable aims and provided the financial resource to help achieve them.

The second cycling and walking investment strategy[4] (CWIS2), published in 2022 and updated in March 2023, aims, by 2025, to increase the percentage of short journeys in towns and cities that are walked or cycled to 46%; increase walking activity to an average of one walking stage per person per day; double cycling activity to 1.6 billion journey stages; and increase the percentage of children aged 5 to 10 who usually walk to school to 55%. The latter is set out as a specific target. Over the longer term, the strategy is that half of all short journeys in towns and cities will be walked or cycled by 2030, and that England will have a 'world-class' cycling and walking network by 2040. CWIS2 also introduced a more inclusive definition of active travel to include wheeling.

To support the implementation of projects that deliver its active travel aims, the Government has made an investment projected to be £3.6 billion from 2021 to 2025, and established ATE. ATE's role is to administer the funding whilst working with local authorities to ensure the delivery of high-quality active travel infrastructure for walking, wheeling and cycling, provide tools to deliver ambitious active travel programmes, and support children and other people to cycle.

1.2 Background to the evidence assessment

In 2022, the Department for Transport (DfT) commissioned Sheffield Hallam University in partnership with the National Centre for Social Research (NatCen) and Mosodi Ltd to undertake a portfolio evaluation of active travel. Overall management of this evaluation programme was transferred to ATE in September 2023. The overall aims of the evaluation are to understand how active travel interventions are being delivered; what impact they are having on uptake of active travel; whether they represent value for money; and how they are contributing to the government's walking and cycling objectives.

4 ATE and Department for Transport (2023) The second cycling and walking investment strategy (CWIS2), 10 March 2023.

To support the development of evaluation activities, ATE commissioned a suite of evidence assessments across a range of research and policy priority areas to help assemble evidence of 'key facts' and identify research gaps. The complete list of these evidence assessments is:

1. Enabling adult cycling.
2. Walking and wheeling.
3. Early consideration of active travel via planning and design.
4. Economy.
5. Health and wellbeing.
6. Journey times, congestion, and resilience.
7. Active school travel.

1.3 Enabling adult cycling

This report presents the results of the enabling adult cycling evidence assessment. It was envisaged that this theme would bring together two major areas of focus: 'interventions to enable behaviour change' and 'infrastructure interventions to create enabling environments.

Influencing and changing behaviours requires the identification of the barriers to cycling (for different people) and what works to overcome these? Alongside this, is the need to create environments which enable adults to cycle.

Ultimately, we were aiming to explore the enablers and facilitators to adult cycling, and how these might increase the propensity to cycle.

1.4 Research questions

This evidence assessment aimed to synthesise available evidence to address the following research question.

- How do the following factors enable adult cycling?
- Cycle training (in all forms e.g. confidence building, proficiency, coaching).
- Cycle infrastructure.
- Cycling equipment, facilities, and security.
- Influencing and incentivisation.

1.5 The structure of this report

The report is structured as follows:

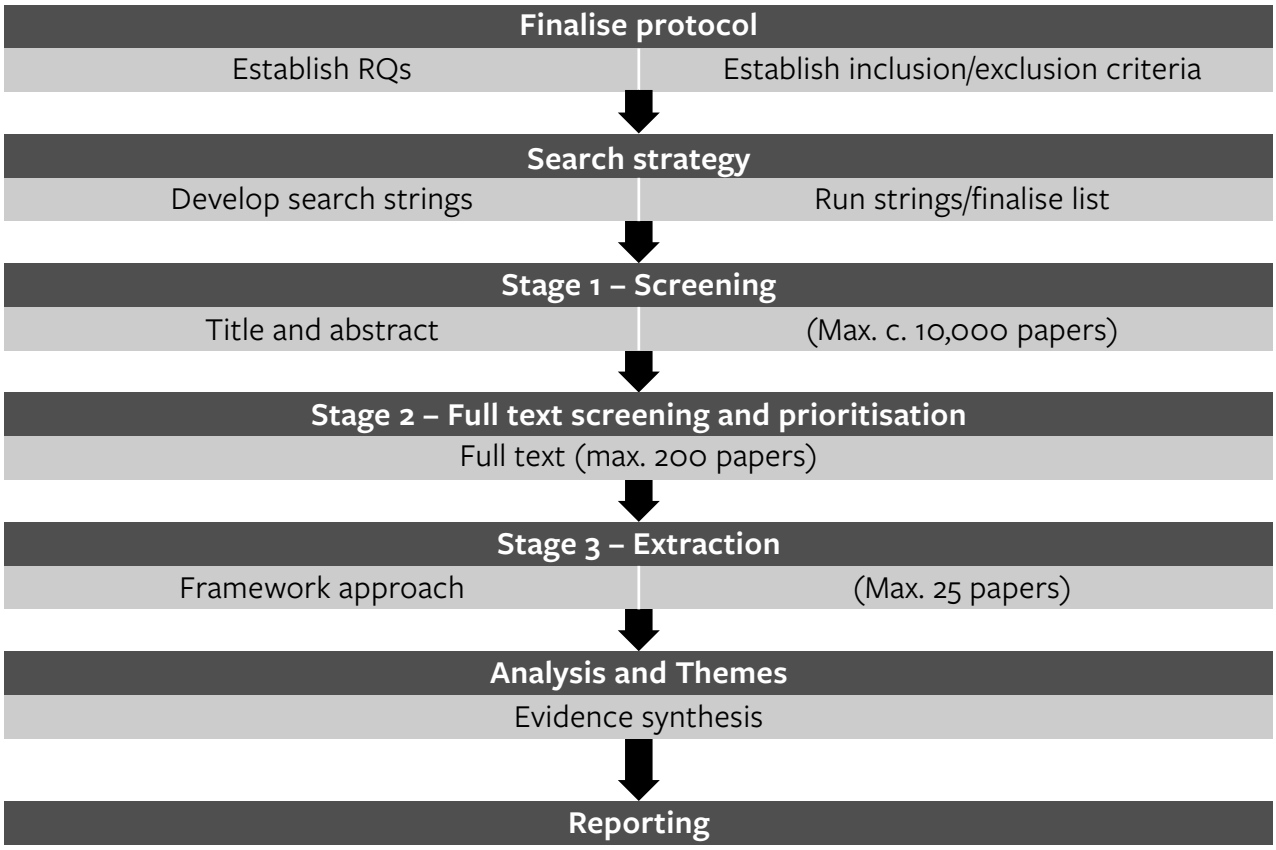
- **Executive summary.** The executive summary provides a high-level summary of the report, as well as a summary of key findings.
- **Introduction.** The first chapter provides background to this evidence assessment.
- **Methodology.** The second chapter provides a summary of the methodology used for identifying and synthesising relevant evidence.
- **Interventions to enable behaviour change.** The third chapter explores evidence on interventions which aimed to enable adult cycling in a variety of ways including through equipment, facilities, incentivisation. These are focused on enabling behaviour change specifically.
- **Enabling Adult Cycling.** The fourth chapter explores evidence on interventions which aimed to enable adult cycling with a specific focus on infrastructure interventions.
- **Conclusion and next steps.** A final chapter provides a summary conclusion of the evidence against the research questions and sets out implications and recommendations in terms of addressing gaps in the evidence base.

2. Methodology

This section outlines the overall methodology and approach to the evidence assessment. It provides further detail about the development of the assessment protocol, each of the specific stages in the identification, screening and extraction of evidence, as well as identifying the limitations of the research design.

The overall design was organised into three key stages and a set of supporting activities, as summarised in Figure 1.

Figure 1: Evidence assessment stages



2.1 Evidence assessment protocol

A protocol was developed which outlined the process and method to be followed. This helped to ensure consistency across the suite of assessments and to support the identification of relevant, high-quality papers within each assessment within a finite resource.

We determined initial thematic priorities for the evidence assessment with ATE. A stakeholder engagement process was held with key staff within ATE, DfT and other organisations to discuss and agree the thematic scope, agree a set of sub-themes to structure the identification and assessment of evidence, research questions and the concepts and terms that would be used to specify the inclusion criteria. Suggestions were also made by stakeholders for specific non-academic studies and reports for consideration in the evidence assessment. Initial scoping was supported by running a series of test searches using generic search strings on bibliographic databases to provide an initial indication of the likely size of the evidence base. This was used to help further refine the thematic scope of the assessment and its sub-themes and provide initial information on the broad composition of the evidence base (e.g. likely availability of UK-based evidence, types of methods and studies, availability of systematic or meta review studies).

2.2 Search strategy

Academic literature was identified as being potentially relevant to the assessment theme and sub-themes using two database searches: an academic search using the Scopus database and a manual grey literature search across a range of relevant sites (full details of this, including the specific search strings used, can be found in Annex A). In addition to this, evidence identified by experts from ATE and DfT at the stakeholder engagement stage was incorporated into the screening.

2.2.1 Inclusion and exclusion criteria

The inclusion criteria were developed to narrow the search to the papers most relevant to the overall theme. These criteria were applied to both search pathways but not to the third pathway, which was the suggested evidence from ATE and DfT staff.

