Active Travel England

Active Travel Portfolio Research and Evaluation Programme

Evidence assessment: The Impacts of Active School Travel

October 2024

Sheffield Hallam University, NatCen and Mosodi Ltd

ACTIVE TRAVEL PORTFOLIO RESEARCH AND EVALUATION PROGRAMME

Title: Evidence assessment: The Impacts of Active School Travel

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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 on the impacts of active school travel. 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 England, the government has an ambition to make walking, wheeling and cycling the natural choices for shorter journeys or as part of a longer journey. The second cycling and walking investment strategy[1] (CWIS2) 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%. Over the longer term, the strategy is that half of all short journeys will be walked or cycled by 2030, and that England will have a 'worldclass' cycling and walking network by 2050.

The structure of this report

The findings are split into four chapters. The first chapter discusses the evidence about the social determinants of AST. The second chapter explores the evidence about the mental and physical health benefits of AST. The third and fourth chapters focus on the AST interventions of cycle training and School Street interventions respectively. Each interventions focused chapter describes evidence about the impact of these interventions, their aims and design features, the factors that could support or hinder success and the approaches taken to monitoring and evaluating their effectiveness.

Methodology

This report presents findings from 51 sources of evidence following a process of systematic searching, screening, prioritising, and evidence extraction. The findings related to the social determinants and health impacts of AST draw on 29 academic sources, whilst the findings on cycle training and School Streets draw on 22 sources of grey literature – primarily these are monitoring and evaluation reports.

It is important to note that to draw more exhaustive conclusions a systematic review would be required.

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

Key findings

This report has attempted to answer the following research questions:

RQ1. To account for the individual/structural conditions that shape school travel behaviour:

- What are the social determinants of AST? For the purposes of this study, we define social determinants as the social and environmental conditions in which the children grow up in

RQ2. To account for the health impacts of engaging in AST:

- What impacts does AST have on children's physical and mental health?
- How do the impacts vary depending on the mode of AST?

RQ3. To gauge the success of previous AST interventions, and help inform the design, monitoring and evaluation of future AST interventions:

- What have been the defining features of previous AST interventions?
- What is the level of variation in the models that have been implemented?
- To what extent have these achieved their intended outcomes?
- What have been the enablers, barriers and contextual factors associated with achieving impact?
- What approaches have been taken to measuring and understanding impact?

This section summarises the key findings of this evidence assessment. Key findings were also synthetised in the Key Findings Tables shown at the end of this section.

The social determinants of AST

The assessment found a lot of evidence on the social determinants of AST for children in the UK and internationally and 19 sources are drawn upon. However, there appear to be gaps around the impact of different social determinants on different modes of AST. Furthermore, all of the studies included were cross-sectional, and therefore causal relationships could not be explored.

Socio-environmental factors and socioeconomic status – there was strong and consistent evidence showing that shorter distances to school were associated with increased AST in primary and secondary school children. However, when cycling to school, the lack of appropriate cycling infrastructure can be a greater barrier than just distance. There was also some evidence of an association between lower levels of AST, higher crime rates, and being exposed to more dangerous road environments. Children living in rural areas were also found to be less likely to engage in AST compared with children living in urban areas, but this difference was likely influenced by the built environment and country-specific factors. Additionally, children from lower income households were more likely to walk to school, and faced greater barriers to cycling to school.

Attitudes and behaviours – positive parental attitudes to AST were strongly associated with increased AST, and strong and consistent evidence was found demonstrating that safety concerns of parents, especially traffic safety, was a key barrier to children engaging in AST. Traffic safety refers to parental perception of how dangerous the traffic is. There was some evidence that increased companionship of friends during journeys to school was positively associated with AST. There appeared to be a gap in the evidence base around children's attitudes and behaviours in relation to AST.

Age and gender – the evidence suggested that children aged between 10 and 12 inclusive were more likely to engage in AST than younger and older age groups although further research was recommended to robustly assess the differing effects of age on AST. In terms of gender, the evidence suggests that boys are more likely to engage in AST than girls. This may be influenced by parents' unequal perception of risk by gender. This is, however, likely more relevant for older children who are less likely to be accompanied by their parents on their journey to school.

The health impact of AST

The assessment found evidence that AST was associated with positive mental and physical health impacts and 15 sources were drawn upon. There was limited evidence about how acive travel mode impacted health. However, there was some evidence that cycling had a greater positive effect on some elements of mental and physical health than walking.

In terms of key findings across different health domains:

Mental health – there was evidence that AST led to improved psychological wellbeing, with a study finding that parents not only notice this positive impact of AST in their children but also experience it themselves. Cycling was found to have a stronger positive impact on children's' psychological wellbeing compared with walking.

Physical health – there was evidence that AST is associated with "healthy body weight", although the mode and intensity of AST are important because sometimes AST will not provide enough activity to impact on BMI. Additionally, young people's wider behaviours, such as diets, are other factors to consider when attempting to draw conclusions. In terms of fitness and strength, some evidence was found that those who cycle to school have stronger handgrip and cardiorespiratory fitness, while both those who walk to school and those who cycle to school have a greater vertical jump height.

Air pollution – there was evidence that the positive health effects of physical exercise exceed the harm caused by air pollution exposure in all but the most extreme air pollution scenarios, of the kind not seen in countries such as the UK. There was mixed evidence about whether AST leads to higher or lower exposure to air pollution, linked to the fact that the air pollution levels associated with active or inactive travel modes depend on a range of journey related factors, such as choice of route and traffic levels.

Sleep quality – there was some evidence that children tended to have a better night's sleep because of higher activity levels when actively travelling to school.

Cognitive development – there was a limited quantity of evidence related to the impact of AST on cognitive development, and the findings presented were mixed.

AST interventions – cycle training

The assessment considered five sources focused on Bikeability, the "UK's official cycle training programme".[2] alongside another five sources describing evidence from other similar initiatives.

2 As described here: https://www.bikeability.org.uk/

In terms of the impacts reported in the studies, there was evidence that cycle training programmes have had a positive impact on cycling skills and participation in both active travel and AST (though the evidence base on AST was particularly small). There was also evidence that they have generally been effective in positively changing perceptions of cycling safety among school staff, children and most importantly parents, as parental safety perceptions play a profound mediating role in cycling participation. However, there was some evidence that increases in rates of cycling following the completion of cycle training are not necessarily sustained over a longer timeframe.

When considering how the reviewed cycle training programmes have been designed and delivered, there appears to be a fairly consistent delivery model and set of aims. However, there were three key dimensions of variation:

- Whether the intervention aimed to increase the reach of training and participation among specific underrepresented groups of children.
- Whether the intervention provided any support in addition to the cycle training itself (e.g. cycling equipment or confidence building and route familiarisation activities which can help to encourage and sustain participation).
- The staffing model – with interventions being staffed predominantly by either volunteers or industry professionals.

The evidence assessment found that the factors associated with the involvement of schools in cycle training initiatives included their capacity to plan and manage the administration requirements; accessing appropriately trained staff; managing the safety concerns of school staff, such as schools not being appropriately located to support AST by bicycle or on-road cycle training; and the provision of bicycles and related equipment. In terms of children's motivations to participate, the social benefits of cycling and the offer of rewards and incentives were important. When it came to parents' concerns for their children to participate, these centred around navigating road safety concerns, in terms of traffic safety, and parents' ability to accompany their children when cycling.

Various approaches were taken to monitoring and evaluating the success of cycle training and associated interventions, such as Bikeability Scotland – with self-reported surveys often being used to understand changes in cycling proficiency and track increases active travel and AST. The included sources made suggestions about how monitoring and evaluation could be enhanced. This included greater consideration about how surveys can be adapted to the needs of different pupils to improve response rates, and, lengthening the observation periods to better understand the longer-term impacts and/or to monitor behaviour change. The latter recommendation is based on evidence that behaviour change as a result of cycle training initiatives is associated with a number of stages and may take some time to be realised.

AST interventions – School Streets

The evidence assessment considered six sources which reported on the design, impact and learning associated with a large number of UK-based School Streets interventions. The remaining sources described other safe school environment interventions.

Overall, there was a wide range of evidence presenting that the School Streets interventions had met their aims of improving road safety by reducing the volume and speed of traffic and improving perceptions of road safety; alongside increasing AST and improving air quality. Good rates of compliance and local support for School Streets was also often reported. Whilst the consistency of positive findings across sources is encouraging in terms of validity, it should be noted that all but one of the sources has drawn on pre and post analysis to detect change

rather than more robust forms of impact evaluation. It is also possible that the sampled School Streets sites considered across the sources may be skewed towards those that have achieved the most positive outcomes (publication bias).

In terms of the design and delivery of School Streets, variation was found in terms of:

- The selection criteria and processes used to identify suitable School Street's locations.
- The duration of road closures in the morning and afternoons.
- The 'strictness' of the exemption policies defining who was allowed to drive in the School Street Zones during closure periods.
- The communication and enforcement of temporary closures, which could include enforcement and monitoring cameras, banners and street signage, collapsible bollards and different monitoring activities to understand whether school pupils were changing their school travel modes (for further detail see below).
- The extent of complementary infrastructure and activities, such as installing cycling and scooter storage facilities, expanding local parking capacity outside of the School Street zone, and the delivery of school-led behaviour change programmes to encourage and support AST and compliance with the School Street.

The evidence assessment found that the factors that could support or hinder success, included:

- The robustness of the selection criteria used to locate a School Street at an appropriate site.
- The levels of commitment and motivation of school staff to support the intervention and the ability to integrate School Streets with wider school-led activities and initiatives associated with active travel and road safety.
- The degree to which School Streets invested ongoing resource in shifting cultures and behaviours.
- The management of compliance and safety related concerns and challenges from schools, staff and the community.
- The approach to enforcement of the closure – with ANPR cameras (which can issue penalty fines to drivers) seen as a more sustainable solution rather than relying on volunteers to manage collapsible bollards.

A range of monitoring and evaluation approaches were used for School Streets, with hands up surveys, travel trackers and cameras being amongst the most used approaches. A notable gap is the collection of longitudinal or follow-up evidence about how and to what extent impacts have been sustained over longer timeframes. This includes once School Streets have been made permanent. A majority report on pilot studies drawing on pre and post data and on monitoring data collected within relatively short timeframes. Further to this, a recommendation for future research would be to investigate the wider impact of School Streets, such as the potential community benefits, health outcomes and lifestyle changes.

Key Findings Tables

The following tables present a summary of the evidence from each chapter. These tables summarise where different features and impacts were or were not reported in the source. Table 3, Table 5 and Table 6 use an 'x' symbol to indicate that the programme has the specific feature. While a blank cell indicates that the feature was not described within the source.

Social determinants of AST

Table 1: AST social determinants and barriers

Social determinant domain	Social determinant type	Evidence found	Source, evidence type and country
Household socioeconomic status	Low income and lack of resources	Children aged 4 to 14 years from lower income households were more likely to walk to school compared with children from higher income households. Barriers identified were affordability of date age-appropriate bikes, cycling equipment and costs of Bikeability initiatives.	Rothman et al., 2018 (Systematic review, North America) Greca et al., 2023 (Qualitative study, interviews (n=18), England)
	Parental education	Contradictory findings around the association between parental educational qualifications and AST.	Salway et al., 2019 (Cross-sectional study, questionnaire and accelerometer data (n=1,296), UK) Rothman et al, 2018 (Systematic review, North America)
Socio-environmental factors	Distance to school	Shorter distances were associated with increased AST (predominantly walking) in children and young people aged 5 to 16 years. For example, the median home to school distance for children aged 11 to 16 years who walked to school was 1.33km (mean 1.38km) and for those who used motorised modes the median was 3.1km (mean 3.9km) (Easton & Ferrari, 2015). Across longer distances (distance was grouped as >6km, 3–5.9km, <3km), children with higher family support for AST were more likely to engage in AST compared with children with low family support. When cycling to school, the lack of appropriate cycling infrastructure can be a greater barrier than just distance.	Bosch et al., 2020 (Cross-sectional study, questionnaire (n=1,889), London, UK) Zhang et al., 2020 (Cross-sectional study, questionnaire and accelerometer data (n=432), Scotland) Garnham-Lee et al., 2017 (Representative survey (n=611), UK) Easton et al., 2015 (Secondary analysis of national dataset (n=26,709), UK) Greca et al., 2023 (Qualitative study, interviews (n=18), England)

Social determinant domain	Social determinant type	Evidence found	Source, evidence type and country
	Area level deprivation	Contradictory findings around the association between area level deprivation, measured by the Index of Multiple Deprivation, and AST.	Garnham-Lee et al., 2017 (Representative survey (n=611), UK) Noonan, 2020 (Secondary analysis of national dataset, England) Salway et al., 2019 (Cross-sectional study, questionnaire and accelerometer data (n=1,296), UK)
	Rural/urban location	Urban localities were associated with higher rates of AST than rural localities; however, rates of AST will vary depending on the specific urban areas and countries.	Potoglou et al., 2017 (Secondary analysis of national dataset (n=7,409), Wales) Easton et al., 2015 (Secondary analysis of national dataset (n=26,709), Sheffield, UK)
	Built environment	Children's (aged 12 to 17 years) perception of good walking and cycling infrastructure, general neighbourhood aesthetics and street connectivity were associated with higher rates of AST. There were inconsistent findings between the association of AST with objective measures of the built environment, such as residential density, land use mix and intersection density.	Klos, et al., 2023 (Systematic review, international) Wong et al., 2011 (Systematic review, international)
	Road safety and crime	Children (aged 5 to 11 years) who had to pass through areas with higher crime rates or were exposed to more dangerous road environments were less likely to engage in AST.	Bosch et al., 2020 (Cross-sectional study, questionnaire (n=1,889), London, UK)
Attitudes and behaviours	Children	Children's (aged 10 to 15) enjoyment of walking to school was not associated with higher rates of AST, but certainty that they could ride or walk to school on most days, was.	Silva et al., 2014 (Cross-sectional study, questionnaire (n=625), Portugal)

Social determinant domain	Social determinant type	Evidence found	Source, evidence type and country
	Parents	Positive parental attitudes to AST were associated with increased AST. Parents with a positive sense of place, including shopkeepers watching over community members, increased positive attitudes to children walking (not cycling). Family support is a stronger determinant than the child's and friends' influence. Safety concerns, especially perceptions around traffic and road safety, and parental unavailability to accompany their children to/ from school were key barriers. Parental unavailability was less of a concern for older children, as they were less likely to be accompanied to school by their parents.	Jing, 2017 (Systematic review, international-high-income countries) Klos, et al., 2023 (Systematic review, international) Waygood et al., 2015 (Secondary analysis of national dataset, Scotland) Rothman et al., 2018 (Systematic review, North America) Healey & Gilmour , 2016 (Quasi-experimental impact evaluation, Australia)
	Friends	Mixed findings around the association of friend's encouragement and AST.	Jing, 2017 (Systematic review, international high-income countries) Silva et al., 2014 (Cross-sectional study, questionnaire (n=625), Portugal)
Child age and gender	Child age	Children (between 10 and 12 years of age) were more likely to engage in AST than younger and older age groups.	Potoglou et al., 2017 (Secondary analysis of national dataset (n=7,409), Wales) Easton et al., 2015 (Secondary analysis of national dataset (n=26,709), Sheffield, UK)
	Child gender	Boys were more likely to engage in AST than girls, due to parents' unequal perception of risk by gender. This is more relevant for older children. Parents saw more safety risk for girls AST than boys when travelling unaccompanied.	Easton et al., 2015 (Secondary analysis of national dataset (n=26,709), Sheffield, UK) Salway et al, 2019 (Cross-sectional study, questionnaire and accelerometer data (n=1,296), UK) Potoglou et al., 2017 (Secondary analysis of national dataset (n=7,409), Wales)

Health impacts

Table 2: AST Health impact evidence

Health Impact domain	Evidence found[3]	Data collection methods	Source and evidence type
Mental health, wellness, and emotional wellbeing	Improved psychological wellbeing score: Cycling = 4.6. All active modes (walking, cycling, scooter) =4.5. Passive travel modes =4.	152 children, from 3rd and 4th school grade (mean age 9.6) took part in the mobility and attitude survey, which measured psychological wellbeing. Wellbeing was measured on a five-point scale where 5 = high wellbeing and 1 = low wellbeing. Children completed the pen and pencil questionnaires in their first school lesson. In the surveys, children would first state their transport mode to school for that morning and then their wellbeing using the 5-point scale with emoticons.	Stark, et al., 2018 (Non-representative survey (n=152) and in-depth interviews (n=31), Austria)
	Parents stated that cycling is better for children's wellbeing and more enjoyable than walking.	Semi-structured interviews with 18 parents.	Greca, et al., 2023 (Qualitative study, interviews (n=18), England)
	Decreased suicide attempts – the prevalence of having at least 1 suicide attempt was: – 9.2% of those active in school travel. – 12.9% of those passive in school travel. It should be noted that the authors recommend further research looking at the association between AST and suicide due to a high level of variation across countries.	Data from the Global School-based Health self-reported survey with 127,097 adolescents aged between 13 and 17 years.	Chen, et al., 2021 (Secondary data analysis, survey (n=127,097), International)
Physical health and physical activity levels	Reduced adiposity – switching from private motorised models of travel to active travel was associated with lower BMI and body fat.	Data from the UK Millennium Cohort Study with 8,432 children born between September 2000 and January 2002. They were surveyed at ages 7, 11 and 14 years.	Laverty, 2021 (Secondary, longitudinal data analysis, questionnaire (n=8,432), UK)
	Increased strength, handgrip and fitness for those who cycle to school.	Handgrip strength, vertical jump and vertical jump peak power were measured in 6,829 English children. Statistical analyses were carried out to assess differences in modes and calculate odds ratios (OR).	Cohen, et al., 2014 (Secondary data analysis, questionnaire and physical test (n=6,829), England)

3 Including figures (where available)

Air pollution (air quality benefits)	The positive impacts of AST on physical health outweigh the negative effects of air pollution.	The study cited by Osbourne et al. conducted by Tainio et al. (2016) carried a risk benefit analysis using a recognised active travel health impact modelling (HIM) approach. This involved comparing the health risks of air pollution with the physical activity-related health benefits from active travel across a wide range of possible air pollution concentrations and active travel levels.	Osbourne, et al., 2021 (Systematic review, International, including 14 UK studies – high-income countries)
	Children who travel by bus are exposed to the most pollution compared to walking and cycling.	As above	Same source as above
	Exposure is dependent on different factors, such as choice of route, level of traffic congestion and air filtration systems on public transport.	As above	Same source as above
Other health impacts: Cognitive Development	Cycling can improve cognitive skills and coordination, which was reported by parents.	Semi-structured interviews with 18 parents	Greca, et al., 2023 (Qualitative study, interviews (n=18), England)
	No clear educational advantage of active travel modes – demographics, health and socioeconomic status have bigger impacts.	Data from the Millennium Cohort Study with 6,778 children born in 2000-2001. They were surveyed at ages 7, 11 and 14 years.	Walker and Gamble, 2023 (Secondary data analysis, survey (n=6,778), UK)
Other health impacts: Improved sleep	Improved sleep – parents reported that children have better sleep due to active travel modes compared to children travelling as car passengers.	152 children (51% female) took part in the mobility and attitude survey. 31 parents took part in a survey with questions about their household and their children. They also took part in in-depth interviews.	Stark, et al., 2018 (Non-representative survey (n=152) and in-depth interviews (n=31), Austria)

Bikeability

Table 3: Cycle training programmes by feature

	Bikeability	NCPS	Bikeability Scotland	Bikeability – Widening Participation Fund	I Bike	Ride or Walk to School
Aim						
Increase cycling skills	✓	✓	✓	✓	✓	✓
Increase active travel by cycle	✓			✓	✓	✓
Increase AST by cycle					✓	✓
Widening participation in active travel by cycle				✓	✓	
Facilitate school capacity building					✓	✓
Design						
Practical-led training sessions	✓			✓	✓	✓
Additional support (equipment or infrastructure)				✓		✓
Additional support (activity based)				✓	✓	✓
Additional support (teacher professional development)					✓	✓

Table 4: Bikeability: Programme aims by success measure type

Programme aims	Outcome measures
Increase cycling proficiency	Hazard perception, measured via survey and practical assessment (Hodgson & Worth, 2015) Perceived safety when cycling, self-reported via survey (Gupta, et al., 2023) Confidence cycling on the road, self-reported via survey (SQW, 2019; Gupta, et al., 2023) Road safety knowledge, assessed via survey (SQW, 2019) Road safety behaviour via self-reported via survey and hospital attendance via Hospital Episode Statistics (HES) dataset (Teyhan, et al., 2016)
Increase active travel by bicycle	Whether cycled over specified period, self-reported via survey (SQW, 2019) Frequency of cycling, self-reported via survey (Gupta, et al., 2023) Perceived increase in other children cycling, self-reported via survey (SQW, 2019) Parental permission to cycle on roads, self-reported via survey (SQW, 2019)
Increase active school travel by bicycle	AST behaviour Self-reported via survey (Teyhan, et al., 2016; Healey & Gilmour, 2016) Perceived impact reported via schools (Healey & Gilmour, 2016)
Widen participation in active travel by bicycle	Increased participation in Bikeability, measured by assessing profile of experimental group against comparison group (Gupta, et al., 2023) Increased cycling confidence, perceived safety and AST frequency among specific groups, assessed via analysis of subgroup differences in self-reported survey responses (Gupta, et al., 2023)
Facilitate school capacity building	Capacity to teach and promote AST, measured via school reports and staff professional development feedback (Healey & Gilmour, 2016)

School Streets

Table 5: School Streets programme by feature

	Healthy School Streets	SSC and traffic displacement	School Streets
Enforcement			
Closure zones via street signs/posters	✓	✓	✓
Staff or volunteers present/police presence	✓	✓[4]	
School Streets education/behaviour change programme	✓	✓	
Collapsible/folding bollards	✓	✓	
Speed limits/traffic monitoring	✓	✓	✓
Monitoring			
Monitoring cameras	✓	✓	
Hands up surveys/questionnaires	✓	✓	✓
Travel trackers	✓	✓	✓
Air quality monitoring	✓	✓	
Infrastructure			
Cycle/scooter storage			
Additional parking		✓	

Table 6: School Streets: Programme aims by success measure type

Programme/ source	Perception of safety	Level of AT	Level of vehicle traffic	Motor vehicle speeds	Air quality
Healthy School Streets (Camden Council, 2018)		✓	✓		✓
School Street Closures and Traffic Displacement (Davis, 2020): City of Edinburgh Council	✓	✓	✓	✓	✓
(Davis, 2020): Solihull MBC		✓	✓		
(Davis, 2020): Perth and Kinross Council	✓	✓	✓		
(Davis, 2020): London Borough of Camden			✓		
(Davis, 2020): London Borough of Croydon		✓	✓		
(Davis, 2020): Southampton City Council	✓				
School Streets (Edinburgh City Council, 2016)	✓	✓	✓	✓	✓
School Streets (Transport for London, 2022)	✓	✓	✓	✓	✓
School Streets (Transport for London, 2021)	✓	✓	✓		

4 Police presence only cited

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[5] (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.