- **Language:** Only English language papers.
- **Country:** UK, Europe, North America, New Zealand, and Australia (those deemed most relevant to the English context).
- **Year:** Papers published from 2013 onwards (to ensure the most recent evidence was prioritised).
- **Publication status:** Published peer-reviewed academic literature and published grey literature.
- **Type of studies:** Systematic/evidence reviews, meta-analysis, theoretical paper, or empirical studies using primary data collection or secondary data analysis.

2.3 Academic database search and search strings

Separate search strings were developed for each of the identified sub-themes within the overall theme. For this assessment, these sub-themes and their broad coverage were as follows:

1. **Training,** including training, proficiency, safety, confidence, education and develop.
2. **Maintenance and repair,** including maintenance, repair, support, workshop, library and rehab.
3. **Equipment,** including share, loan, hub cycles, and e-cycles.
4. **Facilities,** including facility, amenity, storage and hangar.
5. **Incentives,** including inceptives, cycle, bike to work scheme, challenge.
6. **Security,** including security, parking, lock; and,
7. **Infrastructure,** including cycle lane, route, path, track, street, and junction.

These strings were then used to search the Scopus bibliographic database, which is a large and comprehensive database of peer reviewed academic publications. Annex A provides an outline of the search strategies deployed and breaks down the number of results returned for each search string and in each database. The total number of studies identified as being potentially relevant was as follows:

- Sub-theme 1 (equipment, facilities, maintenance, and service interventions): 2,489 (1,353 training, 599 maintenance, 56 equipment, 454
- facilities, 27 security).
- Sub-theme 2 (influencing and incentivisation): 133.
- Sub-theme 3 (infrastructure): 285.

2.4 Grey literature search

To supplement the academic database search, a search of 'grey' literature was conducted across a range of relevant websites using the Google search engine. This applied a standardised set of search strings for all evidence assessments to identify further sources. The results were then manually screened by each theme to identify relevant evidence for inclusion in the full text screening stage. Theme leads coordinated to avoid including the same piece of evidence in multiple themes. For this theme, 11 additional papers were identified for inclusion in the full text screening. A full list of the websites searched for grey literature is included in Annex A.

2.5 Suggested evidence

A final pathway through which evidence was identified was suggested evidence provided by experts at ATE and DfT. The stakeholder engagement stage included inviting suggestions of evidence that might be included in the assessment. For this theme, one papers were identified through this pathway.

2.6 Screening and extraction

2.6.1 Title and abstract screening

2,907 titles were initially screened. This process involved assessment of titles and the publication title against the inclusion criteria. Several rounds of refinement were required to exclude irrelevant articles or publications. All papers were considered against a prioritisation tool and checklist to ensure the final list of papers would address the research questions specifically. The criteria used at this stage were:

- Relevance to the theme and sub-themes.
- Geographic focus (aiming to identify UK based studies where possible).
- Paper type[5] (e.g. systematic review paper, primary research paper, literature review, discussion paper).
- Study/data type (aiming to prioritise inclusion of studies which used real- world data as opposed to modelled or synthetic data).

5 Systematic review papers were prioritised (where available) as these papers synthesise the available evidence on a topic or the effectiveness of an intervention by drawing on multiple primary research papers. This means that evidence from systematic reviews is more comprehensive and reliable than from individual studies.

- Coverage across sub-themes (aiming for a pragmatic distribution of studies across the agreed sub-themes).
- Whether the study was specifically recommended at the stakeholder engagement stage for inclusion; and
- Age of the study (aiming to include most recent studies where possible).
- Age of the study (aiming to include most recent studies where possible).

Following this screening process, 103 studies were accepted for full text review.

2.6.2 Full text screening and prioritisation

103 papers went through full text review from the academic search. An additional 11 were included from the grey literature search and three from recommendations from ATE and DfT, giving a total of 117 articles.

A Weight of Evidence (WoE) scoring was applied to rate the evidence according to the quality of its research design and presentation of findings. This was assessed using the questions and scoring scheme set out in Table 4 to arrive at a final WoE score out of 14 for each candidate source.

Table 4: Weight of Evidence scoring scheme

Question	Score
1. Is there a clear statement of the aims/objectives or clear research questions?	1-4
2. Is the sampling strategy (or data selection strategy if not collecting primary data) clearly described and appropriate for the research questions/aims?	1-4
3. Is the method of data collection and analysis clearly described, and appropriate to answer the aims/research questions?	1-3
4. Are there any concerns regarding accuracy (e.g. discrepancies within the report)? (high score means no concerns)	1-3
Total Weight of Evidence (WoE) score	**4-7 (low)** **8-11 (medium)** **12-14 (high)**

2.6.3 Data extraction

Using the WoE scoring to prioritise the most robust studies, 28 papers were identified to extract data and evidence from. The full list of papers is shown in the Annex B)Table 13: Source information along with their WoE scores. An extraction framework was developed to organise the evidence extracted. The framework was structured thematically, to ensure a spread of papers across the sub-themes. Once extraction was complete, the evidence was summarised and synthesised for inclusion in this report.

2.7 Limitations of the research design

This was a focused evidence assessment. It drew on a limited number of sources in line with the available resource, using a systematic screening and prioritisation process. To draw more exhaustive conclusions a larger Rapid Evidence Assessment (REA) or systematic review would be required to ensure broader coverage of sources.

3. Interventions to enable behaviour change

3.1 Introduction

This chapter examines the evidence of the barriers and enablers to adults cycling with a specific focus on behavioural based interventions. Within this broad topic, we summarise evidence relating to three themes that emerged from the literature included in the assessment:

- Equipment, facilities, and cycle maintenance / service interventions:
  - E-cycles.
  - Cycle facilities – parking and maintenance.
  - Bike share and bike loan schemes.
- Influencing and incentivisation interventions.
- Social and behavioural interventions:
  - Cycle training.
  - Workplace interviews.
  - Other social and behavioural interventions.
- Enabling environments.
- Infrastructure.

3.2 Equipment, facilities, and service interventions

A variety of evidence was identified which examined the significance of equipment, facilities, and services in promoting adult cycling. Among the selected studies, the evidence focused on: e-cycles, cycle parking, maintenance and repair of cycling equipment, cycle share schemes, and cycle loan schemes. The synthesised evidence suggests that a certain level of 'readiness' is required to switch to making some journeys by cycle, including confidence and skills, equipment and accessories, route knowledge, storage, and security.

3.2.1 E-cycles

E-cycle usage and e-cycle loan schemes can be successful in increasing both the use and purchase of e-cycles, replacing some journeys that would otherwise be made by car (Carplus Bikeplus, 2016; Jenkins et al., 2022).

Jenkins et al. (2022) conducted an e-cycle scoping review (107 selected articles) that highlighted that the use of e-cycles (sometimes referred to as Pedal Assisted E-Bikes - PAEBs) has the potential to reduce our reliance on personal cars for short distance trips. This review, in summary, showed that there is potential for e-cycle use to transform personal transportation towards a mode that is eco-friendly, age-friendly, barrier-free, healthy, and cost-effective. However, the authors did not quantify this 'potential' and acknowledged further work would be needed to do so.

A report from Carplus Bikeplus on behalf of CoMoUK, the national organisation for shared mobility, evaluated a shared e-cycle scheme over 12 months (2015- 16) which provided 188 electric bikes, used by 2,667 people, to make 11,702 journeys. The report highlighted that e-bikes attracted a wider demographic of cyclist, particularly women. Additionally, 18% of survey respondents who described themselves as regular users of the e-cycle share scheme were 'Not in Education, Employment, or Training (NEET)' and a further 18% were part time workers.

Bikeplus's (2016)'s evaluation of a shared e-cycle scheme found that half of those who joined the scheme used shared e-bikes at least once a week, including 39% who used the e-cycles three or more times a week. The evaluation found that 13% of regular riders proceeded to purchase an e-bike and a further 17% purchased a standard bike. The scheme reported good engagement from employees using bikes for commuting purposes and incorporated a recommendation to consider increasing the value threshold for e-cycles in the Cycle-to-Work scheme to promote greater adoption and accessibility.

Bikeplus's evaluation of shared e-cycle schemes reported positive health and wellbeing benefits. Overall, 26% of regular e-cycle riders agreed with the survey statement - "I previously struggled to use a regular bike for fitness/health reasons" and a series of case studies from within the 16 test sites described how e-cycles had helped widen access to cycling for users with health conditions or during rehabilitation from injury or illness. The evaluation reported that the scheme had been successful in attracting people back or into cycling and had facilitated people cycling for longer (travel times and distances) – with average cycle journeys increasing from three to five miles - providing physical activity benefits. The survey results (sample size 535) highlighted that people using an e-cycle regularly reported feeling happier (58%) and healthier (41%).

The evidence highlighted in this sub-section suggests there is a certain level of 'readiness' needed to switch to making some journeys by e-cycle, which supports the rationale for delivering training and confidence building sessions as part of bike loan schemes.