5 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 Research questions

The evidence assessment attempts to answer three overall sets of research questions, outlined below.

RQ1. To account for the individual/structural conditions that shape school travel behaviour:

- What are the social determinants of AST? For the purposes of this study, we define social determinants as the social and environmental conditions in which the children grow up in.

RQ2. To account for the health impacts of engaging in AST:

- What impacts does AST have on children's physical and mental health?
- How do the impacts vary depending on the mode of AST?

RQ3. To gauge the success of previous AST interventions, and help inform the design, monitoring and evaluation of future AST interventions:

- What have been the defining features of previous AST interventions?
- What is the level of variation in the models that have been implemented?
- To what extent have these achieved their intended outcomes?
- What have been the enablers, barriers and contextual factors associated with achieving impact?
- What approaches have been taken to measuring and understanding impact?

RQ3 focusses specifically on two types of previous AST interventions: Bikeability (and similar cycle training interventions) and School Streets.

1.4 The structure of this report

The report is structured as follows:

- **Executive summary.** The executive summary provides an overview of the key findings.
- **Introduction.** The first chapter provides background to this evidence assessment.
- **Methodology.** The second chapter provides a summary of data collection methods.
- **Social determinants of AST.** The third chapter explores evidence on the social determinants of AST (i.e. the social and environmental conditions that predict children's school travel behaviour), with a focus on household socioeconomic status; socio-environmental factors; attitudinal and behavioural factors; and child age and gender.
- **The health impacts of AST.** The fourth chapter explores evidence on the health impacts of engaging in AST, with a focus on mental health, physical health and air pollution-related impacts.
- **Cycle training interventions.** With a specific focus on Bikeability (and similar cycle interventions), the fifth chapter outlines the identified evidence on the key components that have underpinned previous School Streets interventions; their impact; the factors supporting and hindering success; and the approaches taken when carrying out monitoring and evaluation.
- **School Streets interventions.** Finally, the sixth chapter, has a specific focus on previous School Streets interventions. Mirroring the structure of chapter five it: outlines the evidence identified on the key components that have underpinned previous School Streets interventions; their impact; the factors supporting and hindering success; and the approaches taken when carrying out monitoring and evaluation.
- **Conclusions 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

A rapid evidence assessment approach was used to identify evidence for this assessment. This chapter describes each stage in this process and also describes the limitations associated with the research design.

It should be noted that the process for selecting evidence for inclusion in this evidence assessment about AST differs from all of the other assessments in this series.

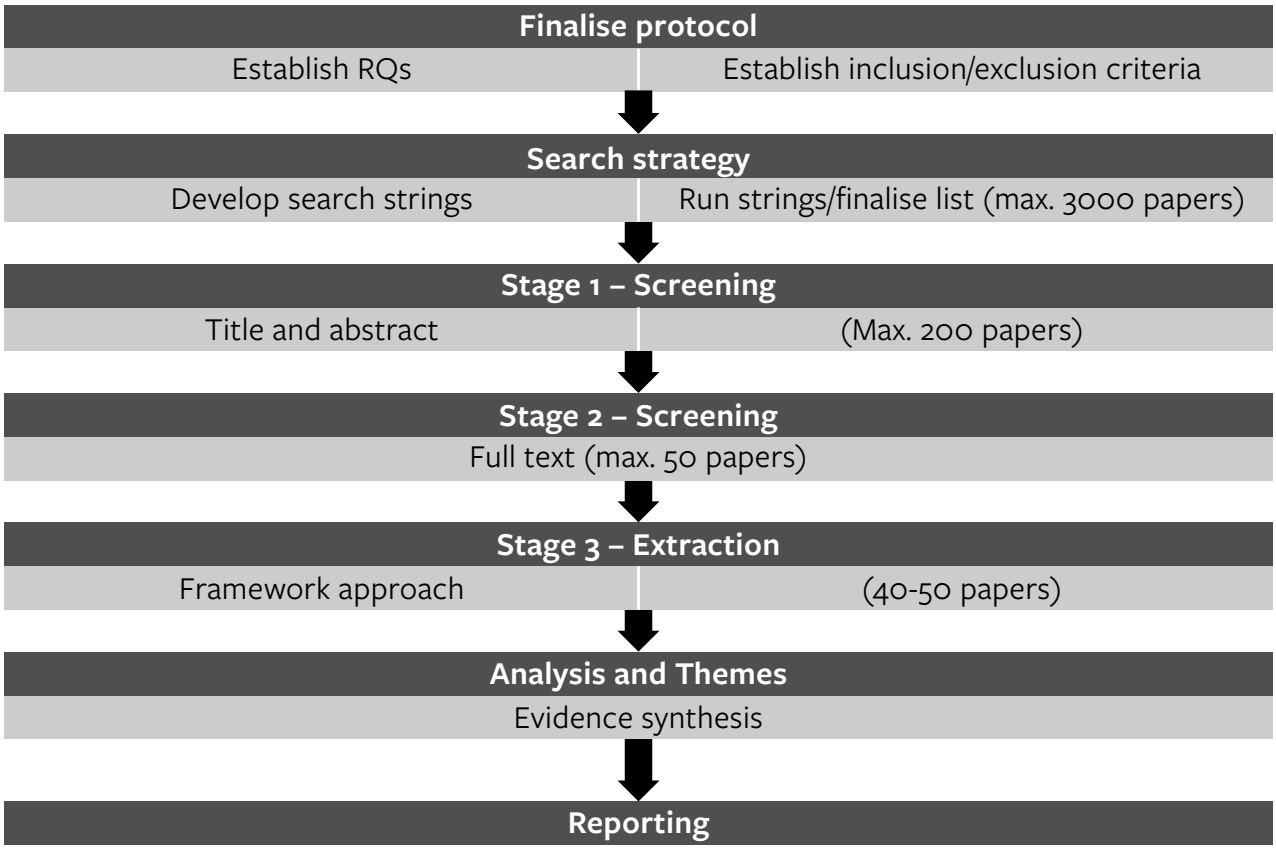
For this evidence assessment about AST, full text screening was undertaken for all 295 sources. For all of the other evidence assessments, a selection was made which prioritised:

- First: sources identified as reviews of a number of other studies at title and abstract screening, and sources recommended by ATE or DfT.
- Second: sources from individual studies.[6]

2.1 Evidence assessment protocol

At the inception of this evidence assessment, a protocol that outlined the process of this evidence assessment and the method was developed to ensure that high-quality and relevant papers were included and analysed for the report. The protocol specified the research questions the evidence assessment would answer as well as the specific focus for each stage of the evidence assessment process, which are summarised in **Figure 1 below.**

Figure 1: Evidence assessment stages



6 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.

2.2 Search strategy

Literature was identified as being potentially relevant to the research aims of this study via two key pathways, an academic search and a manual grey literature search. The Weight of Evidence Framework was used to assess the quality and relevance of academic studies. This involved answering four questions about each source, focused on whether there is a clear statement of aims, a defined sampling strategy and data collection approach and whether there were any quality concerns. Below, we first outline the criteria used to guide the inclusion and exclusion of literature (consistent across search pathways) before summarising each search pathway in more detail. In addition, a third pathway included the recommendation of papers by research partners at CRESR.

2.2.1 Inclusion and exclusion criteria

The inclusion and exclusion criteria were developed to narrow the search to the papers most relevant to each of the research questions. These criteria were applied to both search pathways, with exceptions rules for papers that were felt to be highly relevant despite not meeting one or more of the criteria (for example, including a highly relevant paper published before 2013).

- **Topic/subject matter:** Papers either explored AST and its interventions, or and the impacts and determinants of AST
- **Population:** Primary and/or secondary school aged children (5–17yrs)
- **Language:** English
- **Country:** UK, Europe, North America, New Zealand and Australia.
- **Year:** Papers published post-2013
- **Type of studies:** Systematic review, meta-analysis, theoretical paper, or studies using primary data collection or secondary data analysis
- **Outcome measures:**
  - For RQ1 and RQ2, this included: physical and mental health impacts, social determinants and changes to travel mode.

For RQ3, this included: outcomes associated with the aims of Bikeability (and similar cycle training interventions associated with AST) and/or School Streets interventions

Academic database search and search strings

Two separate academic search strategies were developed for RQ1–RQ2 and RQ3. This involved developing separate search strings and searching several academic databases, including Scopus, PsycINFO, Medline, Transportation Research Information Database (TRID). Appendix B provides an outline of the search strategies deployed and breaks down the number of results returned for each search string and in each database. After removal of any duplicates, the total number of studies identified as being potentially relevant to RQ1 and/or RQ2 was 2864, and for RQ3 this was 970.

Grey literature search

To supplement the lower number of papers identified as being relevant to RQ3 through the academic search, a 'grey literature' search was conducted in Google Scholar. This was to identify further sources that reported on the evaluation of an intervention relevant to the research question. The search focused predominantly on Bikeability (and cycle training) interventions and School Streets interventions. 22 papers were identified through this search pathway and the results included evaluation reports published by authors such as government departments or local councils.

2.3 Screening and extraction

2.3.1 Title and abstract screening

3078 titles and abstracts were initially screened. This process involved assessment of titles and abstracts against the inclusion and exclusion criteria. The criteria summarised in Table 7 above was used at this stage. Following the screening process 233 studies were accepted for full text review.

2.3.2 Full text screening and prioritisation

233 papers went through full text review from the academic search. An additional 22 were included from the grey literature search and 2 were following recommendations from CRESR. The grey literature papers were identified predominantly to explore RQ3. All papers were considered against a prioritisation tool and checklist to ensure the final list of papers would address the research questions specifically. In addition to this, a Weight of Evidence (WoE) criteria was applied to all the academic papers rating the evidence according to the quality of its research design and presentation of findings. This is assessed by asking the following four yes/no questions, to arrive at a score of 0 – 4:[7]

- Is there a clear statement of the aims/objectives or clear research questions?
- Is there a clear and appropriate sampling strategy (or data selection strategy if not collecting primary data)?
- Is there a clearly described data collection method?
- Are there any concerns regarding accuracy of findings?

All academic papers included were considered high quality, receiving a high WoE score of 4 (apart from one paper which received a 3).

- 29 academic papers were prioritised for inclusion against RQ1 and RQ2
- 22 grey literature papers were prioritised for against RQ3

Online hyperlinks to the sources referenced are provided in the reference section at the end of this report.

7 Weight of Evidence scores were calculated slightly differently in the other evidence assessment reports in this series, but using similar questions

2.3.3 Data extraction

An extraction framework was developed to help organise the evidence extracted from the prioritised papers. The framework was structured thematically, according the three research questions. This covered the social determinants of AST; the health impacts associated with engaging in AST in terms of children's physical and mental health, and how these impacts varied depending on the mode of AST; the design of previous AST interventions (focusing specifically on cycle training and School Streets); their impact; and approaches taken to measuring and understanding their impact. Members of the research team read each paper in full and populated the framework with the relevant evidence. Once extraction was complete, the evidence identified as being relevant to each research question was narratively synthesised.

2.4 Limitations of the research design

This was a focused evidence assessment. It drew on a limited number of sources (51 in total) in line with the available resource, to answer the research questions, using a systematic screening and prioritisation process. To draw more exhaustive conclusions a systematic review would be required. This would attempt to collate all empirical evidence that fits pre-specified eligibility criteria to answer a specific research question. It often includes meta-analysis with statistical methods to summarise the study outputs.

3. The social determinants of AST

This chapter provides an overview of the social determinants of AST and attempts to answer RQ1 (what are the social determinants of AST?). For the purposes of this study, social determinants were defined as the social and environmental conditions that children grow up in. The evidence indicates that the social determinants of AST are complex, interlinked and mediated by various factors. In this chapter, we summarise the evidence surrounding four social determinants of AST, including:

- Household socioeconomic status.
- Socio-environmental factors.
- Attitudes and behaviours.
- Child age and gender.

The evidence identified was drawn from quantitative and qualitative research that was conducted with children and/or their parents and explored the associations between various social determinants and AST.

3.1 Household and socioeconomic status

3.1.1 Low income and lack of resources

The evidence indicated that children from lower income households were more likely to walk to school, and that they faced greater barriers to cycling to school.

A systematic review of children aged 4 to 14 years and living in North America reported a moderately strong relationship between low-income households and AST, predominantly in the form of walking (Rothman, et al., 2018). Using proxy measures that determine low income, the review found that car ownership had the strongest relationship with AST. This indicated that low income was likely associated with increased likelihood of walking to school due to lack of access to cars. Furthermore, the review highlighted that lower income households were more likely to be single parent households. Rothman, et al. (2018) explained that these households may experience less available time to drive their children to school, further increasing the likelihood of AST.

A qualitative study with parents of children aged 8 to 12 years in Greater London found that lack of resources was a key barrier to their children cycling to school (Greca, et al., 2023). This included owning outdated cycling equipment and/or difficulties affording new bicycles that were appropriate to the age of the child. Furthermore, the parents described how the high costs of Bikeability initiatives prevented them from enrolling their children.

3.1.2 Parental education

Evidence on the relationship between parental education and AST was contradictory. While Salway et al. (2019) found in a large-scale cross-sectional study that 10 to 11-year-olds from UK households with higher educational qualifications were more likely to engage in AST, a systematic review found that lower parental education was associated with increased AST (Rothman, et al., 2018).

3.2 Socio-environmental factors

3.2.1 Distance to school

There was strong and consistent evidence that shorter distances to school were associated with increased AST in primary and secondary school children. However, in the context of cycling to school, the absence of cycling infrastructure can pose a more significant barrier than just distance (Greca, et al., 2023).

Distance to school, both objective and reported, was consistently found to be strongly associated with AST. For example, sources reported that shorter distance to school was the strongest predictor of AST in children aged 5 to 11 in London (Bosch, et al., 2020), children aged 10 to 12 years in North East Scotland (Zhang, et al., 2020) and in a UK representative sample of 11 to 12-year-olds (Garnham-Lee, et al., 2017). Similarly, after taking socio-spatial clustering within schools and neighbourhoods into account, distance from home to school was found to be by far the strongest determinant of AST in 11 to 16-year-olds in England (Easton & Ferrari, 2015).

A key explanation provided by authors for the relationship between distance to school and AST was that children with longer commuting distances were more likely to be exposed to a greater level of risk along their route (Bosch, et al., 2020; Zhang, et al., 2020). Similarly, Zhang et al. (2020) found that concerns about unaccompanied children negotiating busy roads, alongside prohibitively long journeys on foot or by bike, may lead parents to favour use of car over giving them permission for AST.

Finally, a qualitative study found that distance may not be a barrier to cycling to school when adequate infrastructure was provided, such as cycle lanes and bicycle parking (Greca, et al., 2023). Greca et al. (2023) also found that living close to school may even prevent children from cycling. However, it is unclear whether these children instead walked or were driven to school.

3.2.2 Area level deprivation

The evidence exploring area level deprivation (measured by the Index of Multiple Deprivation (IMD)) and AST was contradictory. One potential explanation for the differences in findings might have been the differing impacts of urban and rural locations on AST.

Garnham-Lee, et al. (2017) found that area level deprivation significantly moderated the relationship between distance to school and AST in 11 to 12-year-olds in the UK who lived in predominantly urban locations. They found that for children living in more deprived areas, the influence of distance to school had a smaller impact on the decision to engage in AST. Conversely, the influence of distance to school on the likelihood of engaging in AST became much stronger in less deprived areas. Possible explanations the authors identified included the limited options available to those living in deprived areas (for example, limited access to a car) and living in urban environments which are closer to schools (Garnham-Lee, et al., 2017). Both these factors could lead to increased likelihood of AST. Similarly, a secondary analysis of the millennium cohort study found that children aged 11 years living in the most deprived neighbourhoods in England were the most likely to engage in AST (Noonan, 2020). In contrast, Salway et al. (2019) reported that 11-year-olds in England from more deprived areas engaged in lower levels of AST. They sampled children from the southwest of England, a region composed of largely rural areas. These contradictory findings from the studies mentioned may be due to differences in rural/urban locations – as discussed in section 3.2.3.

3.2.3 Rural/urban location

There was some evidence to suggest that rural localities were associated with lower rates of AST, however this was likely to be context specific. A secondary analysis of the National Survey for Wales found that children who lived in rural areas were less likely to engage in AST (Potoglou & Arslangulova, 2017). Possible reasons for this could have included that parents living in rural areas tended to use and rely on their cars more compared with those based in urban areas, and that the built environment of urban locations was more walkable (Susilo and Maat, 2007; Sun et al., 2009; Ewing and Cervero, 2010 cited in Potoglou & Arslangulova, 2017). Easton and Ferrari (2015) found that the built environment of urban locations had not only a direct effect on mode of travel, but also an indirect effect by, for example, influencing parental opinion. However, the authors noted that the evidence of the impact of urban form was inconsistent and likely to be highly context specific, as discussed in more detail in section 3.2.4.

3.2.4 Built environment

With the exception of distance to school, findings relating to the association between features of the built environment and AST were inconsistent or weak and were modified by age and gender. Differences were identified between the layout of suburban archetypes and between countries, which limited comparability across studies and likely explained some of the inconsistencies observed in findings (Easton & Ferrari, 2015).

A systematic review of children aged 5 to 18 years found inconsistent findings regarding the association between objective measures (using Geographic Information Systems) of land use mix, residential density, and intersection density (Wong, et al., 2011). Another systematic review found some evidence that children's perceptions of good walking and cycling infrastructure, general neighbourhood aesthetics and street connectivity were associated with higher levels of AST (Klos, et al., 2023).

Other factors, such as age or gender, were likely to modify the relationship between the built environment and AST. For example, Klos, et al. (2023) found different relationships between perceptions of the built environment and AST in females and males. For females, environmental characteristics of the journey to school, such as good walking and cycling infrastructure or general safety, were found to be more important than for males (Klos, et al., 2023). For males, it was suggested that destinations in the neighbourhood, such as recreational facilities, might have been more important for AST than safety aspects (Klos, et al., 2023). In terms of age, perceptions of the built environment might be more important in adolescents' AST behaviour, as opposed to younger children. This is because parents have a stronger influence on whether their child engages in AST when compared with adolescents, due to their increased independence and ability to make their own AST decisions.

3.2.5 Road safety and crime

There was some evidence of an association lower levels of AST and higher crime rates and a lack of road safety. In one study, children aged 5 to 11 in London who had to pass through areas with higher crime rates and higher rates of road accidents, were less likely to engage in AST (Bosch, et al., 2020). Crime and road safety was measured objectively (using crime and accident data), as opposed to evidence about parental perceptions of crime, road safety and local neighbourhood.

3.3 Attitudes and behaviours

While all the studies mentioned in this chapter were cross-sectional, the issue of reverse causality could be more problematic when examining the effect of attitudes on AST behaviour. One key example of this was consideration of whether positive parental attitudes increased levels of AST, or whether increased levels of AST led to more positive parental attitudes toward AST.

3.3.1 Children

There appeared to be a gap in the evidence base around children's attitudes and behaviours and their association with AST. A systematic review noted how most studies measured parental perceptions and did not investigate child self-reported attitudes and behaviours and their association with AST (Rothman, et al., 2018). One cross-sectional study, however, found that children's enjoyment of walking to school was not associated with engagement in AST, whereas higher self-efficacy in children was (Silva, et al., 2014).

3.3.2 Parents

While positive parental attitudes to AST were strongly associated with increased AST, there was strong and consistent evidence demonstrating that the safety concerns of parents, especially relating to road safety, were a key barrier to children engaging in AST. The evidence around the association between parental perception of the local neighbourhood and AST was mixed.

Safety concerns were found to be the most important factor when parents made decisions about their children's school travel mode (Jing, 2017). This included attitudes relating to neighbourhood safety, route safety, walking and biking safety, traffic volume and traffic speed. A systematic review found a possible association between traffic or general safety and AST, but not between crime safety (Klos, et al., 2023). The authors noted that traffic safety as one of the major concerns among parents. However, using the Scottish household survey, Waygood and Susilo (2015) found that neighbourhoods with less traffic danger were associated with decreased AST, perhaps as this made it easier for parents to drive their children to school. Healey and Gilmour (2016) noted the relative inconvenience of accompanying a child to school by bicycle versus use of a car, and highlighted parental unavailability to accompany their child to/from school as a key barrier to AST.

While parental decision making is shaped by a diverse range of considerations, Rothman et al. (2018) explained that the ′present-day parenting model′ emphasises adult supervision and surveillance, leading to more parents driving their children to school and a decline in AST. There was strong evidence showing that positive parental attitudes towards AST were associated with increased AST. One systematic review found a positive relationship between supportive parental attitudes higher levels of AST, although it did not specify what the positive attitudes related to (Rothman, et al., 2018). Similarly, a Portuguese cross-sectional study found that parental encouragement was positively associated with AST, though supportive attitudes among friends was not (Silva, et al., 2014). Furthermore, family support for physical activity was identified as a significant moderator in the relationship between distance to school and AST (Garnham-Lee, et al., 2017). When the distance to school was further, children with low family support were less likely to engage in AST compared with children with higher family support.

Parental perceptions of the local neighbourhood appeared to be important due to their connection with parental perceptions of safety. However, evidence on their association with AST was mixed. In one study, positive perceptions of local shops in the UK (understood as good interactions between shopkeepers and people shopping) was found to be an important factor contributing to sense of place (Waygood & Susilo, 2015). The authors explained that this resulted in parents feeling that there were 'familiar eyes on the street', which increased the likelihood that they would let their children walk to school. However, using the National Survey for Wales, Potoglou and Arslangulova (2017) found that parental perceptions of 'belonging to local area' and 'feeling that people treat each other with respect' were not significantly associated with AST. These differences in findings may be because Waygood and Susilo (2015) specifically examined the effects on walking to school, whereas Potoglou and Arslangulova (2017) grouped walking and cycling together.

3.3.3 Friends

There were mixed findings about the association of friends' encouragement and AST. While one study found that travelling with friends during the journey to/from school was associated with AST, travelling with friends was not possible for children who lived in different neighbourhoods. A systematic review reported two studies where friends' encouragement was not associated with AST, while another found that encouragement from friends had a strong positive association with cycling when the distance between school and home was less than 1km (Jing, 2017). Evidence from a Portuguese cross-sectional study found that increased companionship of friends during journeys to school, but not parents, was positively associated with AST (Silva, et al., 2014). The authors suggested this may have been because young people liked to take the same travel modes as their friends. However, a qualitative study found that while travelling with friends may have facilitated AST, children often had friends in school who lived in neighbourhoods that were far from their homes (Greca, et al., 2023).

3.4 Child age and gender

3.4.1 Age

The evidence suggested that children aged between 10 and 12 were more likely to engage in AST than younger and older age groups. Potoglou and Arslangulova (2017) found that children aged 4 to 9 years were less likely to walk or cycle to school compared with children aged between 10 and 12 years. Another study found that children aged 13 to 16 were less likely to walk to school compared to 11 to 12-year-olds (Easton & Ferrari, 2015). However, the studies mentioned were cross-sectional, and examination of more longitudinal studies would be needed needed to assess the differing effects of age on AST for different age groups.

3.4.2 Gender

The evidence suggested that boys are more likely to engage in AST than girls, although this is likely more relevant for older children who are less likely to be accompanied by their parents on their journey to school.

Boys aged 11 to 16 years are more likely to engage in AST than girls (Salway, et al., 2019; Easton & Ferrari, 2015). Salway et al. (2019) cited wider evidence indicating that differences between boys and girls may be linked to girls being more likely to have higher levels of supervision and restrictions placed on them by parents due to safety concerns. While Potoglou and Arslangulova (2017) found no relationship between gender and AST, this is likely due to their sample including younger age groups as well. Younger children are more likely to be accompanied by parents when walking to school due to their age, whereas older children are more likely to be unaccompanied by parents. This may reflect greater safety concerns among parents of girls of older ages, resulting in gender differences for AST in older age groups.

3.5 Evidence gaps

While there is a lot of evidence on the social determinants of AST for children in the UK and internationally, there appear to be gaps around the impact of different social determinants on different modes of AST.

In terms of evidence quality, a key limitation is that all of the studies were cross-sectional and therefore, causal relationships were not explored. Further qualitative and longitudinal research could help to address this gap in the evidence.

Further research could also address:

- The fact that many of the sources reviewed for this study grouped walking and cycling together, which did not allow for separate walking and cycling modes analysis across a number of the social determinants. For example, parental concerns of traffic safety were found to be a key barrier to children engaging in AST, but it is not known how these parental attitudes differ for children walking or cycling to school.
- Older children's attitudes and behaviours towards AST, which would be particularly valuable, given that parent's attitudes and behaviours towards AST are more significant for younger children. Additionally, longitudinal studies would enable a greater understanding of how attitudes and behaviours, for both children and parents, change over time.

4. The health impacts of AST

This chapter provides an overview of the health impacts of AST and attempts to answer RQ2 (what impacts does AST have on children's physical and mental health, and how do the impacts vary depending on the mode of AST?). We summarise evidence relating to four key types of health impact identified in the literature, which are summarised in Table 2. This evidence was identified in papers that drew on a range of primary and secondary analysis.

The assessment found evidence that AST was positively associated with several mental and physical health domains. There was also some evidence that cycling potentially had a greater positive effect on mental and physical health compared with walking.

4.1 Mental health

4.1.1 Improved psychological wellbeing

There was evidence that AST led to improved psychological wellbeing (PWB). Findings suggested that parents not only notice this positive impact of AST in their children but also experience it themselves.

A study conducted by Stark, et al., (2018) involving a two-stage survey with non-representative samples of 152 children aged 9–10 and 31 parents in Austria provided insights into children's school travel mode and their PWB. It was found that children who used active modes, including walking and cycling, were associated with higher levels of PWB compared to those who travelled by car or public transport (Stark, et al., 2018). Furthermore, surveyed parents were most likely to indicate that their children were 'balanced, happy and pleased' when they had used an active mode to commute to school (including walking, bicycle, and scooter). In comparison, children travelling by car were more likely to be 'bad-tempered, restless and annoyed', although a minority valued the comfort of taking the car (Stark, et al., 2018). For the parent survey, the sample size was small so there should be caution when trying to generalise these results.

A small-scale qualitative study found that cycling had a stronger positive impact on children's psychological wellbeing (PWB) compared with walking (Stark, et al., 2018). Additionally, parents perceived that getting to school by bicycle is more enjoyable and can be good for their wellbeing and health (Greca, et al., 2023).

4.1.2 Decreased suicide attempt rates

There was evidence that AST was associated with decreased suicide attempt rates. This was demonstrated in the analysis of a large-scale dataset collected by the Global School-based Student Health Survey (GSHS) (Chen, et al., 2021). Multivariable logistic regression analysis was used to assess the association between AST and suicide attempts. Among more than 127,000 children aged between 13 and 17 years, those who used AST modes were 18% less likely to attempt suicide (Chen, et al., 2021). The source however did note that the association between AST and suicide attempts varied greatly across the 34 countries, and therefore further research is needed to confirm the association between AST and suicide attempts.

4.2 Physical health

4.2.1 Fitness

There was evidence within the reviewed literature that AST is associated with reduced obesity and lower BMI and with increased strength and fitness, although the mode and intensity of AST and young people's wider behaviours (e.g. dietary habits) are important factors to consider when attempting to draw conclusions.

One quantitative study assessed 6,829 children during physical education classes in the UK (Cohen, et al., 2014). Those that cycled to school were more likely to have greater handgrip and cardiorespiratory fitness. In addition to this, vertical jump height was greater in walkers and cyclists compared to those using other modes of commuting (Cohen, et al., 2014)

4.2.2 Bodyweight

A study drawing on the Millennium Cohort Study (MCS) found that switching from the use of car to active travel modes when commuting to school was associated with reduced obesity, lower BMI and a lower percentage fat (Laverty, et al., 2021). Taking a bigger picture view, research drawing on secondary data analysis from the Gateshead Millennium Study (GMS) found that AST at age 8 to 12 was associated with more favourable physical activity levels throughout adolescence, which in turn can contribute to lower BMI (Farooq, et al., 2021).

Despite this favourable evidence, a systematic review exploring the relationship between AST and obesity found that whilst a majority of studies reported a positive association, the degree of variability in findings represents an "inconclusive result" (Martin-Moraleda, et al., 2022). Attempting to explain this, the authors suggest that the amount, type and intensity of physical activity is important to factor into analysis in terms of whether there is a positive effect in terms of lowering obesity, with some commutes not providing enough activity to impact on BMI. Furthermore, the authors state that it is necessary to consider young people's wider behaviours, including diets, television viewing habits and after school activity participation when attempting to understand the determinants of healthy body weight (Martin-Moraleda, et al., 2022; Noonan, 2020).

4.3 Air pollution

A range of negative health impacts are associated with exposure to air pollution. This includes health and cognitive impacts such as high blood pressure, increased airway inflammation and slower development of working memory (Osbourne, et al., 2021). There was mixed evidence about whether AST leads to higher or lower exposure to air pollution. The difficulty reaching a firm conclusion is explained by the fact that levels of air pollution depend on journey related factors, including choice of route, level of traffic congestion at time of journey and in-vehicle factors related to vehicle's recirculation settings, levels of ventilation and the presence of air filtration systems (Osbourne, et al., 2021).

One study found that AST may lead to lower exposure of air pollution, and consequently better health impacts. In London, an assessment of children's exposure to air pollution during a typical school week identified that exposure was 8% higher for those who were driven to and from school compared to children who walked through back streets located away from roads with heavy traffic (Varaden, et al., 2021). In contrast, another study found that exposure to ultrafine particles is higher for walkers compared to children travelling by car, potentially due to walking alongside busy traffic (Dirks, et al). Further evidence suggests that travelling by car

or on foot are both favourable alternatives to traveling via bus. One study found that children who travel via bus may be exposed to greater levels of air pollution compared to those who travel by car or walk to school, which was explained by bus routes covering busy main roads (Osbourne, et al., 2021).

There was some consideration in the literature given to weighing up the risks associated with exposure to air pollution through AST and the physical benefits of AST. There is evidence from a health impact modelling study (Tainio, et al., 2016) that the positive health effects of physical exercise exceed the harm caused by air pollution exposure in all but the most extreme air pollution scenarios, which are generally not seen in high income countries systems.

4.4 Other health impacts

4.4.1 Cognitive development

There was conflicting evidence related to the impact of AST on cognitive development and the findings available were mixed. In one small scale qualitative study, parents reported that cycling to school can improve cognitive skills and coordination (Greca, et al., 2023). In contrast, secondary analysis found that there was no clear educational advantage for any travel modes to school, and that demographics, health and socioeconomic status have bigger impacts (Walker & Gamble, 2023).

4.4.2 Sleep

A study drawing on qualitative research and non-representative surveys reported that children tended to have a better night's sleep because of their higher activity levels when actively travelling to school (Stark, et al., 2018).

4.5 Evidence gaps

Fifteen sources are drawn upon. This includes both UK and international evidence. The quality of the evidence was mixed, with several sources drawing on small scale qualitative approaches or non-representative surveys. A recommendation, therefore, would be to carry out further higher quality larger-scale studies, in the UK context. Further research should attempt to account in greater detail for the relationships between health impacts and different active travel modes, pupil age and school journey distances. The relationship between AST and car related accident rates is also a theme not covered in the evidence.

5. Cycle training interventions

With a specific focus on Bikeability (and similar initiatives), this chapter examines the evidence on previous cycle training interventions that were associated with AST, and attempts to answer RQ3 (outlined below).

RQ3. To gauge the success of previous AST interventions, and help inform the design, monitoring and evaluation of future AST interventions:

- What have been the defining features of previous AST interventions?
- What is the level of variation in the models that have been implemented?
- To what extent have these achieved their intended outcomes?
- What have been the enablers, barriers and contextual factors associated with achieving impact?
- What approaches have been taken to measuring and understanding impact?

In turn, we describe the key components and dimensions of variation within the interventions we identified; the impact of these interventions; the factors associated with achieving impact (i.e. the enablers, barriers and wider contextual factors); and the approaches taken to measuring and understanding their impact. See Table 3 and

Table 4 for a summary of the cycle training programme features and success measures.

It should be noted that this chapter provides only a preliminary reflection of the evidence base surrounding Bikeability (and similar) initiatives. Due to the limitations of this evidence assessment, a more extensive and systematic research exercise would be required to draw any exhaustive conclusions about the relationship between cycle training interventions and AST.

5.1 Introduction

Bikeability is the UK's official cycle training programme and is underpinned by the National Standard for Cycle Training, which outlines the skills and knowledge requirements for anyone to be able to cycle safely. The programme is core to Gear Change, under which the government has announced an ambition to offer Bikeability training to every school child in England. This has led to a significant expansion of programme delivery since 2020.

Bikeability aims to equip children with the necessary skills and confidence to cycle safely on the road, to sustain their participation in cycling after completing the training and – ultimately – to enable greater and safer participation in cycling across the nation. The programme is structured around three levels of training, which are offered via primary and secondary schools. Level 1 teaches children cycle handling skills off-road; Level 2 teaches them to cycle safely on quiet roads and junctions; and Level 3 teaches them to cycle safely on busy roads and at junctions. Children typically participate in Levels 1 and 2 during school Years 5 or 6 and Level 3 in secondary school.

In addition to Bikeability, we examined the following initiatives, which were identified as being centred around cycle training and either directly equivalent or otherwise comparable to Bikeability:

- **National Cycling Proficiency Scheme** (**NCPS**)**.** NCPS was a central government-owned programme (funded via Cycling England). It was the national cycle training initiative in England until 2007, when the National Standard for Cycle Training was created, and it was rebranded as Bikeability. NCPS had a broadly similar set of aims and delivery structure to Bikeability.
- **Bikeability Scotland.** The Scottish Cycle Training Scheme (SCTS) was the national cycle training initiative in Scotland until 2011 when it was rebranded as Bikeability Scotland, which now serves as Transport Scotland's national equivalent of Bikeability. As with the NCPS, it has a broadly similar set of aims and delivery structure to Bikeability however, unlike Bikeability, delivery is reliant on volunteer staff.
- **Widening Participation Fund** (**WPF**)**.** The WPF was launched in 2022, with £1.44 million in DfT funding to enable 44 projects that centred on removing barriers to participating in Bikeability among five areas where participation has previously been low: areas of deprivation; ethnic minority groups; Level 3 Training; female teenagers; and Special Education Needs or Disabilities (SEND). The WPF funded projects built on the standard Bikeability offer by offering various additional sessions that were tailored to the needs of those who required extra support, for example through girls only sessions, tailored SEND training sessions and parental engagement sessions.
- **I Bike.** I Bike is funded by Transport Scotland and encourages AST by bicycle among children who face barriers to participation in cycling. Specifically, it targets the transition from primary to secondary school and by the gender gap in rates of cycling between boys and girls. The initiative involves having embedded I Bike officers within local authorities, who deliver a programme of school-based activities that are designed to achieve long term behavioural change. While I Bike isn't strictly a cycle training initiative, cycle training sessions are usually a core component, along with various other types of cycling confidence building activities and teacher professional development.
- **Ride or Walk to School** (**RWTS**)**.** RWTS is an ACT Government (Australian Capital Territory) capacity building initiative that aims to provide schools with the necessary resources to teach and encourage AST, including through the provision of cycle training. RWTS is underpinned by the following components: teacher professional development; a bicycle skills and safety programme; provision of bicycles and helmets; assistance with finding bike storage solutions; self-defence; and BMX workshops.
- **Miscellaneous/unspecified.** We also identified various, smaller scale cycle training initiatives that were discussed in the context of a meta-analysis and were not usually identified by name or described individually.

Table 8 provides a summary for each key source of cycle training literature we identified, with a note to specify which cycling initiatives are discussed in each paper. We have labelled these initiatives as either 'cycle training initiatives' or, where they were discussed, 'other cycling initiatives' which did not feature cycle training as a core component of their design but nonetheless sought to promote cycling among school children and were therefore considered complementary to the aims of cycle training initiatives. They are outlined in more detail in Table 9, which sits in Appendix A.

5.2 Key features & variation

In this section, we outline the key features that underpinned the cycle training interventions we identified, as well as the key dimensions of variation between them. In turn, we examine how the aims and design of each intervention differed. As noted at the beginning of this chapter, the evidence presented in this section should be interpreted only as a preliminary indication – more extensive research would be required to produce a categorisation reflective of the entire Bikeability (and wider cycle training) landscape. Table 3 provides an overview of the key features and dimensions of variation that will be discussed in this chapter. It should also be noted that the interventions categorised as 'miscellaneous/unspecified' above are not covered in this section as they were not described in sufficient detail within the literature and in some cases were not specified by name.

5.2.1 Aims

All the cycle training interventions identified in this evidence assessment held the overall aim of increasing cycling proficiency among schoolchildren and thereby facilitating an uptake in their active travel. Bikeability does not aim to increase AST specifically and furthermore, this evidence assessment identified very few studies which identified initiatives for which this was a stated aim. This could reflect either a gap in the AST evidence base and/or a lack of initiatives undertaken with such an aim, though further research is needed to verify this. However, for I Bike and RWTS, increasing AST by bicycle was a stated aim. Furthermore, WPF and I Bike differed from Bikeability in that the initiatives specifically targeted groups of children previously underrepresented in cycle training. Finally, RWTS also differed from Bikeability in that it aimed to build the capacity of schools to encourage an uptake in cycling.

5.2.2 Design

While the National Standard for cycle training stipulates how Bikeability participants should be assessed and the Bikeability Trust provide guidance on cycle training delivery, there is often some degree of variation in the design of Bikeability training (for example, how it is staffed or where the training is delivered). However, at its core, Bikeability and the similar cycle training interventions we identified had a broadly similar design, in that practical-led cycle training sessions were a core component, and they aimed to teach participants a very similar set of skills. The key dimension of variation was whether or not schools were provided with additional support, around the cycle training sessions themselves, to help facilitate an uptake in rates of active travel by bicycle. While the standard Bikeability model does not provide such support, this was a core component of WPF funded Bikeability interventions, and of both I Bike and RWTS. Additional support was either provided via bicycle equipment and infrastructure, or tailored cycling sessions and activities that aimed to further build cycling confidence, incentivise participation in active travel or build the capacity of schools to deliver. Key examples are outlined in more detail in Table 10, which sits in Appendix A.

5.3 Intervention impact

Where impact was discussed, it was generally found that interventions had a positive impact on cycling behaviour. However, it should be noted that we identified a lack of relevant studies that measured the impact of cycle training, particularly on AST behaviour. This might indicate a gap in the AST evidence base and/or a lack of initiatives being undertaken with the specific aim of facilitating an uptake in AST. As such, the evidence we present in this section is drawn from a particularly small evidence base. We identified four ways in which the impact of cycle training was discussed – propensity to cycle (in general), propensity to cycle (to/from school),

widening participation and perceptions of safety.

5.3.1 Propensity and confidence to cycle (in general)

We found the following evidence to suggest that cycle training interventions had positively impacted participants propensity to engage in active travel by bicycle. Though this might in turn predict higher participation in AST by bicycle, this link was not made in the literature:

- SQW (2019) found that being offered Bikeability Level 2 or 3 was positively and statistically significantly associated with increased propensity to have cycled since the start of term, for Year 6 pupils.
- Gupta, et al. (2023) found that 50% of WPF participants reported themselves as expecting to cycle at least once a week after participating in WPF funded Bikeability projects, compared to 24% who said they cycled at least once a week before the training.
- Healey & Gilmour (2016) reported that, when compared with non-participating schools, children in RWTS participating schools were more likely to use active travel every day (27% versus 17%), at least once a week (67% versus 44%) and as their usual mode of travel (51% versus 30%). Furthermore, these levels of participation were shown to have been achieved against a backdrop of decline in rates of active travel within the wider ACT school population. However, it should be noted that the authors do not distinguish between walking, riding or scootering in the reporting of these figures.
- In Gupta, et al.'s study (2023), 64% of WPF participants reported themselves as feeling confident when cycling on roads after participating in WPF funded Bikeability projects (compared to 33% before), and only 7% saying they felt not at all confident after the training (compared to 30% before).
- Hodgson & Worth (2015) reported that, when comparing their before and after responses, children who received Bikeability Level 2 training stated themselves as having significantly greater confidence when cycling on road afterwards. However, they also found that children did not report cycling more after the training and furthermore, their mean scores on a practical assessment decreased during later phases of the evaluation which the report suggested as indicating that the knowledge gained through participation in Bikeability may decline over time if not put into practice.