The combined evidence also suggested differences in the preparedness requirements depending on whether the cycle involved will be a traditional bike or an e-cycle, and whether it is purchased, loaned, or accessed via a share cycle scheme. However, some basic requisites must be in place whatever the type of bike or ownership (e.g. ability and confidence to ride, equipment, storage etc). There is a need for access to secure cycle storage at workplaces and in towns and city centres to support any changes in travel behaviour. Cycle storage at home (or near to home) would also be needed for people purchasing or loaning a bike or e-cycle, and the size and weight of cycles need to be factored into this.

The potential speed of e-cycles and safety concerns related to their wider spread usage were explored in a review by Jenkins et al. (2022). Jenkins reported a perception that cycling at higher speeds whilst riding e-cycles would lead to more harm / safety fears. However, the review concluded that accidents, violations, and injuries are similar when comparing e-cycles to traditional bicycle users. Based on the evidence on violations and crashes, the review suggested that policies are needed to ensure that e-cycles are treated similarly to traditional bicycles in that e-cycles do not require additional regulation (Jenkins et al., 2022).

3.2.2 Cycle share schemes

Evidence highlights that cycle share schemes can positively influence a population's propensity to cycle. However, there are important elements that must be factored in for this to occur, which bring together infrastructural requirements, alongside opportunities to hire a bike with appropriate ease and cost, and of the necessary quality, to provide a positive experience. Furthermore, some evidence from bike share schemes, highlights the potential to inadvertently exclude people from access due to gender, age, and incomes.

Sanmiguel-Rodríguez & Arufe Giráldez (2021) assessed the efficacy of bike share systems to determine whether it was an efficient and sustainable alternative transport mode in cities. The systematic review concluded that bike share systems can help to maintain healthy habits amongst the population, and that better infrastructure, technology and appropriate policies can favour the use of these systems. However, the review also highlighted the 'favourable climatic conditions', and suggested that Spain is one of the countries with the most potential to encourage engagement in outdoor physical activity. This raises questions on the generalisability of the insights to other colder or wetter regions, including the UK. The study authors emphasised that the barriers to cycling are not always evenly felt, for example those who can purchase, maintain, and securely store a bicycle/e-bike or subscribe to a bike-sharing scheme if available have more opportunities to engage with cycling as an alternative mode. It concludes that policy responses must not further disadvantage vulnerable groups.

Sherriff et al. (2020) found that bike sharing can influence a population's inclination to cycle, however, the extent to which people were able to benefit from Manchester's 'MoBike' dockless cycle scheme was based on a range of factors. This included: the spatial distribution and density of the bikes, the quality of the bikes, the cost of hire and the ease of use, and accessibility of the online platforms. In particular, the quality, perceived usability and comfort of the bikes is a limiting factor, with a poor-quality experience potentially forming a major barrier towards future cycling.

Sherriff et al. (2020) also identified a range of barriers to usage of its dockless cycle share scheme. A mixed methods evaluation exploring usage, barriers, and experiences of the dockless (MoBikes) bikes brought together 2,270 online survey respondents and 27 interviews, from people living in, working in, or visiting Greater Manchester. It found that concerns over personal safety, especially for females, can limit bike share scheme use. Evaluation data found that 40% of female users had safety concerns when cycling in traffic, compared to 30% of males. For non-users, this difference was more pronounced - 34% of male and 61% of female 'deciders' and 28% of male and 57% of female 'avoiders' cited safety issues as a concern.[6] This raised concerns that bike share schemes can perpetuate, rather than challenge, gender imbalances in cycling participation and that purposive action is therefore needed. In practical terms, the evidence suggests that cycle share schemes need to be viewed in the context of existing infrastructure and practice; not only should the cycling environment be attractive for any type of cycling, but cycle share bikes should be appropriate for that cycling environment. For cycle share schemes to boost cycling numbers, it needs to be an ambassador for a high-quality and enjoyable cycling experience. It was recommended that bike share operators should be sensitive to the social and physical geography of cities, rather than assuming that a 'one size fits all' approach is adequate. Engaging with existing bodies, including transport authorities and local authorities, in co- creating bike share systems, is also crucial for success (Sherriff et al., 2020).

6 'Deciders' were those that hadn't users bike share in the past 12 months but might in the next year. 'Avoiders' were those that hadn't used bike share in the past 12 months and were 'not at all likely to' in the next year.

3.2.3 Parking and maintenance

Evidence suggests that cycle parking supply, and the quality of this supply, are determinants of cycling for both current and potential cyclists, and that higher quality facilities are important for increasing personal security and safety. Free of charge or subsidised cycle maintenance could potentially increase cycle usage.

A systematic review of bicycle parking concluded that the level of evidence on the importance of bicycle parking was limited, with most studies focusing on cycle parking at public transport stops and workplaces (Heinen & Buehler, 2019). The review also concluded that charging for parking reduces the likelihood of using a facility, and that many cyclists resort to locking their bicycles to street furniture due to a local imbalance between supply and demand. In particular, one study within the review (Geurs et al., 2016) found that free bicycle parking would result in an 11% greater likelihood of cycling to a railway station (vs. having to pay for parking), whilst another study (Mrkajic et al., 2010) monitored parking behaviour before and after the installation of higher-quality parking spaces and reported that occupancy rose from 30%-40% to 68% (cited within Heinen & Buehler, 2019).

Free or reduced cost cycle repair and maintenance was cited as an important factor in instilling confidence and overcoming financial barriers to cycling. A 'Fix Your Bike' voucher scheme provided 400,000 x £50 vouchers to members of the public to support cycle repair or servicing (Cairns et al., 2023). The scheme was effective in attracting people who did little or no cycling: over a third of those applying (35%) said they had cycled less than once a week in the previous year, including 6% who said that they never cycled, whilst only around one third of respondents would have had the work done on their bike anyway without the voucher, indicating the impacts of cycle repair and maintenance above and beyond what would have occurred without the intervention (Cairns et al., 2023). Vouchers on their own were not cited as the sole cause of change, but they were thought to be a catalyst to overcoming financial barriers, improving equipment, and providing a reason/confidence to go into bike shops.

3.3 Influencing and incentivisation interventions

3.3.1 Incentives

Incentives, particularly financial rewards, can effectively promote active travel, such as cycling for commuting purposes, with financial rewards proving more effective than gamification elements in encouraging cycling.

Garrott et al. (2023) conducted a Randomised Control Trial (RCT) to explore the use of incentives to promote active travel. The study found that reducing the effort required from individuals to receive incentives (e.g. direct receipt of an incentive by email rather than having to apply) may lead to increased use, however increasing the value of the incentives did not lead to further increases in use (assuming the incentivisation level was deemed adequate to begin with). The incentives included a £50 sports goods retail voucher, free cycle service, subsidised e-cycle hire scheme, bus tickets, and a reduced household annual management charge. Incentives were useful in helping to initiate new leisure travel or to subsidise existing leisure travel, with little evidence to suggest they initiated commuting behaviours (Garrott et al., 2023).

Findings revealed that people are motivated to engage in more frequent commuter cycling with the use of incentives using a smartphone app. Máca et al. (2020) studied a 'Cyclers' smartphone app in order to evaluate financial and non-financial (gamification) motivational features. The smart gamification comprised of an app which included points, badges, leader boards, and challenges. Financial rewards were more effective than smart gamification (Máca et al., 2020). Similarly to Garrott et al. (2023), Wang et al. (2022) found that providing a small amount of money as a reward for users who cycled to work (or school) every day can effectively encourage people to significantly increase their frequency of cycling. Wang et al.'s (2022) systematic mapping of the scientific literature on the use of gamification to incentivise, finding that the most commonly used gamification elements are goals and challenges, as well as accruing points (Wang et al., 2022).

The evidence base on the use of gamification in transportation is an emerging field. Máca et al. (2020) noted that there is no strong empirical evidence of impact as research in this field is still in the early stages of exploration. Due to new and developing approaches being used, the potential of smartphones to incentivise sustainable travel has still not been fully explored.

3.3.2 Social and behavioural interventions

Possessing the skills, competencies, and confidence to cycle is a major determinant of cycling in the first place and supporting these is essential for enabling behaviour change towards cycling. The evidence below explores the impact of UK cycle training schemes (one targeting the general population, and another specifically tailored for disabled people), workplace cycling interventions, and the wider social determinants of cycling. This includes a focus on how programmes, initiatives and policies can enable adult cycling and support behaviour change to achieve an increase in cycling (both the number of people and the number of trips by bike).

Cycle training interventions

Berent et al. (2021) found that one of the key factors to increasing cycling for disabled people is to provide appropriate cycling training for disabled participants and those who are involved in delivering the training itself, with safety concerns being a key deterrent to cycling for disabled individuals.

The study investigated the delivery of cycling activity and training sessions for disabled people, including the delivery system, supporting materials, instructor training, as well as the perceptions of participants. It found that raising awareness among disabled people and their parents and carers is instrumental to successful engagement, as is accessible provision of educational resources for instructors (Berent et al., 2021).

The study recommended that the presence of traffic safety education within an inclusive cycling curriculum could make a significant difference in building confidence to cycle independently. However, this was also contrasted with two thirds of surveyed cycling instructors believing that traffic safety education should not be a part of cycling activity session for people with disabilities (Berent et al., 2021). The reported mismatch between what is needed and what is currently delivered suggests that there is a requirement for raised awareness and more educational resources for instructors.