5.3.2 Propensity to cycle (to/from school)

We found the following evidence to suggest that cycle training interventions had positively impacted participants' propensity to engage in AST by bicycle:

- Teyhan, at al. (2016) found evidence to suggest that NCPS trained children were more likely to cycle to school at both the ages of 14 and 16 years old, which might suggest that NCPS trained behaviours had persisted into adulthood.
- Systra, et al. reported school survey evidence to suggest that participation in I Bike led to an increase in regular AST by bicycle over a one-year period (3.1% increase), two-year period (1.9% percentage point increase) and three-year period (0.7% percentage point increase).
- Transport Scotland reported that initiatives within their Walking and Cycling Schools Programme were generally perceived to have positively influenced pupil's active travel behaviours and attitudes – where schools already engaged in the active travel agenda, it helped to enhance outcomes and where they were not, it helped to 'plug an essential gap'. It should be noted that Transport Scotland did not collect any quantitative data to support this.

5.3.3 Widening participation

We found the following evidence to suggest that cycle training interventions had increased rates of participation in cycling or AST among groups where participation in cycling had previously been low:

- Gupta, et al. (2023) found that, when compared to schools that had participated in standard Bikeability training, the representation of key groups was statistically significantly higher in WPF-participating schools, groups included: female pupils; those from ethnic minority backgrounds; pupils classed as SEND; and those eligible for pupil premium (which was used as a proxy for identifying children living in areas of deprivation).
- Data collected from participating I Bike schools in five local authorities during the 2014-15 school year suggests that within participating schools, rates of AST increased by 2.4% for female pupils and 2% for male pupils, which may suggest that I Bike had been successful in tackling the gender gap in rates of cycling between boys and girls. However, the authors did not distinguish between modes when reporting these figures. This stands against a backdrop of evidence in other papers which acknowledged that rates of cycling can be lower among girls:
  - Teyhan, et al. (2016) found that very few of the girls in their sample cycled to school, and that their last cycle journey was shorter and a longer time ago than the boys' last journeys. reported their last cycle as being shorter and longer ago than the boys. This was noted as being consistent with similar studies conducted previously and the authors cited further evidence to suggest that boys who cycle to school may be more attracted to cycling to school as a physical activity, whereas girls may be more likely to hold safety concerns.
  - Furthermore, in their systematic review, Schönbach, et al. (2020) speculated that poorer fitness could help to explain differences in participation in cycling to school between boys and girls.
  - Finally, Systra, et al. (2016) reported no noted differences by gender within primary schools around rates of cycling, they did find evidence of a gender spilt in participation rates for cycling initiatives at the secondary school level.
- Transport Scotland (2021) reported that 50% of schools participating in their Walking and Cycling to Schools Programme felt participation in cycling (and walking) initiatives was particularly beneficial for specific groups of pupils (35% were unsure and 15% said it was not beneficial). Various groups were cited as potentially benefitting more, such as primary age children; children from families where there was no cycle provision, who do not encourage physical activity at home or rely heavily on cars; inactive children and children with physical or mental health concerns; children who lack confidence in their abilities or lack independence; those who live closest to the school; low attaining pupils; and pupils living in urban/built up areas with limited access to gardens and safe outside spaces at or near to their home. Bikeability was reported as being particularly beneficially for older primary age children.
- Finally, Goodman, et al.'s research – while not selected for inclusion in this evidence assessment chapter (it focused primarily on the reach of Bikeability training, not its effectiveness) – concluded, from analysing a sample of 6986 English children, that: "cycle training participation rates were lower among minority ethnic children, among children who played sport less often, and among children whose parents were poorer or less educated". These trends were consistent regardless of whether the school offered

Bikeability, suggesting that the scheme helps to widen participation but does not go so far as eliminating overall inequalities in participation rates.

5.3.4 Perceptions of safety

Finally, we found the following evidence to suggest that cycle training interventions positively impact perceptions of cycling safety among parents and/or children. Though this might in turn predict higher participation in AST by bicycle, this link was not made in the literature:

- Systra, et al. (2016) presented both primary and secondary evidence to suggest that while Bikeability does not necessarily increase levels of participation in cycling, it does have a positive impact on both child and parent perceptions of cycling. Furthermore, these impacts appeared to be greater among pupils in schools with a higher proportion of pupils eligible for free school meal.
- Gupta, et al. (2023) reported that the WPF had been successful in increasing perceived safety, with 52% of participants reporting that they felt safe after participating in WPF funded Bikeability projects, compared to 28% before the training. Furthermore, more than one fifth of participants said they did not feel at all safe (21%) before the training versus 7% after the training.
- SQW (2019) reported a statistically significant increase in propensity of parents to allow their children to cycle on the road (reported by 70% of pupils in participating schools, versus 58% in comparison schools).

5.4 Factors affecting intervention success

In this section, we discuss the factors that affected the success of cycling interventions in facilitating an uptake in AST, including enablers, barriers and wider contextual factors. Firstly, we outline factors that were associated with the involvement of schools in cycle training initiatives and the promotion of AST by bicycle, secondly, we outline the factors that were associated with the participation of children in cycle training initiatives and AST by bicycle. It should be noted that some of the examples in this section have not come from previous cycle training interventions. However, all have come from cycling initiatives and therefore bear relevance to the topic of achieving and sustaining an uptake in AST by bicycle (which is an important consideration for future cycle training interventions that aims to achieve such behaviour change).

5.4.1 School involvement

In this section we discuss the factors that shaped the involvement of schools in cycle training interventions and wider promotion of AST by bicycle. Factors included: planning and administration; staffing of cycle training; safety perceptions; and provision of bicycles and related equipment.

The planning and administration involved in delivering an intervention

While several authors noted that lengthy planning and administration must be carried out well in advance for any AST intervention to take place in a given school year (Transport for London, 2021; Gupta, et al., 2023; Transport Scotland, 2011), it was noted that the administrative requirements of on-road cycle training can be particularly difficult to navigate. In one example, a school had opted to deliver playground only training as they felt the volume of paperwork required to deliver training outside of the school was unmanageable (Transport Scotland, 2011).

The staffing of cycle training

Delivering any cycle training intervention relies on the availability of appropriately trained staff, whether that be in the form of staff provided via the programme coordinator, school staff or volunteers from the wider school community. It was not always possible for programme coordinators to provide externally trained professionals, with one study noting that in some cases many qualified Bikeability instructors had retired or left the industry (Gupta, et al., 2023). Having dedicated staff volunteers was cited as a key way of countering this in several studies. When it came to WPF funded Bikeability initiatives, Gupta, et al. (2023) reported that the involvement of school staff also helped to encourage and sustain participation in several ways: they could offer guidance on how to best recruit or engage specific groups of children; they could have a comforting presence for children during the training, especially those less confident; and, when involved for a number of years, staff volunteers can help to support the sustainability of the initiative. However, there were two key issues associated with reliance on staff volunteers:

- **Where staff volunteers lack the necessary skills, this poses a safety risk**. This was especially true where on-road cycle training took place and where the instructor to child ratio was lower (Transport Scotland, 2011). Staff volunteers were nonetheless seen as a valuable resource and so it was suggested that programme coordinators could facilitate 'train the trainer' sessions to upskill volunteers in delivering the training and that due to the often higher availability of staff volunteers, this can present a more efficient solution than recruiting externally trained staff (Gupta, et al., 2023; Transport Scotland, 2021). Gupta, et al. (2023) also recommended that future cycle training facilitation opportunities may be advertised to older participants who demonstrate an appropriate proficiency or keenness for cycling.
- **Overreliance on a small number of school staff volunteers can harm the continuity of any AST initiative** (Vasey, et al., 2022; Healey & Gilmour, 2016; Transport Scotland, 2021). Recommendations for how to tackle resource constraints included advertising such responsibilities in school staff job descriptions and establishing a cross-agency staff network across delivery partners (Systra, et al., 2016).

Safety perceptions among school staff

Various studies discussed concerns from staff involved or eligible for a cycling initiative. Concerns raised included schools not appropriately located to support AST by bicycle or on-road cycle training. In some cases, there was evidence of schools opting not to participate because of potential litigation concerns. School locations where this was cited as a particular concern included deprived locations (in one example, proximity to a housing estate made cycle training unsuitable); being in an urban centre i.e. with dangerous roads; and rural locations, where the greater distance to school made cycling unviable (Healey & Gilmour, 2016; Transport Scotland, 2021). Two key recommendations from Transport Scotland's (2021) study included: giving more support to schools in unsafe locations to undertake infrastructural changes to improve road safety (for example through the installation of cycle paths in and around schools and additional safe bicycle storage); and, where a lack of quiet roads is a barrier, a more gradual phasing of training from playground to on-road and provision of fluorescent clothing to children.

Providing bicycles, cycling equipment and cycling infrastructure

It was found that having the capability to provide pupils with access to bicycles and associated equipment (such as helmets or high visibility jackets), bike maintenance technicians and/or cycling infrastructure may help to further participation in cycle training, especially for

schools located in high poverty areas (Transport Scotland, 2021; Gupta, et al., 2023). Gupta, et al. (2023) noted that a lack of familiarity with funding application processes can be a barrier for some schools, as schools who already have bicycle fleets were able to plan and administer their cycling initiatives faster than those who applied for bicycle funding. Even where schools qualified for funding, practical considerations such as a lack of space for playground cycle storage could be a barrier (Transport Scotland, 2011; Healey & Gilmour, 2016). Recommendations for how programme coordinators could better support schools and/or families included providing more information about the discounts and funding available when purchasing school bicycle fleets; undertaking mapping exercises to ensure existing resources are directed to areas of the highest need; and, where it is not possible to purchase school bicycle fleets, consider bicycle sharing (e.g. from the local authority) and running bicycle maintenance sessions so that bicycles children already own are road worthy (Transport Scotland, 2011; Transport Scotland, 2021).

5.4.2 Child participation

In this section we discuss the factors that shaped children's participation in cycling. In some papers, these factors were discussed in the context of cycle training, and, in others, they were discussed in relation to AST by bicycle in general. For the purposes of this section, we present these factors thematically, rather than specifying how they were discussed in the literature. We separate these into factors primarily associated with a child's motivation and their parent's willingness for them to engage in cycling.

Child-related motivation

Previous studies identified the following key factors as being important in shaping children's motivation to participate in cycling activities:

- **Socialisation and reward** (Systra, et al., 2016). In terms of socialisation, it was reported that cycling with friends increased children's enjoyment of cycling to/from school and therefore their motivation to keep engaging in it. A related suggestion was that future initiatives might implement a 'buddy system' through which children can identify fellow pupils to cycle to/from school with. Similarly, walking school buses were suggested as an effective way of motivating children to walk to/from school. Applying this concept to cycling – cycle trains may be an effective equivalent, but we did not identify any direct discussion of this. In terms of reward, it was reported that experiencing a sense of achievement or receiving a reward was a similarly effective motivator. Previous examples included implementing activity tracking (e.g. via interschool or intraschool competitions) and/or awarding prizes (such as house points or a cap branded with the logo of the intervention) as a way of recognising children's individual or collective participation in AST by bicycle.
- **The transition to secondary school** (Systra, et al., 2016). It was found that the transition from primary to secondary school can introduce a range of changes that made it more complicated or difficult for children to continue cycling to school (e.g. greater distance to school, a larger school kit or greater independence). One recommendation for how future initiatives could help to sustain behaviour included undertaking activities such as led rides and school transition workshops to help familiarise children with the available cycle routes to their new school.

Parental willingness

Previous studies identified the following key factors as being important in shaping parent's motivation for their children to participate in cycling activities:

- **Parental concerns about road safety** (Transport Scotland, 2021; Healey & Gilmour, 2016). Healey & Gilmour (2016) cited this as being the second largest barrier to programme implementation in their pilot survey of school staff (with 52% saying this was a barrier). It was suggested that sharing targeted educational materials with parents can be an effective way of countering parental perceptions where they do not correspond with an actual safety risk.
- **Parental perceptions of their child's capability to cycle safely** (Gupta, et al., 2023; Schönbach, et al., 2020; Vasey, et al., 2022). This was discussed both in relation to parental perceptions of their child's cycling proficiency and their ability to safely navigate the school route. Involving parents in the activities of the cycling intervention proved to be an effective intervention strategy for countering this (for example, through parental assisted homework tasks, family sessions or day trips) as it demonstrated to parents what their child had learnt. Other strategies reported as effective included having bicycle maintenance sessions whereby the safety of participants bicycles was checked, and children were taught how to maintain their bicycle and ensuring that the teaching style was adapted to the group (e.g. by having female-led all girls sessions or targeted SEND training with higher instructor to child ratios).
- **Parental unavailability to accompany their child to/from school** (Healey & Gilmour, 2016; Vasey, et al., 2022). Healey & Gilmour (2016) cited this as being the largest barrier to programme implementation in their pilot survey of school staff (with 58% saying this was a barrier). This barrier was reported as owing to the relative inconvenience of accompanying a child to school by bicycle versus the car, for example the additional time and organisation it takes and the difficulty of combining it with a work commute.

When considering what shapes children's school travel decisions, several authors described parental attitudes as limiting participation to a larger degree than any other factor (Transport Scotland, 2021; Schönbach, et al., 2020; Vasey, et al., 2022). For example, Vasey, et al. (2022) described parental decision making as playing a 'gatekeeping role', whereby an intervention will not be successful in changing a child's behaviour if it does not reassure a parent's safety concerns (even if the intervention strategies are otherwise strong).

5.5 Understanding and measuring impact

Various approaches were taken to monitoring and evaluating the success of cycle training and associated interventions.

Table 11 (Appendix A) provides an overview of the key methodological components that underpinned each of the key evaluations we examined. Within these papers, the authors noted various limitations to understanding and measuring the impact of cycle training and other associated AST interventions, as well as recommendations for how future interventions could address them. We have presented limitations (and recommendations, where identified) most relevant to cycle training below:

- **There is a general need for greater monitoring and measurement of initiatives.** Systra, et al. (2016) noted that AST initiatives in general (including cycle training) have not always capitalised on the data sources available to them to help monitor the impact they are having and to inform the planning and implementation of future initiatives. The authors suggested that programme coordinators could play a greater role in facilitating the monitoring and measurement of initiatives, for example by hosting a central website repository for logging and collating school collected data.
- **Behaviour change requires prolonged intervention and observation.** Coombes & Jones (2016, cited in Schönbach, et al., 2020) state that "individuals may need to go through a number of stages associated with the formulation and implementation of attitudes and beliefs before actually undertaking changes, and this whole process takes some time". Reflecting this, if the observation and measurement of behaviour change is a key aim then interventions and monitoring activities must be sustained over a long enough period for behaviour change to take place and be measured. In their systematic review, Schönbach, et al. (2020) noted that none of the interventions ran for longer than 13 months and speculated this may not have been enough time to observe behaviour change.
- **Intervention success can be measured in various ways.** Measures of impact typically focus on the number of journeys undertaken but this can fail to account for other impacts which can be important for sustaining longer-term behaviour change such as child enjoyment, increased confidence or the development of new skills, many of which are often less readily measurable (Transport Scotland, 2021).
- **It may not be possible to control for outside influences,** such as other school travel initiatives or less formal activities (such as a general encouragement of active travel) delivered in parallel to an AST intervention (Transport Scotland, 2021).
- **A standardised approach to monitoring and evaluation may not be appropriate.** Gupta, et al. (2023) recommended that any future cycle training evaluation should maintain flexibility in its data collection approach as the circumstances and needs of every school will differ. The authors suggested, for example, that giving early consideration to how tools such as surveys can be adapted to the needs of different pupils is important for minimising the extent of missing data (e.g. 'no answer', 'prefer not to say') or non-response.
- **Further monitoring of gender differences may be important.** Given the evidence to suggest that participation in cycle training and AST by bicycle can look quite different for boys and girls, there may be value in exploring this further via the monitoring and evaluation of future cycle training initiatives (Schönbach, et al., 2020).
- **Consider how student surveys can be optimised.** Hodgson & Worth (2015) put forward several recommendations for how student surveys can be optimised for Bikeability. These included gathering baseline data from a large sample of children, to test the functioning of the quiz and inform future rounds of data collection; gathering post-training data from a larger sample of children, to enable more detailed subgroup analysis of impact; using the post-training survey to identify any areas where students have not acquired or attained learning as well, so that aspects of the delivery model can be improved; and gathering post-training survey data again after a longer period of time has passed to establish how well the skills taught in the training are sustained.

6. School Streets interventions

This chapter examines the evidence on School Streets – an intervention which involves implementing a temporary restriction on motorised traffic on the road outside of a school. It attempts to answer RQ3 (outlined below).

RQ3. To gauge the success of previous AST interventions, and help inform the design, monitoring and evaluation of future AST interventions:

- What have been the defining features of previous AST interventions?
- What is the level of variation in the models that have been implemented?
- To what extent have these achieved their intended outcomes?
- What have been the enablers, barriers and contextual factors associated with achieving impact?
- What approaches have been taken to measuring and understanding impact?

In turn, we describe the key components and dimensions of variation within the intervention; the impact of School Streets interventions; the factors associated with achieving impact (i.e. the enablers, barriers and wider contextual factors); and the approaches taken to measuring and understanding their impact.

It should be noted that this chapter provides only a preliminary reflection of the evidence base surrounding School Streets initiatives. Due to the limitations of this evidence assessment, a more extensive and systematic research exercise would be required to draw any exhaustive conclusions across the research questions.

6.1 Introduction

School Streets is a relatively new intervention in the UK mostly implemented around primary schools (Davis, 2020). However, the concept may be linked back to the School Play Streets schemes of the 1930s where certain UK residential streets were closed to traffic between designated hours 'to provide play spaces in localities where there are no playgrounds' (Davis, 2020). In recent years, there has been a surge of interest and uptake of School Streets initiatives as policy makers recognise the potential environmental and public health benefits. This includes reducing congestion, road danger and air pollution around schools, tackling obesity through the promotion of active travel and meeting Net Zero targets. This is exemplified in the London context, where the first School Street was introduced in Camden in 2017, and as of March 2022, a total of 511 Schools Streets were reported to be operating in the city.[8]

This chapter primarily draws on six sources which present evidence and learning about the implementation and impact of School Streets initiatives. These are summarised in Table 13. Further studies on other types of safe school travel environment interventions have been summarised in Table 16.

8 https://www.london.gov.uk/press-releases/mayoral/mayor-hails-success-of-schools-streets-programme

6.2 Key features & variation

In this section, we outline the key aims and points of variation in the School Streets interventions we identified. As noted at the beginning of this chapter, the evidence presented in this section should be interpreted only as a preliminary indication – more extensive research would be required to produce a comprehensive description.

6.2.1 Aims

The primary aim of all the reviewed School Streets interventions was to reduce the volume and speed of motorised traffic within a closure zone at dropping off and collection times. In turn, School Streets interventions consistently aimed to:

- Improve road safety, or the perception of safety, for children and parents in the environment and route to school. This was through reducing traffic and easing congestion to decrease road danger. The perceived safety levels intended to then improve the confidence levels of parents for their children to walk or cycle to school.
- Increase active travel to school through creating a safe and pleasant environment which encourages walking, cycling and scooting to school by restricting access of motorised traffic.
- Improve air quality in line with reducing vehicles and traffic in the area. By creating a car-free zone outside of schools, School Streets aimed to offer a wider community benefit by providing reduced air pollution.

6.2.2 Design

The key dimensions of variation across different School Streets interventions are summarised below with several sources (Transport for London, 2022; Smith et. al., 2022) stressing that each intervention needs be tailored to the specific context and taken forward with local consent.

Terminology

There was some variation in how the intervention is described. In the London context, School Streets interventions were sometimes described as Healthy School Streets and used consistent branding. This reflects the fact that they were part of the wider Healthy Streets programme which began in 2014 through Transport for London (Davis, 2020). By contrast in Solihull, the term School Street Zone has been used, while Perth and Kinross Council described the intervention as a School Exclusion Zone (Davis, 2020).

Selection criteria and local consultation

Local authorities typically led the process of selecting where to implement School Streets. Roles of those responsible for School Streets within local authorities could include School Travel Officers, Travel Planners, Safety Travel Officers or Road Safety Officers.[9] There was variation in terms of the complexity of the process and the number of factors that were considered. The selection criteria included a combination of the following:

- Road layout – some schools will be ruled out from introducing a School Street because they are based on roads where temporary closures are not possible/appropriate.
- Levels of congestion, collision rates and perceived risk near school gates – with higher rates strengthening the case for implementation.

9 http://schoolstreets.org.uk/how/

- Levels of support for the scheme amongst residents and businesses via consultation – with concerns about displaced traffic being a key issue, in some cases resulting in local authority led analysis to investigate.
- Level of through traffic on the proposed School Street and availability of viable diversion routes.
- Anticipated levels of traffic displacement associated with implementing the closure – where excessive rates are anticipated the scheme may be ruled out
- Sufficient parking capacity in the vicinity for parents and carers who wish to "park and stride" to the school.
- Evidence of commitment to supporting AST from the school and school leaders to implement the scheme and promote AST. For example, in the London context, part of the selection criteria for implementing a School Street has included whether the school has or is working towards Transport for London STARS accreditation and whether the school intends to administer the travel mode "hands up surveys" in the current school year.[10]

In the Camden context (Camden Council, 2018), the process began with the Council seeking expressions of interest from local Councillors, schools and residents. The Council then evaluated each expression of interest and selected three sites based on a matrix system which incorporated agreed criteria. Schemes were then taken forward where schools were willing to sign a Memorandum of Understanding defining their responsibilities in relation to delivery.