Johnson & Margolis (2013) found that one London-based cycle training scheme saw statistically significant increases in the frequency of cycling three months after cycle training compared to beforehand. There was a statistically significant increase in the number of days cycled for at least 30 minutes, three months after the training had taken place than

beforehand. This shows that without the training these increases would not have happened. Furthermore, the mean number of days cycled to work in the past week almost doubled from 0.66 days prior to cycle training to 1.33 days three months afterwards.

This London study (Tower Hamlets) also found that the cycle training was far more likely to attract women than men, and that the cycle training had a large positive impact on confidence levels. Also, the cycle training was successful in encouraging participation from new or returning cyclists, rather than existing cyclists wishing to 'top up' their skills (Johnson & Margolis, 2013). Road safety concerns are repeatedly noted as a major barrier to cycling in UK urban areas, therefore the study suggested that the increase in confidence may assist in reducing this barrier.

Campos Ferreira et al. (2022) also noted that there is a somewhat limited pool of evidence on the effectiveness of cycle training in encouraging cycling among individuals.

Workplace interventions

Encouraging cycling at the workplace is part of the overall workplace travel planning process and several studies reported on workplace interventions to increase active travel, which included many features of the DfT's 'Cycle to Work Guarantee'.[7] The workplace evidence reviewed as part of this assessment often brought together a myriad of factors (such as equipment, facilities, training, and support) needed to influence employee behaviour. They all noted the importance of infrastructure in addition to behavioural change strategies in enabling adult cycling.

The UK's Cycle Nation Project (CNP) moved beyond a single-component workplace cycling intervention to design a multi-component individual/social- level intervention tailored to address specific barriers to cycling for employees of a multi-national bank (HSBC) (Connell et al., 2022). The intervention started with the identification of barriers (both at national level and local level via a mixed methods approach) which then shaped the design of an intervention covering six areas (education, persuasion, incentivisation, training, environmental restructuring, and enablement). A cycle hire and cycle servicing scheme was then offered along with an extensive programme of training and behavioural change supported by Cycling Champions (Connell et al., 2022).

The intervention highlighted a series of barriers to cycling, this included: cost (the bike itself and associated equipment), a lack of facilities (both at work and home), non-supportive workplace culture for cycling (including not being able to wear appropriate clothes for cycling), a lack of social support (work colleagues, friends, family who are not interested in cycling, therefore no role models or mentors), and a lack of knowledge (suitable cycle routes and how to plan them, and access to appropriate schemes), and, specifically, lack of 'basic cycling knowledge'. From a series of workplace focus groups, this 'lack of knowledge' was identified as a barrier to cycling. This included a lack of knowledge about suitable cycle routes and route planning, "difficult to navigate" cycle hire and cycle-to-work schemes, and a lack of 'basic cycling knowledge' e.g. bike maintenance skills, such as changing inner tubes.

7 More information on the 'Cycle to Work Guarantee' can be accessed here: https://assets.publishing.service.gov.uk/media/5dc9475440f0b64251080457/cycle-to-work-guidance.pdf. This guarantee highlights good cycle parking facilities, changing showers and lockers, buying assistance, facilitating cycle repairs and inspirational measures such as cycle training, targets and awards, bike 'buddies' as core elements which may enable adult cycling.

The principal barriers to cycling amongst those who had not cycled since childhood were: 'the cycling (on-road) infrastructure does not make me feel safe' (53%) and 'not feeling confident riding on roads' (54%). This compares to 35% and 29% respectively for people who cycle at least weekly (non-cyclists stats based on a survey sample of 5,439).

The approach of identifying the barriers to cycling (via national and local data), and then subsequent design of an intervention to address these barriers, proved successful. The workplace intervention delivered to 68 individuals succeeded in helping participants increase their cycling by three rides, from 1.2 to 4.2, and by 43.1 minutes per week, from 12.7 minutes to 55.9 minutes.

Additionally, participants reported increases in commuting (31.4%), utility journeys (40.0%), and leisure cycling (57.1%), with a 63% overall increase (Connell et al., 2022) (note that these were not shown to be statistically significant increases).

A narrative review of cycling barriers and enablers found that supportive policies and programmes at the organisational and community levels, including workplace cycling initiatives and community cycling events, can increase the number of people cycling as a regular activity (Logan et al., 2023).

Other social and behavioural interventions

The identified evidence incorporated some examples highlighting the success of promotional campaigns to highlight the positive benefits of cycling.

Promotion of cycling as an everyday activity, rather than just a sport, is important to increase participation. Social support and encouragement from peers, family, and friends can positively influence individuals' decision to cycle (Logan et al., 2023).

One study by Nielsen & Haustein (2019) found that a promotional campaign in Denmark which highlighted the benefits of cycling, led to a significant increase in cycling trips, with at least 21 million additional cycling trips conducted because of campaign activities. The study measured the behavioural effects of a cycling campaign aimed at improving people's health through increased physical activity. The campaign's focus on the positive health effects of cycling and the various campaign activities, including local events, media promotions, and social media campaigns, helped to motivate people to cycle more frequently. In particular, the use of a smartphone app that provided personalised feedback and motivation and was found to be a contributing factor to the campaign's success (Nielsen & Haustein, 2019). The methodology combined two datasets (Danish National Travel Survey and a nationally representative project evaluation survey totalling 11,798 responses) and conducted regression analysis (logistic and linear) both of which found significant effects. Additionally, convenience, location, environmental advantages, economic benefits, entertainment, and health benefits were found to be key facilitators of cycling. A review by Sadeghvaziri et al. (2023) assessed active transportation studies that focused on underrepresented populations.

The review of studies found that the creation of cycle lanes and bike share stations tends to occur in socio-economically advantaged regions, potentially excluding people of colour and those with low socio-economic status from environments that encourage walking and cycling. Subsequently, the review identified the key barriers to remove when designing bike share interventions for minority and low-income groups: safety concerns, equipment (lack of helmets specifically), location (lack of nearby stations), ease of access (difficulty renting/returning bikes), and weather conditions (Sadeghvaziri et al., 2023).

A further systematic review studied the determinants of cycling and their effect on the perception of safety, security, and comfort. The review highlighted that perceptions of safety are negatively affected by the fear of traffic-related injuries, fear of injury related to infrastructure, infrastructure maintenance, and the negative behaviour of drivers (Campos Ferreira et al., 2022). Furthermore, concerns about crime, both personal safety and property security, are major factors influencing the security perception of pedestrians and cyclists (Campos Ferreira et al., 2022).

The study draws four important conclusions: that it is important to understand the determinants that influence perceptions of pedestrians and cyclists, which will help with defining and implementing transport policies. Secondly, that transport policies should explore the social and psychological aspects of all road users' interaction (and not just the importance of infrastructure design and maintenance). Thirdly, that all stakeholders including vulnerable road users should be involved in defining policy. Finally, that there is a need to invest in educational programmes that raise road safety awareness (Campos Ferreira et al., 2022).

4. Infrastructure interventions to create enabling environments

4.1 Introduction

This chapter examines the evidence of the barriers and enablers to adults cycling with a specific focus on enabling environments. Whilst the previous chapter examined the behavioural interventions, this chapter focuses on the built environment, specifically infrastructure.

4.2 COVID-19 impacts

To better understand the barriers and facilitators to adult cycling it is important to appreciate how the built environment influences behaviour.[8] The interaction between different elements of the built environment, urban planning, and its influence on behaviour was the focus of several selected studies. Additionally, some infrastructure evidence related to the COVID-19 pandemic was also reviewed.

The pandemic transformed the way people moved around and had significant impact on patterns of infrastructure use, particularly public transport usage which strongly relates to active travel (with many journeys combining the two). The lockdowns, physical spacing guidelines, transport restrictions and stay-at- home orders issued within the pandemic led to a range of temporary changes. However, there have been some legacy impacts and many of the lessons learnt in relation to transport provision remain relevant. Whilst transport usage levels have now largely recovered, the shift to hybrid and homeworking has resulted in work travel remaining supressed whilst travel for leisure purposes has increased.

8 The third report in this suite of evidence assessments - Early consideration of active travel via planning – also reports on evidence related to this in terms of the impact that planning policy and site-level development management and design considerations can have on active travel outcomes.

A research study by Nikitas et al. (2021) combining a literature review and case studies, explored cycling in the era of COVID-19 by assessing some of the cycling friendly initiatives (reallocating street and public space to cyclists, pop- up cycle lanes, e-bike subsidies, free bike share, as well as traffic calming measures) that were introduced across the world during the pandemic. The study assessed the successes and failures of various initiatives and the lessons learnt. The growth in popularity of active travel modes was an immediate positive effect of the virus because it provided socially distanced forms of transport. The study concluded that 'cycling is not a panacea on its own but one key piece in the diverse and multi-dimensional toolkit of travel demand management'. It stated that funding should be allocated to walking, public transport, Mobility-as-a-Service[9] and Mobility-on-Demand[10] initiatives.

4.3 New infrastructure and the urban environment

Evidence suggests that cycling is unlikely to become a mainstream mode of transport without high quality infrastructure. Improvements to infrastructure and interventions to advance the urban environment can positively encourage cycling behaviour, with the provision of new bicycle infrastructure found to be strongly associated with increased levels of physical activity.

The Cycle City Ambition (CCA) programme (Sloman et al., 2020) funded 14 schemes in eight cities over a five-year period (2013-2018). The schemes incorporated a combination of new and improved infrastructure including segregated cycleways, improved cycle routes, green space / canal towpath improvements, traffic calming measures, improved junctions, crossings and bridges, widened cycle access, and improved parking and facilities including workplace and school provision. The programme measured positive trends in cycling levels with increases between +4% and +79%. In four cities, cycle mode share increased by between 0.2%-points and 5%-points, sometimes accompanied by a corresponding decrease in car mode share. Reduced car use was estimated from survey data with at least one million trips switched from car to cycle across eight cities over five years. CCA resulted in improved health outcomes from increased physical activity by 53% of existing cyclists (95% confidence interval of 51-55%) and 80% of new cyclists (95% confidence interval of 51-55%, pooled sample n=3,796). It also contributed to addressing demographic inequalities in cycling participation (gender, age, ethnicity). For example, across the programme the proportion of new cyclists that were female was 42% (95% confidence interval of 37-47%) compared to 33% (95% confidence interval of 32-35%) for existing cyclists.

The CCA report also highlighted the importance of safety improvements, the positive impact of new cycling infrastructure on perceived safety, and the need for continued efforts to address safety concerns. There was strong public support for improving the safety of cycling. A large majority of the general public (69-79% of those surveyed in five CCA cities) believed that the safety of cycling in their city should be improved. This support was even higher among people who cycle, with 71-85% wanting safer conditions for cycling.

9 The Department for Transport defines Mobility as a Service as 'the integration of various modes of transport along with information and payment functions into a single mobility service'. https://www.gov.uk/government/publications/mobility-as-a-service-maas-code-of-practice/mobility-as-a-service-code-of-practice

10 For example, ridesharing (i.e. Uber) and car sharing services.

Evidence on the size of the uplift in cycling on the new infrastructure suggests that more ambitious and large-scale schemes had bigger impacts. Taken together, the schemes funded by CCA are estimated to have replaced over 6 million km per year travelled by car, with associated carbon savings. However, these schemes required substantial resources (budgets of £1- 3million per km are needed for two-way physically segregated cycle superhighways, and bridges may cost £4-5 million). Therefore, the building of comprehensive, Dutch-style cycle networks, towns and cities would require significant investment over extended time periods. A systematic review explored transport policies that increase physical activity and found that the development of new bicycle infrastructure, including traffic-free cycling routes and cycle facilities (for example, cycle storage or changing facilities), has a significant positive effect on physical activity (Zukowska et al., 2022). By implementing policies that provide safe and connected walking and cycling infrastructures, promote active travel whilst also supporting public transport, can increase physical activity. Furthermore, Zukowska et al. (2022) found clear evidence that active travel policies work best when implemented as a comprehensive package of interventions (for example, a combination of infrastructure and behaviour change programmes) , whilst nearly all studies within the systematic review indicated that policies that are enforced by national or regional government, or their agencies (of any level), may achieve specific health goals within a society.

Adam et al. (2020) found that the single most effective measure to increase cycling and improve real and perceived cycling safety was judged to be the provision of a basic level of safe, high-quality infrastructure. This included facilities segregated from motor traffic, where traffic speeds and volumes necessitate, and low speed, shared streets elsewhere. It was suggested that cycling is unlikely to become a mainstream mode of transport without an adequate network of cycle lanes and paths, intersection treatments, and bicycle parking (Adam et al., 2020).

Despite the evidence that cycling levels in the cities increased within the CCA programme (Sloman et al., 2020), surveys of cycling participation did not show an increase in the proportion of people who cycled, possibly due to limitations in the survey methodology. The findings suggest that while individual schemes contribute to mode choice, the overall effect of a complete cycle network would likely be more substantial. Furthermore, it takes time for the full impact of cycling infrastructure to manifest, with some schemes still seeing growth 3-5 years post-completion.

4.4 Segregated, quality infrastructure

Of similar note, a narrative review by Logan et al. (2023) found that cycling infrastructure, such as protected cycle lanes and clearly marked cycle-specific facilities, improves safety, and encourages cycling participation. Cycling collision rates are relatively low, and fatalities are rare events, especially in countries with high levels of cycling infrastructure and clearly marked bike- specific facilities (Logan et al., 2023).

The key features of a ‘cycling-friendly city’ were studied by Yang et al. (2019), categorising results based on the built environment and four domains of cycling behaviours: transport, commuting, recreation, and ‘general’. It was found that for both commuting cycling and general cycling there was a positive association with the existence of cycling paths and facilities, and these are the two most significant built environment factors which may encourage cycling behaviours (Yang et al., 2019).

A systematic review of existing reviews that focused on urban interventions which promote physical activity (including but not limited to active travel and cycling) found that positive effects on physical activity from 'urban interventions' included improving cycling environments, as well as initiatives for active travel, indicating that the urban environment can help promote physical activity. Interventions aimed at walking and cycling (increasing the availability, accessibility, and safety of routes) showed positive effects in promoting physical activity (Zhang et al., 2022).

A review by Lawlor et al. (2023) found that the key success factor to developing quality infrastructure for active travel is 'collaboration with other stakeholders'. It reported that this is necessary to help leverage funding and share resources, and that upskilling was important to support staff and communities. Other themes that can guide success include getting and keeping resources, taking advantage of opportunities, and dealing with policy and politics. The review also found that the arguments perceived to be convincing to decision makers in terms of prioritising active travel were: economic (most persuasive), health, environmental, and public support. Political support was perceived as essential, with strategies to foster support including not de-prioritising cars and gaining funding from external sources (Lawlor et al., 2023).

One study, which employed a longitudinal survey (n=2,500), observed a long- term increase in active travel arising from increased provision of active travel promotion and infrastructure, whilst positive increases in active travel because of an intervention (infrastructure development, promotion, and initiatives) were more prevalent and more immediate for those living closer to the infrastructure than those living further away (Keall et al., 2022). This suggests that distance from infrastructure is an important reason for increasing use of the infrastructure both for reasons of convenience and visibility.

The Cycle City Ambition evaluation (Sloman et al., 2020) found that less ambitious schemes and compromised schemes had less impact e.g. cycle paths with 'light segregation'; 'mixed routes' (e.g. combining on-road cycle lanes marked by white lines, quiet roads and short sections of segregated cycle track); segregated cycle paths adjacent to inter-urban multi-lane roads with busy traffic; and isolated junction treatments. 'Light' segregation is probably better than no segregation, but less effective than 'full' segregation. The report concluded that whilst these schemes may still be worth doing as part of wider investment, on their own they are unlikely to be transformative. Clark & Parkin, 2022), which reviewed 26 relevant papers related to cycling diversion factors.

Cycling diversion factors estimate the proportion of new trips induced by an intervention which would have otherwise been undertaken by another mode (Clark & Parkin, 2022, p. 3). The research presented updated estimates of cycling diversion factors derived from route user intercept surveys (RUIS) conducted across England (and also considers six international studies). The report included secondary analysis of the Cycle City Ambition scheme RUIS data to calculate a weighted mean of typical marginal cycling diversion factors, which was supported by international data (Denmark and USA) and wider observational evidence. Compared to the existing TAG value of 11%, a significantly higher estimate of 24% for the car to cycle diversion factor was calculated – more than double the previous TAG estimate (for every 100 new cycle trips, 24 are estimated to come from car travel). This suggests a substantial shift in travel behaviour due to infrastructure improvements.

5. Determinants of and barriers to participation in active travel

Previous chapters have explored the key determinants and barriers to participation in active travel, influenced by behaviour-based interventions and enabling environments. The presence or absence of the following, plus factors linked to quality and accessibility, have the potential to either encourage or deter participation:

- **High-quality infrastructure,** including traffic-free cycling routes and cycle facilities.
- **E-cycle loan schemes,** which can successfully increase both the use and purchase of e-cycles, particularly among individuals with existing health conditions.
- **Cycle share schemes,** though effective, depend on several conditions (e.g., appropriate cycling infrastructure, ease of use, cost, and quality).
- C**ycle parking,** especially in terms of enhancing security, is crucial for both current and potential cyclists. **Improving the quality and reducing the cost of parking is a determinant of usage.**
- **Incentives,** especially financial rewards.
- **Cycle training schemes,** aimed at the general population and targeted groups such as people with disabilities.
- **Workplace cycling interventions,** such as providing good cycle parking facilities, changing showers and lockers, purchasing assistance, cycle repairs, training, targets and awards, and bike 'buddies'.
- **Promotional campaigns** that present cycling as an everyday activity rather than just a sport.
- **Encouragement** from friends and family.

The evidence review provides some insight into determinants in relation to different demographic groups including gender, people on low incomes and disability. Age and ethnicity are also key determinants however these factors were not a key focus within any of the studies contained in this review.