Road closure period and size of the road closure

Schools Streets initiatives varied in terms of the closure periods. The closure range was between one and two hours at the start of the school day and the same at the end of the school day. Another variation was the size of the road closures that were implemented. For example, a scheme in the London Borough of Redbridge involving two schools sharing one School Street required a large closure zone.

Exemption policy

Each School Street initiative established an exemption policy. This was often agreed in consultation with local stakeholders, and it dictated the types and use of vehicles that could or could not operate within the closure periods. Those typically exempt from the closure included:

- Residents who live on the School Street
- Emergency services and related vehicles
- Those dropping off and collecting goods from schools
- Utility companies
- Local businesses
- Blue and white badge holders requiring access to an address

10 https://www.kingston.gov.uk/sustainable-transport-safer-greener-healthier-travel/school-streets/3

One review which considered five different London based School Streets interventions, noted that some schemes had set "strict" and short exemptions lists, whilst others had adopted "looser" and longer lists. Falling into the latter category, a School Street scheme in Waltham Forest worked up an extensive exemption list which included Royal Mail vehicles, registered carers, Council Waste services and trades vehicles (Transport for London, 2022). When setting an exemption list, it was felt to be important to balance the needs of different sets of individuals with the need to build an effective overall scheme (Transport for London, 2022).

Enforcement and monitoring

In the UK context, School Streets interventions applied for a Traffic Regulation Order (TRO) to ensure that the road closure has a legal basis. Different combinations of technology were used to enforce the temporary closures, which only operated during school term times. This included some combination of:

- **Enforcement and monitoring cameras** – used to monitor traffic levels and to issue penalty fines to those not on an exemption list. In some cases, fines were only issued after an initial warning period, where drivers breeching the closure zone were issued with a warning letter
- **Collapsible bollards** – commonly used for School Streets providing a physical barrier into the Street – these tended to be manually raised and collapsed by volunteers (e.g. school staff, parents) at the start and finish of each closure period.
- **Street signage** – highlighting the closure location and timings, with some schemes also deploying road surface markings or hand drawn banners and posters promoting the scheme
- **Monitoring activities** – to understand the impacts of the scheme in terms of active travel several sources in the literature describe using a 'hands up' survey and travel trackers which are short questionnaires administered to school pupils on a daily basis to understand school travel modes. Other forms of monitoring included qualitative interviews; parking and travel mode surveys; path tracing software – to visualise pedestrian flow; radar cameras and automatic intelligence technology – to count the number of vehicles; pedestrians and cyclists using relevant roads; and conflict and interaction analysis – to understand how vehicles, pedestrians and cyclists were interacting and the severity level of any conflicts.

Complementary infrastructure and activities

A range of complementary infrastructure was associated with School Streets interventions. This included additional cycling and scooter storage facilities – to accommodate the increase in AST (Transport for London, 2022), as well as the identification of additional parking capacity in the surrounding area so that parents could park outside of the closure zone and actively travel into school (Davis, 2020). In the UK context, this is known as "park and stride" (Davis, 2020).

Alongside infrastructure, some of the School Street initiatives cited in the literature placed an emphasis on complementary activities led by the school to encourage more active travel. In Camden, the school invested in organised promotional events, cycle training and offered incentives and rewards to boost levels of AST (Camden Council, 2018). In Southwark, a School Streets initiative was launched at a Play Street event, where the road was closed to support play and community (Transport for London, 2022).

6.3 Intervention impact

Overall, there was a wide range of evidence presenting how the School Streets interventions met the aims outlined above. The evidence found positive impacts in:

- Improving road safety: This involved decreasing traffic and motorists speed, displacing traffic, and improving perceptions of road safety
- Increasing AST
- Improving air quality
- This section also considers how support for the intervention was impacted and other wider benefits of School Streets.

6.3.1 Volume and speed of traffic

- Evidence was found, from monitoring device data, that the volumes and speed of traffic within School Streets closure zones and the surrounding streets had reduced (Transport for London, 2022).
- An evaluation of five London-based School Streets initiatives found that vehicle speeds reduced by up to 6.3 miles per hour across the case studies in the hours of operation compared to outside of them. The evaluation also saw around a 70–90% reduction across the case studies in the number of vehicles travelling through the School Street during the closure period (Transport for London, 2022).
- A literature review carried out by Edinburgh Napier University, drawing on 16 School Streets studies, concluded that there is medium strength evidence that in almost all cases the number of motor vehicles across school closure and neighbouring streets had reduced (Davis, 2020).
- A review of School Streets interventions located in Edinburgh (Edinburgh City Council, 2016, cited in Davis 2020), highlighted that the average speed reduction across all of the School Streets interventions (restricted streets) surveyed was 1.2mph, whilst 1.2mph was also the average reduction seen across all surrounding streets.
- A pilot carried out in Edinburgh involving 9 School Streets interventions reported achieving lower vehicle speeds on School Streets and peripheral streets and an overall reduction in net vehicle volumes on the streets surrounding the pilot schools during restriction times (Edinburgh City Council, 2016). For example, speed surveys for the Sciennes School Street intervention identified average speed reductions of 2.7mph on School Streets, and 2.1mph reductions on surrounding streets. While traffic volume surveys indicate that vehicle volumes on the School Streets were vastly reduced, whilst there was a marginal increase in vehicles across the numerous surrounding streets (Edinburgh City Council, 2016).
- A Transport for London (2021) evaluation found that 23% of surveyed parents and carers identified reduced traffic and congestion as a top benefit of School Streets, while 6% felt that the intervention had moved the problem or congestion to other areas.

6.3.2 Traffic and parking displacement

- Across the School Streets literature, concerns were frequently raised by residents about the knock-on effects of vehicle speeds and volumes and parking issues on peripheral streets, because of restrictions to vehicles on School Streets. However, as evidenced below, mitigating actions have often been successful and concerns about traffic displacement and inconvenience have tended to reduce once schemes have been implemented.
- A literature review drawing on 16 School Streets studies concludes that there is "strong and consistent evidence" that actions to mitigate traffic displacement (including provision of additional parking capacity outside of closure zones) were successfully applied and that traffic displacement had not caused road safety issues of any significance (Davis, 2020). For example, at the Marston Green School Street in Edinburgh, alternative parking provision provided was regarded as convenient and accessible and was well used by many parents. At the Haslucks Green School Street in Edinburgh an alternative facility had been identified and whilst there was some evidence of a small increase in displacement parking, this was dispersed across a number of roads and the impact therefore was limited (Davis, 2020).
- A local authority led review of nine Edinburgh-based School Streets interventions found that parent and resident perceptions related to vehicle displacement and the potential for inconvenience improved once the scheme began running and that the net effect of the intervention was fewer vehicles on streets around schools after the initiative compared with before. However, new patterns in car parking by parents following the closures did attract some new complaints from affected residents (Edinburgh City Council, 2016).

6.3.3 Perceived road safety

Following the implementation of the intervention, parents and carers perceived improvements in the safety of their School Streets. There is also some evidence that most residents shared this perception. This aligns with the sharp reported drops in motorised traffic within School Street closure zones and the good levels of compliance that have been reported (see Sections 6.3.1 and 6.3.6).

A literature review which considered 16 School Streets interventions concluded that there is medium strength evidence that perceived road safety on surrounding streets as well as the closure streets improved as parents and pupils increase their AST (Davis, 2020).

An evaluation (Edinburgh City Council, 2016, cited in Davis, 2020) which reviewed 10 School Streets interventions in Edinburgh found through pre and post perceptions surveys that parents agreed that the streets surrounding the school gates felt safer after the scheme was implemented and they perceived improved safety for children. This aligned with residents' responses that following implementation, on the whole motorists were complying with School Street closures.

A pilot carried out in Edinburgh involving 9 School Streets interventions found that 66% of parents agreed that the streets with vehicle restrictions felt safer during operating times, while 16% disagreed. A majority of School Streets residents also agreed (61% compared with 13% who disagreed) as did a majority of residents on peripheral streets (48% compared with 12% who disagreed) (Edinburgh City Council, 2016).

A survey of parents and carers commissioned by Transport for London (2021) found that 39% of respondents answering an open-ended question about the "best thing" about the School Streets intervention was that it created or had the potential to create a safer environment for children.

6.3.4 AST

- School Streets interventions presented an increase in AST, including increased walking and cycling, although in some instances the reported increases are modest.
- A literature review considering 16 School Streets interventions concluded that there is strong evidence that active travel levels increased at the schools with street closures (Davis, 2020).
- In the central London context of Holborn, pre and post monitoring of numbers of driven trips (using a daily 'Travel Tracker' survey that asked pupils to record their school travel modes) showed a decrease of 43% in car use. The review authors speculated that this reduction may be explained by the fact many parents and carers were driving short distances achieving only a relatively marginal benefit by using their cars. Therefore, with the increase in inconvenience associated with parking outside of the zone, following the street closure, combined with the improved street environment, this was enough to shift their travel habits (Camden Council, 2018)
- An evaluation of a School Streets pilot in Edinburgh found through 'before' and 'after' surveys (looking at data from 6 of the 9 schemes) that the number of children using AST modes had increased, whilst those being driven had fallen. However, the overall reported percentage changes were modest, with walking increasing by 3%; Park and Stride increasing by 2%; Cycling reducing by 1%; and being driven to/from school reducing by 6% (Edinburgh City Council, 2016).
- A review of five London based School Streets interventions commissioned by Transport for London (2022) reported increases in AST following implementation. For example, the results from the Southwark scheme showed a 6% increase in users walking and cycling. An increase in the numbers of pedal cycles was also observed during the School Street operation hours, with 23 captured per hour during the drop off and pick up times, compared to ten per hour outside of the closure period.
- Drawing again on (Transport for London, 2022), in terms of AST behaviours and trends in the use of space, on-street monitoring across five interventions showed that:
  - Within the School Street closure zones, over half of all people cycling approached the school using the road as opposed to the pavement, while primary school aged children tended to cycle on the pavement.
  - In terms of walking within the zone, a majority chose to walk on the pavements, however at sites where traffic levels within the zone were low, walking in the road was more common.
  - Those driving and cycling were also observed to slow down, pause and gently swerve to provide more space and allow people walking to cross safely.
- A Transport for London commissioned survey found that parents at schools where School Streets was operating were more likely to be satisfied with the ease and safety of AST compared with a set of matched control sites. Furthermore, respondents reported walking more often to school which was attributed to both the introduction of School Streets and to Covid-19 (e.g. influenced by social distancing advice) (Transport for London, 2021).

6.3.5 Air quality

- School Streets interventions have had a positive impact on the air quality around schools. Air quality impacts have often focused on Nitrogen Oxide levels and have drawn on air quality monitoring data, calculations based on changes in the volumes of traffic or on perceptions data.
- A School Streets pilot in Camden resulted in an overall improvement in air quality on school days – with air quality monitors detecting a 3.8% reduction in Nitrogen Oxide levels. The authors noted that the readings were not time of day sensitive, and it was expected that a greater reduction in Nitrogen Oxide levels was achieved during the School Street closure hours (Camden Council, 2018)
- An evaluation (Edinburgh City Council, 2016, cited in Davis, 2020) which reviewed 10 School Streets interventions in Edinburgh concluded that across the schemes, air quality improvements associated reductions in Nitrogen Oxides were found. Details on the measurement approach and specific results were not provided.
- An evaluation of a School Streets pilot in Edinburgh showed improvements in air quality across the nine schemes, in the form of a reduction in Nitrogen Oxide levels calculated by assessing changes in the volume of traffic. The evaluation concludes that across all the schemes (bar two which were excluded due to data issues) that Nitrogen Oxide levels reduced by 1,631 grams per kilometre (Edinburgh City Council, 2016).
- A review of five London based School Streets interventions (Transport for London, 2022) found in qualitative interviews that school staff and parents appreciated a range of benefits including a reduction in air pollution.
- A study comparing School Streets intervention and control sites (Transport for London, 2021) found that respondents at Intervention Schools reported less dissatisfaction with air quality than at Control Schools.

6.3.6 Support for the intervention and compliance

- School Streets interventions achieved support from parents and carers and good levels of compliance providing effective enforcement measures and efforts to shift behaviours have been pursued.
- A School Streets pilot in Camden reported that 80% of residents reacted positively to the proposal during initial consultation for the scheme, although it was noted that the area had very high numbers of car-free households, and therefore support could be lower in more areas where reliance on cars was greater (Camden Council, 2018).
- A literature review considering 16 School Streets interventions concluded that there is medium strength evidence that closures are supported by the majority of parents, carers and residents living in both the closure zones and neighbouring streets, and that support increased after the intervention was trialled. (Davis, 2020).
- An evaluation of three School Streets introduced in Solihull found that they were well supported by local residents and compliance by parents was perceived to be good. (Davis, 2020).
- A Transport for London commissioned survey found that 81% of parents in schools where School Streets was being implemented felt that it was suitable for their school, and that three out of four supported making the intervention permanent, subject to a community consultation (Transport for London, 2021).

- An evaluation reviewing 10 School Streets schemes in Edinburgh reported that perceptions of motorist compliance improved over time according to both School Street and peripheral street residents. However, almost one-third of parents and carers and one-quarter of peripheral residents still perceived non-compliance as an issue (Davis, 2020).
- A School Streets pilot in Camden reported that some car users initially attempted to drive around the collapsible bollards by mounting the pavement – requiring changes to the street architecture to prevent this (Camden Council, 2018).

6.3.7 Wider benefits

An evaluation of five London-based School Streets initiatives commissioned by Transport for London (2022) found that school staff and parents and carers based across the schools appreciated the broader benefits of the initiative. This included the fact that the initiative: presented opportunities to educate and motivate children (presumably around active travel and the importance of being active), it supported social interaction and a more pleasant atmosphere at the school gates, and it increased the appeal of the school and wider area (Transport for London, 2022).

6.4 Factors affecting intervention success

In this section, we discuss the factors that affected the success of School Streets interventions.

6.4.1 Robust selection criteria

A number of the sources identified the importance of setting the right combination of selection criteria and of taking a systematic approach to reaching decisions as important success factors. This included:

- Avoiding locations where the proposed School Street was a busy through-road or on a bus route or accepting that the intervention would be more challenging and resource intensive to enact and enforce in these instances (Edinburgh City Council, 2016).
- Avoiding School Streets where large numbers of exemptions must be given (e.g. children hospital nearby) since this would make the traffic reduction aims much harder to achieve (Edinburgh City Council, 2016).
- Only progressing School Streets where there is demonstrable motivation and commitment to supporting the intervention – including the commitment to data collection travel mode surveys aimed at school pupils (Edinburgh City Council, 2016).

6.4.2 Commitment from school staff

- Across the School Streets literature, the high motivation and commitment of school staff at different levels was recognised as an important success factor and was therefore often a key part of the selection criteria when considering where to locate a School Street (for example, Edinburgh City Council, 2016; Camden Council, 2018).
- The importance of school staff commitment was evident in a study focused on the Canadian context, where a School Streets intervention in Montreal failed to launch most notably because the school and municipal leadership were not sufficiently committed (Smith, et al., 2022).

6.4.3 Integration with wider active travel and road safety initiatives

- A key success factor identified by school staff and Council officers in a review of London based School Streets initiatives was the importance of effective integration of the intervention with wider active travel and road safety initiatives taking place in the school and neighbourhood (Transport for London, 2022).
- Similarly, a review of a School Street pilot in Camden highlighted the importance of wider school-led activities which should begin before the intervention goes live. The school understood their role as leading a behaviour change programme, which combined promotional events, cycle training and offering incentives and rewards for active travel. Furthermore, within the same source, it was noted that schools should be ready to draw on in-kind support and expertise of existing Local Authority School Transport Planning officers when it comes to bringing about the required behaviour change (Camden Council, 2018).

6.4.4 Shifting culture and behaviours

It is recognised that successful School Streets interventions involved shifting the behaviours and culture of a set of stakeholders. This includes promoting a shift towards AST; supporting compliance with the closure zone from motorists and ensuring that staff are committed to delivering the intervention (e.g., routine data collection, partnership working with local stakeholders, and acting as stewards during closure times). A learning point is that this process of behaviour change is not necessarily linear – progress can move both backwards and forwards – and that effecting change requires empathy and a flexible and collaborative approach to working with different stakeholders (Transport for London, 2022).

6.4.5 Enforcement and compliance

Several sources identified challenges related to enforcement and compliance and it was recognised as a key success factor:

- Enforcement of the closure zone is presumably easier where ANPR cameras (which can generate penalty fines) are in place. However, there is case study evidence (Camden Council, 2018) that ANPR cameras costs are sometimes seen as prohibitive, and the collapsible bollards used in this instance were vulnerable to damage from heavy vehicles which further raised the costs of the intervention.
- Frustration was expressed by some parents and carers who pointed out that they had to drive due to distance from the school – underlining the importance of identifying parking capacity near the closure zone to accommodate them (Transport for London, 2022).
- It was noted that not all School Streets have good signage about the scheme and some parents raised concerns about poor enforcement of the scheme. This had meant that some parents continued to park in the school closure zone. It was not clear how widespread this challenge was and what enforcement approach was taken in these contexts (Transport for London, 2022).
- In a School Street introduced in Ealing, London, the council introduced ANPR cameras to enforce the closure periods, because volunteer-led enforcement (which involved manually raising/collapsing bollards) became increasingly difficult to sustain (Transport for London, 2022).

6.4.6 Safety risks

- Parents taking part in a School Streets study observed that outside of the closure periods children may continue to walk on the roads, when in fact it is not safe to do so. This was an unintended risk. However, it is not clear, how widespread this challenge was (Transport for London, 2022), as this issue was only cited in one source.

6.5 Understanding and measuring impact

A range of methods were used to monitor and measure the impact of School Streets interventions. The table below presents an overview of these approaches and their key components.

Table 7: School Streets sources - Type of evidence and intervention details.

Title and reference	Type of evidence and intervention details
1.Healthy School Streets – Opening Streets to Children Camden Council, 2018	Grey literature – A council authored report on a School Streets Pilot in Holborn, Camden, which had funding from Transport for London
2. School Street Closures and Traffic Displacement: A Literature 'Review with semi-structured interviews' Reference: Davis, 2020	Grey literature – A report which combines the findings from a literature review drawing on 16 School Street studies and qualitative interview with council officers involved in schemes
3. 'School Streets pilot project evaluation' Reference: Edinburgh City Council, 2016	Grey literature – A report on the results and key learning of a School Streets pilot which involved trialling School Streets across nine primary schools in Edinburgh.
4. 'A Tale of Two Cities: Unpacking the Success and Failure of School Street Interventions in Two Canadian Cities' Reference: Smith et al, 2020	Academic article – A realist evaluation of two School Streets interventions planned in Kingston and Montreal, Canada focusing on the factors that contributed to their success or failure.
5. 'Getting to know School Streets An in-depth analysis of five School Streets in London' Reference: Transport for London, 2022	Grey literature – A Transport for London authored report on the results and learning from five London-based School Streets pilots. Draws on 21 qualitative interviews from across sites and range of monitoring data collected by the interventions.
6. School Streets Intervention Sites vs. Control Sites Full Report Reference: Transport for London, 2021	Grey literature – A Transport for London authored report on the results of School Streets study – combining a survey of parents/carers across 10 London boroughs comparing intervention schools with matched control site schools and qualitative interviews with parents/carers.

The reviewed papers noted various limitations to understanding and measuring the impact of School Streets interventions:

- There are limitations with the study samples in terms of representativeness. For example, in their review of School Streets drawing on 16 studies and reports, Davis (2020) notes that while the findings across sites are consistent, which "provides some confidence through triangulation", the findings cannot by verified and cannot claim to offer a representative appraisal of School Streets. Greater certainty of the findings, the authors argue, could be provided by undertaking a systematic review or meta-analysis. A further potential limitation not commented on by the authors, is that the effectiveness of School Streets may potentially be overestimated due to publication bias. That is the tendency to favour the publication of studies with positive results.
- Single/small case studies sources have limitations. In their case study of a School Street in Camden, Camden Council (2018) found positive outcomes with improvements in air quality and a reduction in driven trips to schools. Despite these positive outcomes however, Camden Council acknowledge that this is an experiment with a single subject, and a wider set of data is needed to confirm the findings. This would need to include sites where children/parents were heavily dependent on cars. The authors also note that the reported findings draw on a small amount of data from the case study site regarding children's reported travel habits. Therefore, it is possible that the data could be skewed by changes in weather, roadworks or other factors.

  Smith, Gosselin, Collins, & Frohlich (2022) compared a successful School Street case study with an unsuccessful case study, and found key barriers and enablers to implementation. However, they similarly stated that their study is limited due to its examination of only two School Street pilots and because they interviewed a small number of stakeholders in each location. They stated that an analysis of additional successful and failed pilots would have enabled them to better determine whether their list of mechanisms and contextual factors was comprehensive and whether some C-M-O links (context-mechanism-outcome configurations) are more important than others.
- Studies have tended to draw on pre and post analysis to detect impact rather than using more robust forms of impact evaluation. While Transport for London (2021) used a quasi-experimental approach to understand School Street impact, comparing 19 intervention schools with 17 matched control schools, most sources have tended to rely on pre and post data to draw conclusions.

7. Conclusions

This report provides valuable insights about the health impacts and social determinants of AST as well as evidence about the effectiveness of AST interventions, focusing on cycle training and School Streets. Across these four different areas this report also highlights the gaps and limitations of the evidence base, identifying areas for future research.

This report has attempted to answer the following research questions:

RQ1. To account for the individual/structural conditions that shape school travel behaviour:

- What are the social determinants of AST?

RQ2. To account for the health impacts of engaging in AST:

- What impacts does AST have on children's physical and mental health?
- How do the impacts vary depending on the mode of AST?

RQ3. To gauge the success of previous AST interventions, and help inform the design, monitoring and evaluation of future AST interventions:

- What have been the defining features of previous AST interventions?
- What is the level of variation in the models that have been implemented?
- To what extent have these achieved their intended outcomes?
- What were the enablers, barriers and contextual factors associated with achieving impact?
- What approaches have been taken to measuring and understanding impact?

There was evidence that AST is associated with positive mental and physical health effects. This included evidence that AST led to improved psychological wellbeing; with cycling emerging as having a greater positive impact than walking. AST was also associated with healthy body weight, although the mode and intensity of AST and young people's wider behaviours must be taken into consideration when attempting to draw conclusions. There was also evidence that AST may lead to improved sleep quality and that the positive health effects of physical exercise exceed the harm caused by air pollution exposure in all but the most extreme air pollution scenarios.

A range of social determinants of AST were found in the evidence. This included that shorter distances to school were associated with increased AST in primary and secondary school children. Parental attitudes were also found to be important; with positive parental attitudes to AST being strongly associated with increased AST; and parental concerns about traffic safety emerging as a key barrier to children engaging with AST. In terms of age and gender, the evidence found that children aged between 10 and 12 inclusive were more likely to engage in AST than younger and older age groups, and that boys were more likely to engage in AST than girls.

There was some evidence that cycle training programmes have had a positive impact on cycling skills and on rates of cycling to school, however these increases may not always be sustained over a longer timeframe. There was also evidence that they have generally been effective in positively changing perceptions of cycling safety among school staff, children and most importantly parents, who play a profound mediating role in cycling participation – with concerns about traffic safety emerging as a key consideration. The evidence assessment found that the factors associated with the involvement of schools in cycle training initiatives

included their capacity to plan and manage the administration and equipment requirements and accessing appropriately trained staff.

The evidence showed that School Streets interventions had met their aims of improving road safety by reducing the volume and speed of traffic and improving perceptions of road safety, alongside increasing AST and improving air quality. Good rates of compliance and local support for School Streets was also often reported. In terms of the factors influencing success, this included setting robust selection criteria to locate a School Street at an appropriate site; the levels of commitment and motivation of school staff to support the intervention and the degree to which those delivering School Streets invested ongoing resource in shifting cultures and behaviours and linked the intervention with wider complementary activities within and around the school.

7.1 Future research

Future research should address these key gaps to advance understanding and inform effective policies on AST. In particular:

- Studies which adopt higher quality methodologies and more representative samples to better understand the health impacts of AST; this includes research designs that attempt to account in greater detail for the relationships between health impacts and different active travel modes, pupil age and school journey distances.
- Studies about the social determinants of AST which adopt qualitative and longitudinal methods to address the fact the studies to date were cross-sectional and therefore did not explore causal relationships or how attitudes and behaviours towards AST may change over time as children get older.
- Research which attempts to better understand the relationship between different AST modes and social determinants, given that previous studies have tended to group walking and cycling together.
- Improving the overall evidence base about the effectiveness of School Streets. Firstly by carrying out a more comprehensive assessment of these interventions with a larger and more representative sample. And secondly, by using more robust forms of impact evaluation given that the reviewed evidence draws primarily on pre and post analysis and lacks the inclusion of comparison areas.
- To further understand School Streets, it would be beneficial to address the gap in longitudinal and follow-up evidence about how and to what extent impacts associated with School Streets interventions have been sustained over longer timeframes; as well as investigating in more depth the wider impact of School Streets, such as the potential community benefits, health outcomes and lifestyle changes.
- Consideration about how monitoring and evaluation data collection approaches used to understand the impact of cycle training interventions can be improved to address poor response rates and gaps in the data (e.g. improved survey design; greater role of programme coordinators in leading data collection).
- Studies about cycle training interventions with lengthened observation periods to better understand the longer-term impacts and/or to monitor behaviour change; and further research and monitoring of gender differences, given there is evidence to suggest that participation in cycle training and AST by bicycle can look quite different for boys and girls.

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Appendix A: further details on the interventions

Cycle training interventions

Table 8: Overview of cycle training studies

Title and reference	Type of evidence and intervention details
1. Bikeability Impact Study Final Report Cycle training initiatives: Bikeability Reference: SQW, 2019	Grey literature – An evaluation report assessing the effectiveness of Bikeability in increasing primary school children's propensity to cycle. The study adopted a quasi-experimental design that measured the outcomes of Year 6 pupils in schools that had offered Bikeability Levels 1-2 against a comparison group.
2. Research into the impact of Bikeability training on children's ability to perceive and appropriately respond to hazards when cycling on the road Cycle training initiatives: Bikeability Reference: Hodgson et al., 2015	Grey literature – An evaluation report assessing the impact of Bikeability Level 2 training on children's cycling hazard perception. The study compared the responses of trained (intervention) and untrained (comparison) children to various assessments.
3. Bikeability Widening Participation Fund (WPF) Evaluation Cycle training initiatives: WPF (Bikeability) Reference: Gupta, et al. (2023)	Grey literature – A process and impact evaluation report to assess the WPF and inform the business case for future Bikeability funding. While the process evaluation focused on how WPF funded projects were delivered, the impact evaluation measures the outcomes of the projects, against WPF's aims.
4. Cycle Training in Primary Schools Research Cycle training initiatives: SCTS Reference: Transport Scotland (2011)	Grey literature – A research report providing an in-depth exploration of eleven case studies, focussed on the planning and delivery of cycle training in Scottish primary schools. The case studies involved qualitative research with cycle training programme stakeholders.
5. The impact of cycle proficiency training on cycle-related behaviours and accidents in adolescence: findings from ALSPAC, a UK longitudinal cohort Cycle training initiatives: NCPS Reference: Teyhan, et al. (2016)	Academic literature – A study examining the longitudinal impact of NCPS training on cycling outcomes. This was explored through comparison of 14- and 16-year-old Avon Longitudinal Study of Parents and Children (ALSPAC) respondents who said they had or had not received NCPS training.

Title and reference	Type of evidence and intervention details
6. Scottish government tackling the school run research study Cycle training initiatives: Bikeability; I Bike Other cycling initiatives: School Camps; Give Everyone Cycle Space; The Big Pedal; Cycle Friendly Schools, STARS Reference: Systra, et al. (2016)	Grey literature – A research study report that brings together evidence on the approaches that have been effective in influencing school transport choices (of which Bikeability was identified). The study primarily involved qualitative fieldwork in primary and secondary schools, with school staff, pupils and stakeholders.
7. Evaluation of Transport Scotland's Walking and Cycling Schools Programme Cycle training initiatives: Bikeability Scotland; I Bike Other cycling initiatives: Cycle Friendly Schools Awards; Cycling Friendly Secondary Schools Development Grant Fund; Education and Young People (EYP) Team Activities; Cycle and Scooter Parking Fund (part of EYP) Reference: Transport Scotland (2021)	Grey literature – An evaluation report exploring the effectiveness of its Walking and Cycling Schools Programme, including on facilitating an uptake in AST. The programme comprises various initiatives, including Bikeability Scotland. The evaluation adopted a mixed methods approach that combined existing impact data and primary data collection with schools, local authorities and other stakeholders.
8. Ride or Walk to School Program Cycle training initiatives: RWTS Reference: Healey & Gilmour (2016)	Grey literature – An evaluation report assessing the effectiveness of the RWTS programme in facilitating a sustained uptake in AST. The evaluation primarily involved school surveys.
9. Strategies and effects of school-based interventions to promote active school transportation by bicycle among children and adolescents: a systematic review Cycle training initiatives: miscellaneous/unspecified Reference: Schönbach, et al. (2020)	Academic literature – A systematic review summarising evidence on the approaches and effects of school-based interventions that aimed to increase AST by bicycle. Nine studies were included, exclusively covering control trials from a total of seven interventions. These initiatives either provided cycle training and/or various other approaches that sought to promote cycling among school children, such as bicycle trains, crossing guards and gamification or incentivisation activities.
10. Changing Primary School Children's Engagement in AST Using Safe Routes to School Interventions: A Rapid Realist Review Cycle training initiatives: miscellaneous/unspecified Reference: Vasey, et al. (2022)	Academic literature – A Rapid Realist Review that sought to understand the contextual factors and underlying mechanisms influencing children's engagement in AST. It specifically considered 'Safe Routes to School' (SR2S) interventions, which included cycle training initiatives, but it should be noted that cycle training was discussed to a very limited extent.

Table 9: Overview of general cycling initiatives as being complementary to the aims of Bikeability

Initiative	Referenced in	How encourages cycling
Cycle Friendly Schools Awards (Cycling Scotland)	Transport Scotland (2021) Systra, et al. (2016)	Awards schools that meet standards in areas such as bicycle maintenance, equipment and training and provides funding to support schools in taking these measures.
Cycling Friendly Secondary Schools Development Grant Fund (Cycling Scotland)	Transport Scotland (2021)	Provides funding for schools to purchase equipment such as bicycles, helmets, locks and maintenance equipment.
Education and Young People (EYP) Team Activities (Sustrans) and Cycle and Scooter Parking Fund	Transport Scotland (2021)	Provides cycle storage facilities in schools.
Give Everyone Cycle Space (Cycling Scotland)	Systra, et al. (2016)	National campaign that encourages drivers to give space to cyclists and supports schools through the provision of targeted confidence building activities.
The Big Pedal (Sustrans)	Systra, et al. (2016)	Challenge that incentivises schools to compete against each other to record the greatest rates of AST by bike or scooter.
Sustainable Travel Accreditation and Recognition for Schools (STARS) STARS Education (Modeshift STARS)	Systra, et al. (2016)	Awards schools for achieving an uptake in AST (including by bicycle).
School camps (Cycling Scotland)	Systra, et al. (2016)	Residential camps that encourage pupils to develop a project that promotes cycling in their school.

Table 10: Features of cycling interventions provided in addition to cycle training, to faciltate an uptake in cycling

Additional features	How encourages cycling	Interventions
Informal sessions	Additional practice sessions offered outside of the official cycle training, to pupils who had not cycled before or were less confident.	WPF
Female led, girls only sessions	Provision of training in a more relaxed and supportive environment for girls.	WPF
SEND training sessions	Tailored cycle training for SEND students, for example with higher trainer to pupil ratios or with trainers who had a physical or learning disability.	WPF
Student self-defence sessions	Self-defence workshops designed to increase student safety and mitigate parental safety concerns.	RWTS
Teacher professional development	Provision of training resources to help upskill teachers in delivering cycling based activities.	RWTS, I Bike
Parental engagement sessions	These sessions were designed to improve parental perceptions of children's cycling, for example through family cycling or educational events.	WPF
Social/fun sessions	This included any activity that incentivised cycling by providing an element of social interaction or fun. Examples included active travel breakfasts, 'smoothie bike sessions', inter-school competitions, bike clubs and led rides.	WPF, I Bike

Additional features	How encourages cycling	Interventions
Route planning	This involved assisting children with identifying their safest or most efficient route to school.	RWTS, I Bike
Bicycle maintenance sessions	These sessions aimed to build children's confidence in maintaining their bicycle on their own, and thereby making it more affordable.	WPF, I Bike
Provision of bicycles and related equipment	Typically to make cycling accessible where affordability was a barrier to pupils or schools, for example through the provision of bicycle fleets and helmets to schools, or assistance with bicycle storage solutions.	WPF, RWTS

Table 11: Overview of methodologies - cycle training studies

Source	Intervention	Evaluation methodology	Population	Data collection	Topics
SQW (2019)	Bikeability	Impact (quasi-experimental design)	• Intervention group (Year 6 Bikeability trained pupils) • Comparison group (Year 6 untrained pupils) • Parents/guardians	Baseline and follow-up surveys	• Child cycling behaviour, proficiency, and confidence • Parental permission • Parent and child cycling behaviour
Hodgson et al. (2015)	Bikeability	Impact	• Intervention group (Year 5 Bikeability trained pupils) • Comparison group (Year 5 untrained pupils)	Baseline and follow-up assessments	• Hazard perception and response ability quiz • Practical hazard perception assessment (trained pupils only)
Gupta, et al. (2023)	Bikeability	Impact	WPF project participants	Pre- and post-surveys (using validated measures)	• Socio-demographic information • Access to bicycles • Cycling confidence • Perceived safety of cycling
Gupta, et al. (2023)	Bikeability	Process	WPF project leads	Questionnaire	• Project planning, recruitment and delivery
Gupta, et al. (2023)	Bikeability	Process	WPF project instructors, school staff, and training provider staff	Case study depth interviews	• Project planning, recruitment and delivery
Transport Scotland (2021)	Walking and Cycling Schools Programme	Mixed methods	Schools	Survey	• Awareness and understanding of programme and initiatives within it • Participation • Perceived impact • Barriers to engagement • Suggestions for improvement

Source	Intervention	Evaluation methodology	Population	Data collection	Topics
Transport Scotland (2021)	Walking and Cycling Schools Programme	Mixed methods	Local authorities	Survey	• Participation in programme initiatives • Understanding of aims and content • Impact of COVID-19 • Barriers and facilitators to planning and delivery • Desired support
Transport Scotland (2021)	Walking and Cycling Schools Programme	Mixed methods	School staff	Depth interviews	• Participation in and experience of initiatives
Transport Scotland (2021)	Walking and Cycling Schools Programme	Mixed methods	Delivery partners	Depth interviews	• Experience and perceptions of the programme
Healey & Gilmour (2016)	RWTS		Project staff	Depth interviews	• Experience and lessons learnt from programme implementation
Healey & Gilmour (2016)	RWTS		Programme partners	Survey	• Programme effectiveness
Healey & Gilmour (2016)	RWTS		Pilot school staff	Survey	• Participation in programme • Use of programme resources
Healey & Gilmour (2016)	RWTS		Year 5 and 6 trained participants and parents	Survey	• Cycling behaviour
Systra, et al. (2016)	Various	Qualitative	School staff	Interviews	• Outcomes • Challenges • Infrastructural and wider attitudinal and cultural aspects
Systra, et al. (2016)	Various	Qualitative	Students	Focus groups	• Perceptions and experiences of school travel
Systra, et al. (2016)	Various	Qualitative	Children and parents	Interviews	• Parental views and experiences of the school run and initiatives
Systra, et al. (2016)	Various	Qualitative	Local authority and other stakeholders	Interviews	• Views and experiences of planning and implementing initiatives

Source	Intervention	Evaluation methodology	Population	Data collection	Topics
Transport Scotland (2011)	Various	Qualitative	• Road Safety Officers • Head teachers and classroom assistants • Volunteer trainers and parents	Interviews	• Experience of planning, delivering and sustaining cycle training • Views on cycle training success; attitudes • Perceived barriers to on-road training

Table 12: Overview of research tools, where they are provided in cycle training study reports

Study	Research Tools	Document
SQW (2019)	On-screen quiz Practical assessment	Evaluation report appendices, pages 8-19
Gupta, et al. (2023)	Pre- and post- surveys Evaluation questionnaire Case study interview topic guide	Evaluation report – Appdendix B 95-105
Systra, et al. (2016)	Fieldwork topic guides	Evaluation report – Appendix C 111-117

Safe school travel environment (School Streets) interventions

Table 13: Overview of School Streets studies

Title and reference	Type of evidence and intervention details
1. Healthy School Streets – Opening Streets to Children Camden Council, 2018	Grey literature – A council authored report on a School Streets Pilot in Holborn, Camden, which had funding from Transport for London
2. School Street Closures and Traffic Displacement: A Literature 'Review with semi-structured interviews' Reference: Davis, 2020	Grey literature – A report which combines the findings from a literature review drawing on 16 School Street studies and qualitative interview with council officers involved in schemes
3. 'School Streets pilot project evaluation' Reference: Edinburgh City Council, 2016	Grey literature – A report on the results and key learning of a School Streets pilot which involved trialling School Streets across nine primary schools in Edinburgh.
4. 'A Tale of Two Cities: Unpacking the Success and Failure of School Street Interventions in Two Canadian Cities' Reference: Smith et al, 2022	Academic article – A realist evaluation of two School Streets interventions planned in Kingston and Montreal, Canada focusing on the factors that contributed to their success or failure.
5. 'Getting to know School Streets An in-depth analysis of five School Streets in London' Reference: Transport for London, 2022	Grey literature – A Transport for London authored report on the results and learning from five London-based School Streets pilots. Draws on 21 qualitative interviews from across sites and range of monitoring data collected by the interventions.
6. School Streets Intervention Sites vs. Control Sites Full Report Reference: Transport for London, 2021	Grey literature – A Transport for London authored report on the results of School Streets study – combining a survey of parents/carers across 10 London boroughs comparing intervention schools with matched control site schools and qualitative interviews with parents/carers.

Table 14: Overview of methodologies - School Streets studies

Source	Sample and Population	Evaluation Methodology	Data collection methods	Topic
School Streets – Opening Streets to Children Camden Council (2018)	1 school trial Camden, London	Impact – Case Study	• Data collected from hands- up surveys and via 'Travel Tracker' • Feedback was collected from residents and businesses • Air quality data collected on the street outside the school	• To track children's daily travel-frequency and type • Consultation process on street closure • Monitoring NO2 levels
School Street Closures and Traffic Displacement: A Literature 'Review with semi-structured interviews Davis (2020)	16 studies and reports have been synthesised in the source	Review	• Literature Review	• Impact and attitudes of School Street closures
School Street Closures and Traffic Displacement: A Literature 'Review with semi-structured interviews Davis (2020)	5 remote interviews were undertaken with council officers involved in schemes from: Camden, Croydon, Southwark, Solihull, and Southampton City Council, UK	Impact	• Semi structured interviews	• Experience of School Street closures
School Streets pilot project evaluation Edinburgh City Council (2016)	9 primary schools, Edinburgh, Scotland	Pilot evaluation	• Pre and post vehicle speed monitoring surveys • Pre and post surveys of residents • School travel tracker • Stakeholder views • Air quality: Vehicle volume data also enabled an analysis of air quality using the Department for Environment, Food and Rural Affairs Emissions Factors Toolkit to determine emissions of Nitrogen Oxides (NOX – measured in grams per kilometre: g/km)	• Impact of experimental Traffic Regulation Order (ETRO)

Source	Sample and Population	Evaluation Methodology	Data collection methods	Topic
A Tale of Two Cities: Unpacking the Success and Failure of School Street Interventions in Two Canadian Cities Smith, Gosselin, Collins, & Frohlich, (2022)	6 interviews key stakeholders in Montreal, 5 interviews with key stakeholders in Kingston, Canada	A realist evaluation, Kingston and Montreal, Canada	• Analysis of documents: meeting minutes, supporting documents, researcher notes • Semi-structured interviews with stakeholder	• To understand the mobilisation phase • Detail from knowledgeable stakeholders about how and why the School Street interventions were launched or not
'Getting to know School Streets An in-depth analysis of five School Streets in London' Reference: Transport for London (2022)	5 School Streets in London boroughs of Ealing, Haringey, Redbridge, Southwark and Waltham Forest, UK	Grey literature Report – Analysis of 5 case studies	• 21 x one-hour qualitative in-depth interviews across the 5 School Streets with stakeholders involved in delivering, operating and using the School Street • Data was collected over two days at each School Street via cameras and Automatic Intelligence technology, a parking, loading and activity survey, path tracing software	• Explore how the scheme functions and how they were involved in planning, delivery and operation • To understand how vehicle and pedestrian behaviour changed when the School Street was in operation
School Streets Intervention Sites vs. Control Sites Full Report Reference: Transport for London (2021)	36 Schools from Brent, Enfield, Haringey, Hackney, Islington, Westminster, Lambeth, Merton, Wandsworth and Hounslow, UK took part in the study: 19 Intervention schools; 17 Control schools. Total of 496 responses were received	Grey literature Report comparing intervention schools with matched control site schools	• Self- selecting sample of parents and carers who completed a 10-minute online survey • Survey of parents/carers across 10 London borough comparing intervention schools with matched control site schools and qualitative interview with parents/carers	• Awareness and attitudes towards School Streets

Table 15: Overview of research tools, where they are provided in School Streets study reports

Study	Research Tools	Document
Camden Council (2018)	School selection matrix Consultation letter Memorandum of Understanding	Evaluation report appendices, pages 8-16
Davis (2020)	Topic Guide and Interview Questions	Report – Appdendix 1 page 26- 29