Gender. There is a major difference between the cycling rates of men and women and there are differences in perceptions, barriers and motivations, which were highlighted within the evidence reviewed. Safety concerns were identified as a more prevalent barrier for women, along with a lack of cycle-related knowledge and confidence. Several studies on e-cycles reported success in engaging women on their programmes (45% compared to 25% for personal cycles), and cycle training initiatives were reported to be more likely to attract women than men. One study found that e-cycles can contribute to normalising cycling for females, to a greater extent than traditional bikes. The findings from these studies focused on e-cycles and cycle training highlight potential routes to raising cycle confidence amongst women. Cycle training can contribute to overcoming the barrier linked to cycle-related knowledge, increasing both skills and confidence in maintenance and repair.

People on low incomes. One review highlighted that the creation of cycle lanes and bike share stations tends to occur in socio-economically advantaged regions, potentially excluding people of colour and those with low socio- economic status from environments that encourage walking and cycling. The review identified key factors to consider / barriers to remove when designing bike share interventions for minority and low-income groups: safety concerns, equipment (lack of helmets specifically), location (lack of nearby stations), and ease of access (difficulty renting/returning bikes).

People with disabilities. One of the key factors to increasing cycling for people with disabilities is to provide appropriate cycling training. Safety concerns are a key deterrent, and training is one possible intervention to address this.

6. Limitations

Notwithstanding the positives highlighted above, this evidence assessment quantified the limitations and gaps in evidence.

Generalisation – some studies cited in the evidence assessment focus on specific geographic locations or demographics, such as MoBikes bike share (Greater Manchester), Tower Hamlet's cycle training (London) or a systematic review of cycling opportunities in Spain. It is essential to consider the generalisability of these findings to other regions or populations, as factors such as the weather, income levels and wider demographic factors may limit the ability for replicability or scalability of results.

Emerging fields – the use of gamification (game or challenge-based features) linked to transportation is an emerging field. One study noted that there is no strong empirical evidence of impact as research in this field is still in its infancy, with another stating that 'the potential of smartphones to incentivise sustainable travel has still not been fully explored'. It posed a key question for policymakers 'what should the role of smartphone incentives be in policy?'

Longitudinal evidence – many studies represent a snapshot in time (such as the e-cycle loan scheme, shared e-cycles and Cycle Nation [workplace] Project). There is limited longitudinal evidence of the impact across all interventions assessed. This is a major evidence gap – without evidence of the impact of initiatives over time, it is not possible to demonstrate comprehensive impact of long-term sustained behavioural change / mode shift. The challenge of sustained behavioural change was highlighted within the two e-cycle interventions, where the 'cliff-edge' reversion to previous travel habits was noted predominantly due to a lack of resources to continue cycling. This may also be applicable within other time-limited interventions.

Inclusion and diversity – whilst the evidence assessment includes some representation of women, disabled people, and those from lower economic groups, this is limited and there are likely to be additional barriers or considerations specific to these populations which should be explored in greater detail. There is a major difference between the cycling rates of men and women and much of the insight reveals differences in perceptions and barriers for women, particularly relating to safety concerns and a lack of cycle-related knowledge and confidence. The motivations of women are not explored in detail within much of the evidence assessed. Some studies also note the overrepresentation of certain demographic groups e.g. males and those from more affluent areas. The e-cycle share scheme also highlighted the need for further research on the potential role of e-cycles within rural communities.

Collaboration and integration – whilst individual interventions show promise, there is a lack of robust evidence on the need for comprehensive, integrated policies which address multiple aspects of cycling promotion and support, including (but not limited to) infrastructure, education, safety, and accessibility. The evidence needs to demonstrate how different approaches work together synergistically to address multiple barriers.

This evidence assessment clearly underscores the need for improvements to infrastructure and behavioural change interventions delivered in tandem to improve perceptions of safety, accessibility, and confidence to encourage more people to cycle more often. One recommendation would be for ATE to undertake or commission a synthesis of the findings across the suite of evidence assessments to help to map the strengths and weaknesses in evidence and what is missing in order to develop a plan to address this.

7. Conclusions

This report provides valuable insights into enabling adult cycling through various interventions and infrastructure improvements, along with highlighting gaps and limitations in terms of the evidence base. In some instances, particularly review studies, knowledge of the context is absent, and in others the provided detail is limited. This presents a challenge in terms of using this evidence and determining the strength of the evidence base (n.b. The Weight of Evidence score for each piece of evidence in the review is given in Annex B).

This report has attempted to answer the following research question:

RQ1 How do the following factors enable adult cycling?

- Cycle training (in all forms e.g. confidence building, proficiency, coaching).
- Cycle infrastructure.
- Cycling equipment, facilities, and security.
- Influencing and incentivisation.

Cycle training can encourage cycling when delivered within appropriate instructor training, educational resources and supporting materials for participants (including those with disabilities). Specifically, the provision of traffic safety education within an inclusive cycling curriculum could make a significant difference in building confidence to cycle independently.

Cycle infrastructure can encourage cycling through the provision of segregated cycleways, improved cycle routes, green space / canal towpath improvements, traffic calming measures, improved junctions, crossings and bridges, widened cycle access, and improved parking and facilities, including workplace and school provision.

Equipment and facilities such as e-cycle loan schemes and cycle share schemes can encourage cycling, particularly when perceived as offering affordable, high-quality goods that can be used within appropriate cycling infrastructure. E-cycle can be particularly appealing to those with existing health conditions.

Incentives in the forms of financial rewards and influencing in terms of promotional campaigns portraying cycling as an everyday activity rather than just a sport can encourage cycling.

The evidence base brings together findings which demonstrate the importance of developing a culture of cycling. The following examples highlight some of the success factors identified within the evidence base, although the extent to which these are generalisable (and could be rolled out more widely) is largely unexplored and there is no way to assess effectiveness between interventions (e.g. which delivered the greatest impact and / or value for money) because of the limitations outlined:

- **Cycle hire and bike share schemes** – both via traditional bikes, and via providing people with an opportunity to try and learn more about e-cycles – are an important way to increase opportunities for potential cyclists to test things out without committing to purchasing a cycle and accompanying equipment. E-cycles can contribute to normalising cycling for females, to a greater extent than traditional bikes.

- **The Fix Your Bike scheme** showed some success in trying to get people to repair and maintain their existing cycles and to increase people's motivation and opportunity to cycle (and put existing bikes into use). This was the only evidence on cycle maintenance included in this review.
- **The Cycle Nation Project** highlighted the need for a multi-dimensional approach which brings together different components to support individuals to become more 'ready' to cycle (including bike loans, training, mentoring, promotion etc).
- **Enhancing individuals' feelings of self-efficacy** and beliefs about their own capability to cycle is an important element of influencing behaviour change. Many studies highlighted how important this is and emphasised that confidence and knowledge can be significant barriers.
- **The importance of new and enhanced infrastructure** for increasing cycling and influencing mode shift was demonstrated by the Cycle City Ambition programme. The evaluation highlighted the need for medium and long-term impacts to be tracked, as short-term measures will represent an underestimate of true value.
- **Cycling diversion factors** (the estimate of the proportion of new trips induced by an intervention which would have otherwise been undertaken by another mode) were calculated by Clark & Parkin (2022) to be more than double the TAG value (24% rather than 11%). This suggests a substantial shift in travel behaviour due to infrastructure improvements and is something that needs to be factored into future policy decisions.

The identified evidence provided insight into several key determinants and barriers to participation in active travel, influenced by behaviour-based interventions and enabling environments. Key determinants to enabling adult cycling include.

- High-quality infrastructure.
- E-cycle loan schemes.
- Cycle share schemes.
- Cycle parking.
- Incentivisation.
- Cycle training schemes.
- Workplace cycling interventions.
- Promotional campaigns.
- Encouragement.

These elements need to be high quality and accessible to encourage adult cycling. Some determinants and barriers have a greater effect on people from specific demographic groups e.g. safety concerns are more prevalent among women and people with disabilities. It is also important to consider intersectionality between characteristics and to understand that barriers are not experienced universally. There is a need to explore barriers and facilitators in greater detail and from a wide variety of perspectives, because demographic groupings are not homogenous and there are no 'one size fits all' solutions.

7.1 Future research

Nevertheless, this report has also identified several significant gaps and limitations within the evidence base, which suggest an agenda for future research.

Notably, there are concerns regarding the generalisability of certain research findings, particularly when studies are concentrated on specific geographical areas or demographic groups. Additionally, there is a lack of evidence in emerging fields, such as the application of gamification in transport, and a shortage of longitudinal studies that explore the impact of the interventions assessed. The absence of such longitudinal evidence represents a major gap, hindering research from effectively demonstrating the long-term impacts of sustained behavioural change and mode shifts.

Further gaps exist in the areas of inclusion and diversity in adult cycling. While the evidence assessment includes some representation of women, disabled individuals, and those from lower economic backgrounds, this representation is limited. There are likely additional barriers or considerations unique to these groups that warrant more thorough exploration. Lastly, there is a scarcity of robust evidence concerning comprehensive, integrated policies that address multiple facets of cycling promotion and support, including infrastructure, education, safety, and accessibility.

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Annex A – Database searches

Sub-theme: Training

- Platform: Elsevier.
- Date searched: 8 February 2024.
- Number of results: 1,353.