Table 16: Other safe school travel environment interventions

Other SSTE initiative	Source	Overview	Source type/ Methods	Outputs
Safe Routes to School (SR2S)	Vasey, Carroll, Daniel, & Cargo (2022) (International)	Safe Routes to School (SR2S) are implemented to improve children's engagement in AST. SR2S interventions are guided by the Six E's framework: Education, Encouragement, Engineering, Engagement, Equity, and Evaluation.	Rapid Realist Review was conducted including 45 documents.	SR2S can promote and engage children in AST, but aspects such as parental perceptions of safety, school implementation, and infrastructure can affect this.
Living Streets and the Cycling and Walking Investment Strategy (CWIS)	Smith (2018) (UK)	Living Streets aims to enable and support more primary school children to walk to school, by providing a safe, pleasant, and unpolluted route, so that they are more likely to continue walking beyond primary school.	Recommendation report	There is a new target for 55% of primary school children in England walking to school by 2025. Distance, time and safety are the most significant barriers to children walking to school, as many parents do not feel confident allowing their children to walk alone but also report not having time to walk with them
Safer Communities	Smith, et al., (2020) (New Zealand)	The Safer Communities Programme involved engineering treatments coupled with road safety education and promotion initiatives. The objective was to improve road safety, increase active travel to school and other community destinations, and increase public transport patronage. The overall aims were to reduce road traffic trauma and congestion.	Two schools evaluated. Children completed GIS surveys, and parents completed telephone interviews. Pedestrians and cyclist behaviour was also monitored.	AST was found to decrease in this study. Barriers to AST were found to be distance, parental convenience, traffic safety concerns,

Other SSTE initiative	Source	Overview	Source type/ Methods	Outputs
Active and Safe Routes to School (ASRTS) and its flagship school travel plan (STP) program	Buttazzoni, Coen, & Gilliland (2018) (Canada)	Active and Safe Routes to School (ASRTS), a national health promotion initiative, has led the campaign for AST through its flagship school travel plan (STP) program. STPs promote and raise awareness of AST through the five 'Es': education, encouragement, enforcement, engineering, and evaluation.	10 schools were evaluated. This involved interviews and focus groups with STP facilitators.	To support AST, more work needs to be done on thorough pre-implementation assessments and developing a pro-AST culture.
Walking and Cycling Schools Programme	Transport Scotland (2021)	Transport Scotland's Walking and Cycling Schools Programme comprises a range of behaviour change and infrastructure initiatives, delivered in primary and secondary schools across Scotland by several Active Travel Delivery Partners. The overall aim was promoting and encouraging take up of sustainable and active travel means among children for everyday shorter journeys as an alternative to car use.	The evaluation involves a survey of 352 schools from 25 different local authority areas across Scotland.	The programme was successful in achieving a broad reach (albeit primary schools engage better than secondary level, and some geographical variation exists) and contributes positively to pupils' active travel attitudes and behaviours.
Travelwise	Ikeda, Mavoa, Cavadino, Carroll, Hinckson, Witten & Smith (2020) (New Zealand)	Travelwise aims to create a safer traffic environment in the immediate school environment via curriculum, school ethos and parents and community. It also includes infrastructural changes such as installation of pedestrian crossings.	Evaluation of 19 schools, using a GIS survey with children and telephone interviews with parents/ carers and principals.	Advantages of the Travelwise programme were highlighted in terms of the provision of pedestrian crossings and walking/ cycling infrastructure around and the encouragement of AST.
Ride or Walk to School Program (RWTS)	Healey & Gilmour (2016) (Australia)	Part of the government's Healthy Weight Initiative targeting zero growth in overweight and obesity. It aimed to encourage students to ride or walk to school and included assistance with finding bike storage solutions.	Evaluation of 52 school involving, meetings, data reviews, interviews, surveys with the schools and parents	There were increases in AST. Main gaps identified were parental engagement, and distance to school

Other SSTE initiative	Source	Overview	Source type/ Methods	Outputs
Wayfinding and Park and Stride	Rowe, Payne Riches, & Image (2023) (UK)	Wayfinding routes were implemented along footpaths on frequented walking and/or cycling routes, and between schools and designated car parks (Park and Stride) from where parents or carers were encouraged to park and walk the remaining distance to school. These routes included interactive, colourful waymarking signs on footpaths, places of interest such as bug hotels, and banners and finger posts to direct the way.	4 intervention and 2 control schools in Oxfordshire were evaluated. Online surveys were completed by parents and hands up surveys were completed by children. Interviews and focus groups were conducted post-intervention, with parents, pupils and school staff. No2 levels were monitored as well	AST increased in areas implementing Park and Stride. Vehicle counts decreased from pre- to post-intervention. There were no appreciable differences in levels of NO2.

Appendix B: database searches

Academic database search strings for RQ1-RQ2

Below, we provide an overview of the search strings deployed in each academic database for RQ1 and RQ2 (including Scopus, PsycINFO, Medline and TRID) and the number of results returned in each.

Scopus

- Platform: Elsevier
- Date searched: June 21, 2023
- Number of results: 2420

Table 17: Search strings used in Scopus

String no	Search string	No of results
1	TITLE-ABS((school*) W/3 (travel* OR transport* OR commut* OR journey*)) OR AUTHKEY((school*) W/3 (travel* OR transport* OR commut* OR journey*))	4184
2	TITLE-ABS(active OR walk* OR cycl* OR bicycl* OR scooter* OR mode*) OR AUTHKEY(active OR walk* OR cycl* OR bicycl* OR scooter* OR mode*)	22,386,930
3	#1 AND #2	2333
4	TITLE-ABS((walk* OR bik* OR cycl*) W/3 (school*)) OR AUTHKEY((walk* OR bik* OR cycl*) W/3 (school*))	2422
5	TITLE-ABS("walking school bus*" OR "School Streets" OR "Living Streets" OR "Youth Sport Trust" OR Sustrans OR bikeability OR "modeshift STARS" OR "TfL STARS" OR "Walk Once a Week" OR WOW OR "Beat the Street" OR megamotion OR "Bike It" OR "Ready Set Ride" OR "o Ride" OR "Bike Club" OR "School Travel Plans" OR "Walk to School Outreach" OR "Safe Routes to School" OR "Road Safety GB" OR "Active Travel Days" OR "Walking to School Days") OR AUTHKEY("walking school bus*" OR "School Streets" OR "Living Streets" OR "Youth Sport Trust" OR Sustrans OR bikeability OR "modeshift STARS" OR "TfL STARS" OR "Walk Once a Week" OR WOW OR "Beat the Street" OR megamotion OR "Bike It" OR "Ready Set Ride" OR "o Ride" OR "Bike Club" OR "School Travel Plans" OR "Walk to School Outreach" OR "Safe Routes to School" OR "Road Safety GB" OR "Active Travel Days" OR "Walking to School Days")	101
6	#3 OR #4 OR #5	4138

String no	Search string	No of results
7	TITLE-ABS(determinant* OR factor* OR characteristic* OR socioeconomic* OR social* OR economic* OR income* OR demograph* OR barrier* OR facilitator* OR enabl* OR gender OR ethnic* OR race OR racial OR cultur* OR urban OR rural OR parent* OR caregiver* OR family OR families OR sibling* OR choice* OR choose OR ″trip-chain*″ OR perception* OR perceive* OR predictor* OR ((work OR job OR office) W/2 (commut* OR travel* OR transport*)) OR ((child* OR youth) W/2 (autonomy OR independence OR independent OR ″self-reliance″ OR ″self-sufficien*″ OR empower*))) OR AUTHKEY(determinant* OR factor* OR characteristic* OR socioeconomic* OR social* OR economic* OR income* OR demograph* OR barrier* OR facilitator* OR enabl* OR gender OR ethnic* OR race OR racial OR cultur* OR urban OR rural OR parent* OR caregiver* OR family OR families OR sibling* OR choice* OR choose OR ″trip-chain*″ OR perception* OR perceive* OR predictor* OR ((work OR job OR office) W/2 (commut* OR travel* OR transport*)) OR ((child* OR youth) W/2 (autonomy OR independence OR independent OR ″self-reliance″ OR ″self-sufficien*″ OR empower*)))	25,203,784
8	TITLE-ABS(physical* OR fitness OR exercise OR mental* OR emotional* OR wellbeing OR ″well being″ OR weight OR health* OR obes* OR psychsocial* OR psychologic* OR psychiatric* OR bmi OR ″body mass″ OR ″quality of life″ OR respiratory OR ″lung health″ OR pollution OR ″air quality″ OR asthma* OR particulate* OR smog) OR AUTHKEY(physical* OR fitness OR exercise OR mental* OR emotional* OR wellbeing OR ″well being″ OR weight OR health* OR obes* OR psychsocial* OR psychologic* OR psychiatric* OR bmi OR ″body mass″ OR ″quality of life″ OR respiratory OR ″lung health″ OR pollution OR ″air quality″ OR asthma* OR particulate* OR smog)	13,353,607
9	#7 OR #8	32,733,676
10	#6 AND #9	3525
11	Limit to 2013 to present	2420

PsycINFO

- Platform: Ebsco
- Date searched: June 21, 2023
- Number of results: 688

Table 18: Search strings used in PsycINFO

String no	Search string	No of results
1	TI((school*) N3 (travel* OR transport* OR commut* OR journey*)) OR AB((school*) N3 (travel* OR transport* OR commut* OR journey*)) OR SU((school*) N3 (travel* OR transport* OR commut* OR journey*)) OR KW((school*) N3 (travel* OR transport* OR commut* OR journey*))	1037
2	TI(active OR walk* OR cycl* OR bicycl* OR scooter* OR mode*) OR AB(active OR walk* OR cycl* OR bicycl* OR scooter* OR mode*) OR SU(active OR walk* OR cycl* OR bicycl* OR scooter* OR mode*) OR KW(active OR walk* OR cycl* OR bicycl* OR scooter* OR mode*)	1,416,859
3	S1 AND S2	573
4	TI((walk* OR bik* OR cycl*) N3 (school*)) OR AB((walk* OR bik* OR cycl*) N3 (school*)) OR SU((walk* OR bik* OR cycl*) N3 (school*)) OR KW((walk* OR bik* OR cycl*) N3 (school*))	655

String no	Search string	No of results
5	TI("walking school bus*" OR "School Streets" OR "Living Streets" OR "Youth Sport Trust" OR Sustrans OR bikeability OR "modeshift STARS" OR "TfL STARS" OR "Walk Once a Week" OR WOW OR "Beat the Street" OR megamotion OR "Bike It" OR "Ready Set Ride" OR "o Ride" OR "Bike Club" OR "School Travel Plans" OR "Walk to School Outreach" OR "Safe Routes to School" OR "Road Safety GB" OR "Active Travel Days" OR "Walking to School Days") OR AB("walking school bus*" OR "School Streets" OR "Living Streets" OR "Youth Sport Trust" OR Sustrans OR bikeability OR "modeshift STARS" OR "TfL STARS" OR "Walk Once a Week" OR WOW OR "Beat the Street" OR megamotion OR "Bike It" OR "Ready Set Ride" OR "o Ride" OR "Bike Club" OR "School Travel Plans" OR "Walk to School Outreach" OR "Safe Routes to School" OR "Road Safety GB" OR "Active Travel Days" OR "Walking to School Days") OR SU("walking school bus*" OR "School Streets" OR "Living Streets" OR "Youth Sport Trust" OR Sustrans OR bikeability OR "modeshift STARS" OR "TfL STARS" OR "Walk Once a Week" OR WOW OR "Beat the Street" OR megamotion OR "Bike It" OR "Ready Set Ride" OR "o Ride" OR "Bike Club" OR "School Travel Plans" OR "Walk to School Outreach" OR "Safe Routes to School" OR "Road Safety GB" OR "Active Travel Days" OR "Walking to School Days") OR KW("walking school bus*" OR "School Streets" OR "Living Streets" OR "Youth Sport Trust" OR Sustrans OR bikeability OR "modeshift STARS" OR "TfL STARS" OR "Walk Once a Week" OR WOW OR "Beat the Street" OR megamotion OR "Bike It" OR "Ready Set Ride" OR "o Ride" OR "Bike Club" OR "School Travel Plans" OR "Walk to School Outreach" OR "Safe Routes to School" OR "Road Safety GB" OR "Active Travel Days" OR "Walking to School Days")	309
6	S3 OR S4 OR S5	1316
7	TI(determinant* OR factor* OR characteristic* OR socioeconomic* OR social* OR economic* OR income* OR demograph* OR barrier* OR facilitator* OR enabl* OR gender OR ethnic* OR race OR racial OR cultur* OR urban OR rural OR parent* OR caregiver* OR family OR families OR sibling* OR choice* OR choose OR "trip-chain*" OR perception* OR perceive* OR predictor* OR ((work OR job OR office) N2 (commut* OR travel* OR transport*)) OR ((child* OR youth) N2 (autonomy OR independence OR independent OR "self-reliance" OR "self-sufficien*" OR empower*))) OR AB(determinant* OR factor* OR characteristic* OR socioeconomic* OR social* OR economic* OR income* OR demograph* OR barrier* OR facilitator* OR enabl* OR gender OR ethnic* OR race OR racial OR cultur* OR urban OR rural OR parent* OR caregiver* OR family OR families OR sibling* OR choice* OR choose OR "trip-chain*" OR perception* OR perceive* OR predictor* OR ((work OR job OR office) N2 (commut* OR travel* OR transport*)) OR ((child* OR youth) N2 (autonomy OR independence OR independent OR "self-reliance" OR "self-sufficien*" OR empower*))) OR SU(determinant* OR factor* OR characteristic* OR socioeconomic* OR social* OR economic* OR income* OR demograph* OR barrier* OR facilitator* OR enabl* OR gender OR ethnic* OR race OR racial OR cultur* OR urban OR rural OR parent* OR caregiver* OR family OR families OR sibling* OR choice* OR choose OR "trip-chain*" OR perception* OR perceive* OR predictor* OR ((work OR job OR office) N2 (commut* OR travel* OR transport*)) OR ((child* OR youth) N2 (autonomy OR independence OR independent OR "self-reliance" OR "self-sufficien*" OR empower*))) OR KW(determinant* OR factor* OR characteristic* OR socioeconomic* OR social* OR economic* OR income* OR demograph* OR barrier* OR facilitator* OR enabl* OR gender OR ethnic* OR race OR racial OR cultur* OR urban OR rural OR parent* OR caregiver* OR family OR families OR sibling* OR choice* OR choose OR "trip-chain*" OR perception* OR perceive* OR predictor* OR ((work OR job OR office) N2 (commut* OR travel* OR transport*)) OR ((child* OR youth) N2 (autonomy OR independence OR independent OR "self-reliance" OR "self-sufficien*" OR empower*)))	3,368,837

String no	Search string	No of results
8	TI(physical* OR fitness OR exercise OR mental* OR emotional* OR wellbeing OR "well being" OR weight OR health* OR obes* OR psychsocial* OR psychologic* OR psychiatric* OR bmi OR "body mass" OR "quality of life" OR respiratory OR "lung health" OR pollution OR "air quality" OR asthma* OR particulate* OR smog) OR AB(physical* OR fitness OR exercise OR mental* OR emotional* OR wellbeing OR "well being" OR weight OR health* OR obes* OR psychsocial* OR psychologic* OR psychiatric* OR bmi OR "body mass" OR "quality of life" OR respiratory OR "lung health" OR pollution OR "air quality" OR asthma* OR particulate* OR smog) OR SU(physical* OR fitness OR exercise OR mental* OR emotional* OR wellbeing OR "well being" OR weight OR health* OR obes* OR psychsocial* OR psychologic* OR psychiatric* OR bmi OR "body mass" OR "quality of life" OR respiratory OR "lung health" OR pollution OR "air quality" OR asthma* OR particulate* OR smog) OR KW(physical* OR fitness OR exercise OR mental* OR emotional* OR wellbeing OR "well being" OR weight OR health* OR obes* OR psychsocial* OR psychologic* OR psychiatric* OR bmi OR "body mass" OR "quality of life" OR respiratory OR "lung health" OR pollution OR "air quality" OR asthma* OR particulate* OR smog)	2,315,564
9	S7 OR S8	4,102,804
10	S6 AND S9	1192
11	Limit to 2013 to present	688

Medline

- Platform: PubMed
- Date searched: June 21, 2023
- Number of results: 4987

Table 19: Search strings used in Medline

String no	Search string	No of results
1	school*[tiab] AND (travel*[tiab] OR transport*[tiab] OR commut*[tiab] OR journey*[tiab])	4184
2	active[tiab] OR walk*[tiab] OR cycl*[tiab] OR bicycl*[tiab] OR scooter*[tiab] OR mode*[tiab]	22,386,930
3	#1 AND #2	2333
4	(walk*[tiab] OR bik*[tiab] OR cycl*[tiab]) AND (school*[tiab])	2422
5	"walking school bus*"[tiab] OR "School Streets"[tiab] OR "Living Streets"[tiab] OR "Youth Sport Trust"[tiab] OR Sustrans[tiab] OR bikeability[tiab] OR "modeshift STARS"[tiab] OR "TfL STARS"[tiab] OR "Walk Once a Week"[tiab] OR WOW[tiab] OR "Beat the Street"[tiab] OR megamotion[tiab] OR "Bike It"[tiab] OR "Ready Set Ride"[tiab] OR "o Ride"[tiab] OR "Bike Club"[tiab] OR "School Travel Plans"[tiab] OR "Walk to School Outreach"[tiab] OR "Safe Routes to School"[tiab] OR "Road Safety GB"[tiab] OR "Active Travel Days"[tiab] OR "Walking to School Days"[tiab]	101
6	#3 OR #4 OR #5	4138

String no	Search string	No of results
7	determinant*[tiab] OR factor*[tiab] OR characteristic*[tiab] OR socioeconomic*[tiab] OR social*[tiab] OR economic*[tiab] OR income*[tiab] OR demograph*[tiab] OR barrier*[tiab] OR facilitator*[tiab] OR enabl*[tiab] OR gender[tiab] OR ethnic*[tiab] OR race[tiab] OR racial[tiab] OR cultur*[tiab] OR urban[tiab] OR rural[tiab] OR parent*[tiab] OR caregiver*[tiab] OR family[tiab] OR families[tiab] OR sibling*[tiab] OR choice*[tiab] OR choose[tiab] OR "trip-chain*"[tiab] OR perception*[tiab] OR perceive*[tiab] OR predictor*[tiab] OR ((work[tiab] OR job[tiab] OR office[tiab]) AND (commut*[tiab] OR travel*[tiab] OR transport*[tiab])) OR ((child*[tiab] OR youth[tiab]) AND (autonomy[tiab] OR independence[tiab] OR independent[tiab] OR "self-reliance"[tiab] OR "self-sufficien*"[tiab] OR empower*[tiab]))	25,203,784
8	physical*[tiab] OR fitness[tiab] OR exercise[tiab] OR mental*[tiab] OR emotional*[tiab] OR wellbeing[tiab] OR "well being"[tiab] OR weight[tiab] OR health*[tiab] OR obes*[tiab] OR psychsocial*[tiab] OR psychologic*[tiab] OR psychiatric*[tiab] OR bmi[tiab] OR "body mass"[tiab] OR "quality of life"[tiab] OR respiratory[tiab] OR "lung health"[tiab] OR pollution[tiab] OR "air quality"[tiab] OR asthma*[tiab] OR particulate*[tiab] OR smog[tiab]	13,353,607
9	#7 OR #8	32,733,676
10	#6 AND #8	3525
11	Limit to 2013 to present	2420

Transportation Research Information Database (TRID)

- Platform: TRID
- Date searched: June 27, 2023
- Number of results: 500

Table 20: Search strings used in TRID

Search strings	No of results
(((active OR walk* OR cycl* OR bicycl* OR scooter* OR mode*) AND ("school travel" OR "school journey*" OR "school transport*" OR "school commut*")) OR "active travel to school" OR "walking to school" OR "biking to school" OR "cycling to school" OR "walking school bus*" OR "School Streets" OR "Living Streets" OR "Youth Sport Trust" OR Sustrans OR "modeshift STARS" OR "TfL STARS" OR "Walk Once a Week" OR "Beat the Street" OR megamotion OR "Ready Set Ride" OR "o Ride" OR "Bike Club" OR "School Travel Plans" OR "Walk to School Outreach" OR "Safe Routes to School" OR "Road Safety GB" OR "Active Travel Days" OR "Walking to School Days") AND (determinant* OR factor* OR characteristic* OR socioeconomic* OR social* OR economic* OR income* OR demograph* OR barrier* OR facilitator* OR enabl* OR gender OR ethnic* OR race OR racial OR cultur* OR urban OR rural OR parent* OR caregiver* OR family OR families OR sibling* OR choice* OR choose OR "trip-chain*" OR perception* OR perceive* OR predictor* OR physical* OR fitness OR exercise OR mental* OR emotional* OR wellbeing OR "well being" OR weight OR health* OR obes* OR psychsocial* OR psychologic* OR psychiatric* OR bmi OR "body mass" OR "quality of life" OR respiratory OR "lung health" OR pollution OR "air quality" OR asthma* OR particulate* OR smog OR ((work OR job OR office) AND (commut* OR travel* OR transport*)) OR ((child* OR youth) AND (autonomy OR independence OR independent OR "self-reliance" OR "self-sufficien*" OR empower*))) Limit 2013-2023	500

Academic database search strings for RQ3

Below, we provide an overview of the search strings deployed in each academic database for RQ3 (including Scopus, PsycINFO, Medline and TRID) and the number of results returned in each.