Table 5: Training sub-theme search string

String no.	Search string	No. of results
1	TITLE-ABS-KEY(active OR bicycl* OR cycl* OR bik*) W/2 (commut* OR journey* OR travel*)	6,003
2	TITLE-ABS-KEY ("training course" OR "cycl* proficienc*" OR "cycl* safety training" OR "bicycl* proficienc*" OR "bicycl* safety training" OR "bik* proficienc*" OR "bik* safety training" OR course OR confiden* OR educat* OR proficien* OR "proficiency training" OR hub OR develop*)	20,858,797
3	#1 AND #2	2,196
4	Limit language to English	2,100
5	Limit document type to article, review	1,715
6	Limit publication year to 2013-2024	1,353

Sub-theme: Maintenance

- Platform: Elsevier.
- Date searched: 8 February 2024.
- Number of results: 599.

Table 6: Maintenance sub-theme search string

String no.	Search string	No. of results
1	TITLE-ABS-KEY (active OR bicycl* OR cycl* OR bik*) W/2 (commut* OR journey* OR travel*)	6,003
2	TITLE-ABS-KEY (maintenance OR repair* OR support* OR "cycl* workshop" OR "cycl* kitchen" OR "cycl* librar*" OR "cycl* repair" OR "cycl* rehab*" OR "bicycl* workshop" OR "bicycl* kitchen" OR "bicycl* librar*" OR "bicycl* repair" OR "bicycl* rehab*" OR "bik* workshop" OR "bik* librar*" OR "bik* kitchen" OR "bik* repair*" OR "bik* rehab*")	8,059,516
3	#1 AND #2	870
4	Limit language to English	848
5	Limit document type to article, review	710
6	Limit publication year to 2013-2024	599

Sub-theme: Equipment

- Platform: Elsevier.
- Date searched: 8 February 2024.
- Number of results: 56.

Table 7: Maintenance sub-theme search string

String no.	Search string	No. of results
1	TITLE-ABS-KEY (active OR bicycl* OR cycl* OR bik*) W/2 (commut* OR journey* OR travel*)	6,003
2	TITLE-ABS-KEY (″bicycl* share″ OR ″bicycl* hub″ OR ″bicycl* loan″ OR ″cycl*share″ OR ″cycl* hub″ OR ″cycl* loan″ OR ″bik* share″ OR ″bik* hub″ OR ″bik* loan″ OR ″bicycl* hangar″ OR ″cycl* hangar″ OR ″bik* hangar″)	477
3	#1 AND #2	66
4	Limit language to English	66
5	Limit document type to article, review	57
6	Limit publication year to 2013-2024	56

Sub-theme: Facilities

- Platform: Elsevier.
- Date searched: 8 February 2024.
- Number of results: 454.

Table 8: Maintenance sub-theme search string

String no.	Search string	No. of results
1	TITLE-ABS-KEY (active OR bicycl* OR cycl* OR bik*) W/2 (commut* OR journey* OR travel*)	6,003
2	TITLE-ABS-KEY (facilit* OR amenit* OR storage)	3,808,067
3	#1 AND #2	748
4	Limit language to English	732
5	Limit document type to article, review	579
6	Limit publication year to 2013-2024	454

Sub-theme: Incentives

- Platform: Elsevier.
- Date searched: 8 February 2024.
- Number of results: 133.

Table 9: Maintenance sub-theme search string

String no.	Search string	No. of results
1	TITLE-ABS-KEY (active OR bicycl* OR cycl* OR bik*) W/2 (commut* OR journey* OR travel*)	6,003
2	TITLE-ABS-KEY (incentive* OR ″cycl* to work″ OR ″bik* to work″ OR ″bicycl* to work″ OR ″cycl* to work scheme″ OR ″bik* to work scheme″ OR ″bicycl* to work scheme″ OR ″bik* challenge″ OR ″bicycl* challenge″ OR ″cycl* challenge*″)	194,123
3	#1 AND #2	212
4	Limit language to English	209
5	Limit document type to article, review	185
6	Limit publication year to 2013-2024	133

Sub-theme: Security

- Platform: Elsevier.
- Date searched: 8 February 2024.
- Number of results: 27.

Table 10: Maintenance sub-theme search string

String no.	Search string	No. of results
1	TITLE-ABS-KEY (active OR bicycl* OR cycl* OR bik*) W/2 (commut* OR journey* OR travel*)	6,003
2	TITLE-ABS-KEY (″bik* security″ OR ″bicycl* security″ OR ″cycl* security″ OR ″bicycl* park*″ OR ″cycl* park*″ OR ″bike park*″ OR ″bik* locker*″ OR ″bicycl* locker*″ OR ″cycl* locker*″	389
3	#1 AND #2	47
4	Limit language to English	47
5	Limit document type to article, review	33
6	Limit publication year to 2013-2024	27

Sub-theme: Infrastructure

- Platform: Elsevier.
- Date searched: 8 February 2024.
- Number of results: 133.

Table 11: Maintenance sub-theme search string

String no.	Search string	No. of results
1	TITLE-ABS-KEY (active OR bicycl* OR cycl* OR bik*) W/2 (commut* OR journey* OR travel*)	6,003
2	TITLE-ABS-KEY ("cycl* lane*" OR "cycl* route*" OR "cycl* path*" OR "cycl* track*" OR "cycl* street*" OR "cycl* junction*" OR "bicycl* lane*" OR "bicycl* route*" OR "bicycl* path*" OR "bicycl* track*" OR "bicycl* street*" OR "bicycl* junction*" OR "bik* lane*" OR "bik* route*" OR "bik* path*" OR "bik* track*" OR "bik* street*" OR "bik* junction*")	10,844
3	#1 AND #2	436
4	Limit language to English	426
5	Limit document type to article, review	351
6	Limit publication year to 2013-2024	285

Grey literature

- Platform: Google (using bespoke search strings).
- Date searched: 28 February 2024.
- Number of results: 136.

Table 12: Grey literature searches

Organisation	Search string	Valid results
Active Oxfordshire	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site :activeoxfordshire.org/	6
Active Travel Academy (University of Westminster)	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: westminster.ac.uk/ata/	5
Age UK	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: ageuk.org.uk/	6
Association of Cycle Traders (ACT)	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: cycleassociation.uk/	1
British Heart Foundation (BHF)	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: bhf.org.uk/	2
Campaign for Better Transport	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: bettertransport.org.uk	10
Campaign for National Parks	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: cnp.org.uk/	4

Organisation	Search string	Valid results
Centre for Transport & Society (University of the West of England)	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: uwe.ac.uk/research/centres-and-groups/cts	0
Cycle BOOM	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: cycleboom.org/	1
Cycling UK	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: cyclinguk.org/	18
Disability Rights UK	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: disabilityrightsuk.org/	2
Living Streets	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site :livingstreets.org.uk/	6
ModeShift	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: modeshift.org.uk	0
National Institute for Health and Care Excellence (NICE)	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: nice.org.uk/	0
Partnership for Active Travel and Health	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: pathforwalkingcycling.com/	0
Paths for All	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: pathsforall.org.uk/	10
Royal National Institute of Blind People (RNIB)	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: rnib.org.uk/	1
Sustrans	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: sustrans.org.uk/	15
The Ramblers	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: ramblers.org.uk/	1
Transport & Health Study Group (THSG)	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site :transportandhealth.org.uk/	4
Transport for London (TfL)	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: tfl.gov.uk/	0
Transport Research Laboratory (TRL)	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site :trl.co.uk/	8
Transportation Research Group (University of Southampton)	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: southampton.ac.uk/research/groups/transportation- group	0
Sport England	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: sportengland.org/	9

Organisation	Search string	Valid results
Systra	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: systra.com/uk/	1
Transport Scotland	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: transport.gov.scot/	0
Bikeability	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: bikeability.org.uk/	0
Transport for New Homes	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: transportfornewhomes.org.uk/	4
ITS Leeds	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: leeds.ac.uk/transport	0
Centre for Cities	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: centreforcities.org/	7
Chartered Institute of Highways and Transport	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: ciht.org.uk/	14
Chartered Institute of Logistics and Transport	(INTITLE:research OR study OR analysis) AND (active AROUND(2) (travel OR commute OR journey OR transport)) AND AFTER:2012 AND site: ciltuk.org.uk/	1
Total		**136**

Annex B – Details of sources included in the full assessment

Table 13: Source information

Reference and DOI	Method / data	Sample	Geography	Weight of Evidence score	Reason for inclusion where WoE is not high	Equipment, Facilities and Service interventions	Influencing and incentivisation	Infrastructure
Adam, L., Jones, T., & te Brömmelstroet, M. (2020). Planning for cycling in the dispersed city: establishing a hierarchy of effectiveness of municipal cycling policies. *Transportation*, 47(2), 503– 527.	Delphi study of experts	n=28	New Zealand	10 (medium)	Ensure coverage across sub-themes.			✓
Berent, P. A., Fujiyama, T., & Yoshida, N. (2021). Evaluating delivery of cycling activity and training programmes for disabled people in the UK. *IATSS Research*, 45(3), 371–381	Mixed methods including interviews and cross-sectional surveys	n=132 (surveys), n=17 (interviews)	UK	10 (medium)	Ensure coverage across sub-themes.		✓	
Cairns, S., Cohen, T., Hiblin, B., & Fevyer, D. (2023). Fix Your Bike Voucher Scheme Evaluation. Report for the Department for Transport.	Evaluation report based on mixed methods including surveys and interviews	n=45,785 (public survey), n=250 (business survey), n=20 (interviews)	UK	13 (high)	-	✓		
Campos Ferreira, M., Dias Costa, P., Abrantes, D., Hora, J., Felício, S., Coimbra, M., & Galvão Dias, T. (2022). Identifying the determinants and understanding their effect on the perception of safety, security, and comfort by pedestrians and cyclists: A systematic review. *Transportation Research*, 91, 136–163.	Systematic review	68 papers	Portugal	14 (high)	-	✓	✓	
Clark, B., & Parkin, J. (2022). Cycling Diversion Factors Rapid Evidence Assessment Summary Report.	Evidence assessment	26 papers	UK	-	ATE recommended due to relevance	✓		

Reference and DOI	Method / data	Sample	Geography	Weight of Evidence score	Reason for inclusion where WoE is not high	Equipment, Facilities and Service interventions	Influencing and incentivisation	Infrastructure
Bikeplus / Carplus (2016). Shared Electric Bike Programme. CoMoUK. Report for the Department for Transport.	Evaluation report based on mixed methods including surveys, interviews to develop case studies and some GPS tracking	535 respondents (470 individuals) over two waves	UK	-	ATE recommended due to relevance	✓		
Connell, H., Logan, G., Somers, C., Baker, G., Broadfield, S., Bunn, C., Harper, L. D., Kelly, P., McIntosh, E., Pell, J. P., Puttnam, J., Robson, S., Gill, J. M. R., & Gray, C. M. (2022). Development and optimisation of a multi- component workplace intervention to increase cycling for the Cycle Nation Project. *Frontiers in Sports and Active Living.*, 4.	Mixed methods including interviews, focus groups, and longitudinal surveys	n=20,000 (surveys), n=6 workplaces (interviews/ focus groups)	UK	13 (high)	-		✓	
Garrott, K., Foley, L., Cummins, S., Adams, J., & Panter, J. (2023). Feasibility of a randomised controlled trial of financial incentives to promote alternative travel modes to the car. *Journal of Transport & Health*, 32.	Mixed methods including surveys and interviews	n=99	UK	14 (high)	-		✓	
Heinen, E., & Buehler, R. (2019). Bicycle parking: a systematic review of scientific literature on parking behaviour, parking preferences, and their influence on cycling and travel behaviour. *Transport Reviews*, 39(5), 630–656.	Systematic review	94 papers	Global	12 (high)	-	✓		

Reference and DOI	Method / data	Sample	Geography	Weight of Evidence score	Reason for inclusion where WoE is not high	Equipment, Facilities and Service interventions	Influencing and incentivisation	Infrastructure
Jenkins, M., Lustosa, L., Chia, V., Wildish, S., Tan, M., Hoornweg, D., Lloyd, M., & Dogra, S. (2022). What do we know about pedal assist E-bikes? A scoping review to inform future directions. *Transport Policy*, 128, 25– 37.	Scoping review	107 studies.	Global	12 (high)	-	✓		
Johnson, R., & Margolis, S. (2013). A review of the effectiveness of adult cycle training in Tower Hamlets, London. *Transport Policy*, 30, 254–261.	Longitudinal survey	n=471	UK	11 (medium)	Ensure coverage across sub-themes.	✓	✓	
Keall, M., Randal, E., Abrahamse, W., Chapman, R., Shaw, C., Witten, K., Woodward, A., & Howden-Chapman, P. (2022). Equity and other effects of a program facilitating and promoting active travel. *Transportation Research*, 108.	Longitudinal survey	n=2,500	New Zealand	13 (high)	-		✓	
Lawlor, E. R., Ellis, K., Adams, J., Jago, R., Foley, L., Morris, S., Pollard, T., Summerbell, C., Cummins, S., Forde, H., Foubister, C., Xiao, C., & Panter, J. (2023). Stakeholders' experiences of what works in planning and implementing environmental interventions to promote active travel: a systematic review and qualitative synthesis. *Transport Reviews*, 43(3), 478–501.	Systematic review	35 papers	UK	13 (high)	-			✓
Logan, G., Somers, C., Baker, G., Connell, H., Gray, S., Kelly, P., McIntosh, E., Welsh, P., Gray, C. M., & Gill, J. M. R. (2023). Benefits, risks, barriers, and facilitators to cycling: a narrative review. *Frontiers in Sports and Active Living*, 5.	Systematic review	127 papers	UK	12 (high)	-	✓	✓	

Reference and DOI	Method / data	Sample	Geography	Weight of Evidence score	Reason for inclusion where WoE is not high	Equipment, Facilities and Service interventions	Influencing and incentivisation	Infrastructure
Máca, V., Ščasný, M., Zvěřinová, I., Jakob, M., & Hrnčíř, J. (2020). Incentivizing Commuter Cycling by Financial and Non-Financial Rewards. *International Journal of Environmental Research and Public Health*, 17(17), 6033–14.	Randomised control trial	n=482	Czech Republic	13 (high)	-		✓	
Nielsen, T. A., & Haustein, S. (2019). Behavioural effects of a health-related cycling campaign in Denmark: Evidence from the national travel survey and an online survey accompanying the campaign. *Journal of Transport & Health*, 12, 152–163.	Longitudinal survey	n=11,798	Denmark	12 (high)	-		✓	
Nikitas, A., Tsigdinos, S., Karolemeas, C., Kourmpa, E., & Bakogiannis, E. (2021). Cycling in the Era of COVID-19: Lessons Learnt and Best Practice Policy Recommendations for a More Bike-Centric Future. *Sustainability*, 13(9).	Evidence review and case-studies	Unspecified	Global	11 (medium)	Ensure coverage across sub-themes.	✓	✓	✓
Sadeghvaziri, E., Javid, R., & Jeihani, M. (2023). Active Transportation for Underrepresented Populations in the United States: A Systematic Review of Literature. Transportation Research Record.	Systematic review	60 papers	US	14 (high)	-		✓	✓
Sanmiguel-Rodríguez, A., & Arufe Giráldez, V. (2021). Active Commuting and Sustainable Mobility in Spanish Cities: Systematic Review. *Sport Mont.*, 19(3), 95–105.	Literature review	33 papers	Spain	14 (high)	-	✓		✓

Reference and DOI	Method / data	Sample	Geography	Weight of Evidence score	Reason for inclusion where WoE is not high	Equipment, Facilities and Service interventions	Influencing and incentivisation	Infrastructure
Sherriff, G., Adams, M., Blazejewski, L., Davies, N., & Kamerāde, D. (2020). From Mobike to no bike in Greater Manchester: Using the capabilities approach to explore Europe's first wave of dockless bike share. *Journal of Transport Geography*, 86.	Mixed methods including surveys and interviews	n=2,270 (survey), n=17 (interviews)	UK	13 (high)	-	✓		
Sloman, L., Dennis, S., Hopkinson, L., Goodman, A., Farla, K., Hiblin, B., & Turner, J. (2020). Cycle City Ambition Programme: Final Evaluation Report. Department for Transport.	Mixed methods including automatic and manual mode counts, secondary data, Route User Intercept Surveys, Surveys	n=3,796 (across 42 surveys)	UK	-	ATE recommended due to relevance	✓		✓
Wang, W., Gan, H., Wang, X., Lu, H., & Huang, Y. (2022). Initiatives and challenges in using gamification in transportation: a systematic mapping. *European Transport Research Review.*, 14(1).	Systematic review	30 papers	China	14 (high)	-		✓	
Yang, Y., Wu, X., Zhou, P., Gou, Z., & Lu, Y. (2019). Towards a cycling-friendly city: An updated review of the associations between built environment and cycling behaviors (2007– 2017). *Journal of Transport & Health*, 14.	Meta-analysis	39 studies	Global	12 (high)	-			✓

Reference and DOI	Method / data	Sample	Geography	Weight of Evidence score	Reason for inclusion where WoE is not high	Equipment, Facilities and Service interventions	Influencing and incentivisation	Infrastructure
Zhang, Y., Koene, M., Reijneveld, S. A., Tuinstra, J., Broekhuis, M., van der Spek, S., & Wagenaar, C. (2022). The impact of interventions in the built environment on physical activity levels: a systematic umbrella review. *The International Journal of Behavioral Nutrition and Physical Activity*, 19(1).	Systematic 'review of reviews'	7 review papers	Netherlands	14 (high)	-			✓
Zukowska, J., Gobis, A., Krajewski, P., Morawiak, A., Okraszewska, R., Woods, C. B., Volf, K., Kelly, L., Gelius, P., Messing, S., Forberger, S., Lakerveld, J., Braver, N. den, & Bengoechea, E. G. (2022). Which transport policies increase physical activity of the whole of society? A systematic review. *Journal of Transport & Health*, 27.	Systematic review	32 papers	Global	14 (high)	-		✓	✓