Scopus

- Platform: Elsevier
- Date searched: June 21, 2023
- Number of results:672

Table 21: Search strings used in Scopus

String no	Search string	No of results
1	TITLE-ABS((school*) W/3 (travel* OR transport* OR commut* OR journey*)) OR AUTHKEY((school*) W/3 (travel* OR transport* OR commut* OR journey*))	4184
2	TITLE-ABS(active OR walk* OR cycl* OR bicycl* OR scooter* OR mode*) OR AUTHKEY(active OR walk* OR cycl* OR bicycl* OR scooter* OR mode*)	22,386,930
3	#1 AND #2	2333
4	TITLE-ABS((walk* OR bik* OR cycl*) W/3 (school*)) OR AUTHKEY((walk* OR bik* OR cycl*) W/3 (school*))	2442
5	TITLE-ABS("walking school bus*" OR "School Streets" OR "Living Streets" OR "Youth Sport Trust" OR Sustrans OR bikeability OR "modeshift STARS" OR "TfL STARS" OR "Walk Once a Week" OR WOW OR "Beat the Street" OR megamotion OR "Bike It" OR "Ready Set Ride" OR "o Ride" OR "Bike Club" OR "School Travel Plans" OR "Walk to School Outreach" OR "Safe Routes to School" OR "Road Safety GB" OR "Active Travel Days" OR "Walking to School Days") OR AUTHKEY("walking school bus*" OR "School Streets" OR "Living Streets" OR "Youth Sport Trust" OR Sustrans OR bikeability OR "modeshift STARS" OR "TfL STARS" OR "Walk Once a Week" OR WOW OR "Beat the Street" OR megamotion OR "Bike It" OR "Ready Set Ride" OR "o Ride" OR "Bike Club" OR "School Travel Plans" OR "Walk to School Outreach" OR "Safe Routes to School" OR "Road Safety GB" OR "Active Travel Days" OR "Walking to School Days")	2250
6	#3 OR #4 OR #5	6146

String no	Search string	No of results
7	TITLE-ABS(((provision* OR provide OR give OR gave) W/2 (cycle* OR bicycle* OR bike* OR scooter*)) OR ((proficien* OR confiden* OR safety OR train* OR teach* OR storage OR promot* OR parking) W/3 (bicycle* OR bike* OR biking OR cycling)) OR ((safety OR promot* OR safe) W/3 (walk*)) OR ″cycling lane*″ OR ″cycle lane*″ OR ″bike lane*″ OR ″biking lane*″ OR ″crossing guard*″ OR ″crossing patrol*″ OR ″school walk zone*″ OR ″neighborhood walkability″ OR ″neighbourhood walkability″ OR ″no car zone*″ OR ″school travel environment*″ OR behaviour* OR behavior* OR gamif* OR incentiv* OR ″COM-B″ OR capability OR capable OR motivat* OR opportunit* OR ″safe route*″ OR infrastructure OR ″drop off″ OR street* OR road* OR crossing* OR walkway* OR sidewalk* OR traffic OR injur* OR accident* OR collision* OR crash* OR pedestrian) OR AUTHKEY(((provision* OR provide OR give OR gave) W/2 (cycle* OR bicycle* OR bike* OR scooter*)) OR ((proficien* OR confiden* OR safety OR train* OR teach* OR storage OR promot* OR parking) W/3 (bicycle* OR bike* OR biking OR cycling)) OR ((safety OR promot* OR safe) W/3 (walk*)) OR ″cycling lane*″ OR ″cycle lane*″ OR ″bike lane*″ OR ″biking lane*″ OR ″crossing guard*″ OR ″crossing patrol*″ OR ″school walk zone*″ OR ″neighborhood walkability″ OR ″neighbourhood walkability″ OR ″no car zone*″ OR ″school travel environment*″ OR behaviour* OR behavior* OR gamif* OR incentiv* OR ″COM-B″ OR capability OR capable OR motivat* OR opportunit* OR ″safe route*″ OR infrastructure OR ″drop off″ OR street* OR road* OR crossing* OR walkway* OR sidewalk* OR traffic OR injur* OR accident* OR collision* OR crash* OR pedestrian)	11,626,755
8	TITLE-ABS((intervention* OR program* OR pilot* OR project* OR scheme*) AND (outcome* OR benefit* OR enabl* OR barrier* OR impact* OR evaluat* OR trial* OR predict* OR facilitat* OR measur* OR compar* OR assess* OR analyse* OR analyze* OR analysing OR analyzing OR analysis OR analytical OR estimate* OR estimating OR estimation* OR cause* OR causal OR experiment* OR effect* OR evidence OR random* OR assign* OR treatment OR control* OR allocat*)) OR AUTHKEY((intervention* OR program* OR pilot* OR project* OR scheme*) AND (outcome* OR benefit* OR enabl* OR barrier* OR impact* OR evaluat* OR trial* OR predict* OR facilitat* OR measur* OR compar* OR assess* OR analyse* OR analyze* OR analysing OR analyzing OR analysis OR analytical OR estimate* OR estimating OR estimation* OR cause* OR causal OR experiment* OR effect* OR evidence OR random* OR assign* OR treatment OR control* OR allocat*))	7,110,467
9	#6 AND #7 AND #8	998
10	Limit to 2013 to present	672

PsycINFO

- Platform: Ebsco
- Date searched: June 21, 2023
- Number of results:204

Table 22: Search strings used in PsycINFO

String no	Search string	No of results
1	TI((school*) N3 (travel* OR transport* OR commut* OR journey*)) OR AB((school*) N3 (travel* OR transport* OR commut* OR journey*)) OR SU((school*) N3 (travel* OR transport* OR commut* OR journey*))	4184
2	TI(active OR walk* OR cycl* OR bicycl* OR scooter* OR mode*) OR AB(active OR walk* OR cycl* OR bicycl* OR scooter* OR mode*) OR SU(active OR walk* OR cycl* OR bicycl* OR scooter* OR mode*)	22,386,930
3	S1 AND S2	2333
4	TI((walk* OR bik* OR cycl*) N3 (school*)) OR AB((walk* OR bik* OR cycl*) N3 (school*)) OR SU((walk* OR bik* OR cycl*) N3 (school*))	2442
5	TI("walking school bus*" OR "School Streets" OR "Living Streets" OR "Youth Sport Trust" OR Sustrans OR bikeability OR "modeshift STARS" OR "TfL STARS" OR "Walk Once a Week" OR WOW OR "Beat the Street" OR megamotion OR "Bike It" OR "Ready Set Ride" OR "o Ride" OR "Bike Club" OR "School Travel Plans" OR "Walk to School Outreach" OR "Safe Routes to School" OR "Road Safety GB" OR "Active Travel Days" OR "Walking to School Days") OR AB("walking school bus*" OR "School Streets" OR "Living Streets" OR "Youth Sport Trust" OR Sustrans OR bikeability OR "modeshift STARS" OR "TfL STARS" OR "Walk Once a Week" OR WOW OR "Beat the Street" OR megamotion OR "Bike It" OR "Ready Set Ride" OR "o Ride" OR "Bike Club" OR "School Travel Plans" OR "Walk to School Outreach" OR "Safe Routes to School" OR "Road Safety GB" OR "Active Travel Days" OR "Walking to School Days") OR SU("walking school bus*" OR "School Streets" OR "Living Streets" OR "Youth Sport Trust" OR Sustrans OR bikeability OR "modeshift STARS" OR "TfL STARS" OR "Walk Once a Week" OR WOW OR "Beat the Street" OR megamotion OR "Bike It" OR "Ready Set Ride" OR "o Ride" OR "Bike Club" OR "School Travel Plans" OR "Walk to School Outreach" OR "Safe Routes to School" OR "Road Safety GB" OR "Active Travel Days" OR "Walking to School Days")	2250
6	S3 OR S4 OR S5	6146

String no	Search string	No of results
7	TI(((provision* OR provide OR give OR gave) N2 (cycle* OR bicycle* OR bike* OR scooter*)) OR ((proficien* OR confiden* OR safety OR train* OR teach* OR storage OR promot* OR parking) N3 (bicycle* OR bike* OR biking OR cycling)) OR ((safety OR promot* OR safe) N3 (walk*)) OR "cycling lane*" OR "cycle lane*" OR "bike lane*" OR "biking lane*" OR "crossing guard*" OR "crossing patrol*" OR "school walk zone*" OR "neighborhood walkability" OR "neighbourhood walkability" OR "no car zone*" OR "school travel environment*" OR behaviour* OR behavior* OR gamif* OR incentiv* OR "COM-B" OR capability OR capable OR motivat* OR opportunit* OR "safe route*" OR infrastructure OR "drop off" OR street* OR road* OR crossing* OR walkway* OR sidewalk* OR traffic OR injur* OR accident* OR collision* OR crash* OR pedestrian) OR AB(((provision* OR provide OR give OR gave) N2 (cycle* OR bicycle* OR bike* OR scooter*)) OR ((proficien* OR confiden* OR safety OR train* OR teach* OR storage OR promot* OR parking) N3 (bicycle* OR bike* OR biking OR cycling)) OR ((safety OR promot* OR safe) N3 (walk*)) OR "cycling lane*" OR "cycle lane*" OR "bike lane*" OR "biking lane*" OR "crossing guard*" OR "crossing patrol*" OR "school walk zone*" OR "neighborhood walkability" OR "neighbourhood walkability" OR "no car zone*" OR "school travel environment*" OR behaviour* OR behavior* OR gamif* OR incentiv* OR "COM-B" OR capability OR capable OR motivat* OR opportunit* OR "safe route*" OR infrastructure OR "drop off" OR street* OR road* OR crossing* OR walkway* OR sidewalk* OR traffic OR injur* OR accident* OR collision* OR crash* OR pedestrian) OR SU(((provision* OR provide OR give OR gave) N2 (cycle* OR bicycle* OR bike* OR scooter*)) OR ((proficien* OR confiden* OR safety OR train* OR teach* OR storage OR promot* OR parking) N3 (bicycle* OR bike* OR biking OR cycling)) OR ((safety OR promot* OR safe) N3 (walk*)) OR "cycling lane*" OR "cycle lane*" OR "bike lane*" OR "biking lane*" OR "crossing guard*" OR "crossing patrol*" OR "school walk zone*" OR "neighborhood walkability" OR "neighbourhood walkability" OR "no car zone*" OR "school travel environment*" OR behaviour* OR behavior* OR gamif* OR incentiv* OR "COM-B" OR capability OR capable OR motivat* OR opportunit* OR "safe route*" OR infrastructure OR "drop off" OR street* OR road* OR crossing* OR walkway* OR sidewalk* OR traffic OR injur* OR accident* OR collision* OR crash* OR pedestrian) OR KW(((provision* OR provide OR give OR gave) N2 (cycle* OR bicycle* OR bike* OR scooter*)) OR ((proficien* OR confiden* OR safety OR train* OR teach* OR storage OR promot* OR parking) N3 (bicycle* OR bike* OR biking OR cycling)) OR ((safety OR promot* OR safe) N3 (walk*)) OR "cycling lane*" OR "cycle lane*" OR "bike lane*" OR "biking lane*" OR "crossing guard*" OR "crossing patrol*" OR "school walk zone*" OR "neighborhood walkability" OR "neighbourhood walkability" OR "no car zone*" OR "school travel environment*" OR behaviour* OR behavior* OR gamif* OR incentiv* OR "COM-B" OR capability OR capable OR motivat* OR opportunit* OR "safe route*" OR infrastructure OR "drop off" OR street* OR road* OR crossing* OR walkway* OR sidewalk* OR traffic OR injur* OR accident* OR collision* OR crash* OR pedestrian)	1,900,914
8	TI((intervention* OR program* OR pilot* OR project* OR scheme*) AND (outcome* OR benefit* OR enabl* OR barrier* OR impact* OR evaluat* OR trial* OR predict* OR facilitat* OR measur* OR compar* OR assess* OR analyse* OR analyze* OR analysing OR analyzing OR analysis OR analytical OR estimate* OR estimating OR estimation* OR cause* OR causal OR experiment* OR effect* OR evidence OR random* OR assign* OR treatment OR control* OR allocat*)) OR AB((intervention* OR program* OR pilot* OR project* OR scheme*) AND (outcome* OR benefit* OR enabl* OR barrier* OR impact* OR evaluat* OR trial* OR predict* OR facilitat* OR measur* OR compar* OR assess* OR analyse* OR analyze* OR analysing OR analyzing OR analysis OR analytical OR estimate* OR estimating OR estimation* OR cause* OR causal OR experiment* OR effect* OR evidence OR random* OR assign* OR treatment OR control* OR allocat*)) OR SU((intervention* OR program* OR pilot* OR project* OR scheme*) AND (outcome* OR benefit* OR enabl* OR barrier* OR impact* OR evaluat* OR trial* OR predict* OR facilitat* OR measur* OR compar* OR assess* OR analyse* OR analyze* OR analysing OR analyzing OR analysis OR analytical OR estimate* OR estimating OR estimation* OR cause* OR causal OR experiment* OR effect* OR evidence OR random* OR assign* OR treatment OR control* OR allocat*)) OR KW((intervention* OR program* OR pilot* OR project* OR scheme*) AND (outcome* OR benefit* OR enabl* OR barrier* OR impact* OR evaluat* OR trial* OR predict* OR facilitat* OR measur* OR compar* OR assess* OR analyse* OR analyze* OR analysing OR analyzing OR analysis OR analytical OR estimate* OR estimating OR estimation* OR cause* OR causal OR experiment* OR effect* OR evidence OR random* OR assign* OR treatment OR control* OR allocat*))	890,380
9	S6 AND S7 AND S8	326
10	Limit to 2013 to present	204

Medline

- Platform: PubMed
- Date searched: June 21, 2023
- Number of results: 1683 (consider OVID)

Table 23: Search strings in Medline

String no	Search string	No of results
1	school*[tiab] AND (travel*[tiab] OR transport*[tiab] OR commut*[tiab] OR journey*[tiab])	4184
2	active[tiab] OR walk*[tiab] OR cycl*[tiab] OR bicycl*[tiab] OR scooter*[tiab] OR mode*[tiab]	22,386,930
3	#1 AND #2	2333
4	(walk*[tiab] OR bik*[tiab] OR cycl*[tiab]) AND (school*[tiab])	2442
5	"walking school bus*"[tiab] OR "School Streets"[tiab] OR "Living Streets"[tiab] OR "Youth Sport Trust"[tiab] OR Sustrans[tiab] OR bikeability[tiab] OR "modeshift STARS"[tiab] OR "TfL STARS"[tiab] OR "Walk Once a Week"[tiab] OR WOW[tiab] OR "Beat the Street"[tiab] OR megamotion[tiab] OR "Bike It"[tiab] OR "Ready Set Ride"[tiab] OR "o Ride"[tiab] OR "Bike Club"[tiab] OR "School Travel Plans"[tiab] OR "Walk to School Outreach"[tiab] OR "Safe Routes to School"[tiab] OR "Road Safety GB"[tiab] OR "Active Travel Days"[tiab] OR "Walking to School Days"[tiab]	2250
6	#3 OR #4 OR #5	6146
7	(((provision*[tiab] OR provide[tiab] OR give[tiab] OR gave[tiab]) AND (cycle*[tiab] OR bicycle*[tiab] OR bike*[tiab] OR scooter*[tiab])) OR ((proficien*[tiab] OR confiden*[tiab] OR safety[tiab] OR train*[tiab] OR teach*[tiab] OR storage[tiab] OR promot*[tiab] OR parking[tiab]) AND (bicycle*[tiab] OR bike*[tiab] OR biking[tiab] OR cycling[tiab])) OR ((safety[tiab] OR promot*[tiab] OR safe[tiab]) AND (walk*[tiab])) OR "cycling lane*"[tiab] OR "cycle lane*"[tiab] OR "bike lane*"[tiab] OR "biking lane*"[tiab] OR "crossing guard*"[tiab] OR "crossing patrol*"[tiab] OR "school walk zone*"[tiab] OR "neighborhood walkability"[tiab] OR "neighbourhood walkability"[tiab] OR "no car zone*"[tiab] OR "school travel environment*"[tiab] OR behaviour*[tiab] OR behavior*[tiab] OR gamif*[tiab] OR incentiv*[tiab] OR "COM-B"[tiab] OR capability[tiab] OR capable[tiab] OR motivat*[tiab] OR opportunit*[tiab] OR "safe route*"[tiab] OR infrastructure[tiab] OR "drop off"[tiab] OR street*[tiab] OR road*[tiab] OR crossing*[tiab] OR walkway*[tiab] OR sidewalk*[tiab] OR traffic[tiab] OR injur*[tiab] OR accident*[tiab] OR collision*[tiab] OR crash*[tiab] OR pedestrian[tiab]))	11,626,755
8	((intervention*[tiab] OR program*[tiab] OR pilot*[tiab] OR project*[tiab] OR scheme*[tiab]) AND (outcome*[tiab] OR benefit*[tiab] OR enabl*[tiab] OR barrier*[tiab] OR impact*[tiab] OR evaluat*[tiab] OR trial*[tiab] OR predict*[tiab] OR facilitat*[tiab] OR measur*[tiab] OR compar*[tiab] OR assess*[tiab] OR analyse*[tiab] OR analyze*[tiab] OR analysing[tiab] OR analyzing[tiab] OR analysis[tiab] OR analytical[tiab] OR estimate*[tiab] OR estimating[tiab] OR estimation*[tiab] OR cause*[tiab] OR causal[tiab] OR experiment*[tiab] OR effect*[tiab] OR evidence[tiab] OR random*[tiab] OR assign*[tiab] OR treatment[tiab] OR control*[tiab] OR allocat*[tiab]))	7,110,467
9	#6 AND #7 AND #8	998
10	Limit to 2013 to present	672

Transportation Research Information Database (TRID)

- Platform: TRID
- Date searched: June 27, 2023
- Number of results: 366 (with duplicates removed)

Table 24: Search strings used in TRID

String no	Search string	No of results
1	(((active OR walk* OR cycl* OR bicycl* OR scooter* OR mode*) AND ("school travel" OR "school journey*" OR "school transport*" OR "school commut*")) OR "active travel to school" OR "walking to school" OR "biking to school" OR "cycling to school" OR "walking school bus*" OR "School Streets" OR "Living Streets" OR "Youth Sport Trust" OR Sustrans OR "modeshift STARS" OR "TfL STARS" OR "Walk Once a Week" OR "Beat the Street" OR megamotion OR "Ready Set Ride" OR "o Ride" OR "Bike Club" OR "School Travel Plans" OR "Walk to School Outreach" OR "Safe Routes to School" OR "Road Safety GB" OR "Active Travel Days" OR "Walking to School Days") AND (((provision OR provide OR give OR gave OR proficient OR proficiency OR confident OR confidence OR safety OR train OR trains OR training OR trained OR teach OR teaching OR storage OR promote OR promotes OR promoting OR promoted OR parking OR safety OR safe) AND (cycle* OR bicycle* OR bike* OR scooter* OR biking OR walk OR walking)) OR "cycling lane" OR "cycling lanes" OR "cycle lane" OR "cycle lanes" OR "bike lane" OR "bike lanes" OR "biking lane" OR "biking lanes" OR "crossing guard" OR "crossing guards" OR "crossing patrol*" OR "school walk zone*" OR "neighborhood walkability" OR "neighbourhood walkability" OR "no car zone*" OR "school travel environment*") Limit 2013-2023	295
2	(((active OR walk* OR cycl* OR bicycl* OR scooter* OR mode*) AND ("school travel" OR "school journey*" OR "school transport*" OR "school commut*")) OR "active travel to school" OR "walking to school" OR "biking to school" OR "cycling to school" OR "walking school bus*" OR "School Streets" OR "Living Streets" OR "Youth Sport Trust" OR Sustrans OR "modeshift STARS" OR "TfL STARS" OR "Walk Once a Week" OR "Beat the Street" OR megamotion OR "Ready Set Ride" OR "o Ride" OR "Bike Club" OR "School Travel Plans" OR "Walk to School Outreach" OR "Safe Routes to School" OR "Road Safety GB" OR "Active Travel Days" OR "Walking to School Days") AND ((intervention* OR program* OR pilot* OR project* OR scheme*) AND (outcome* OR benefit* OR enabl* OR barrier* OR impact* OR evaluat* OR trial* OR predict* OR facilitat* OR measur* OR compar* OR assess* OR analyse* OR analyze* OR analysing OR analyzing OR analysis OR analytical OR estimate* OR estimating OR estimation* OR cause* OR causal OR experiment* OR effect* OR evidence OR random* OR assign* OR treatment OR control* OR allocat*)) AND (behaviour* OR behavior* OR gamif* OR incentiv* OR "COM-B" OR capability OR capable OR motivat* OR opportunit* OR "safe route*" OR infrastructure OR "drop off" OR street* OR road* OR crossing* OR walkway* OR sidewalk* OR traffic OR injur* OR accident* OR collision* OR crash* OR pedestrian) Limit 2013-2023	217