Effects of active travel interventions in population groups subject to inequity and disadvantage: protocol for a systematic review

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Background

Active travel is defined as walking, cycling, wheeling (the use of mobility aids), or scootering activity, for the functional purpose of transport to a particular destination (i.e. getting from place to place), such as work, school or the shops (Public Health England 2016; Saunders et al, 2013). Physical activity generally (Warburton and Bredin, 2017), as well as active travel specifically (Dinu et al, 2019; Friel et al, 2024), have been directly linked to health benefits. Beyond potential benefits for population health, active travel also confers important co-benefits for planetary health (Rutter et al, under review). For example, it provides opportunities for replacing journeys that would otherwise have used more environmentally damaging modes. Reducing emissions from vehicles and road materials improves air quality with associated health as well as environmental benefits. Moreover, substantial reductions in land transport emissions are needed to meet Net Zero commitments (Marteau et al, 2021). The vital importance for population and planetary health of rapid modal shifts towards active transport is highlighted in numerous policy documents and reports including being central to two of the Lancet-Chatham House Commission's recommendations for policy actions with the potential to improve population health post COVID-19 (Rutter et al, under review). However, levels of active travel in the UK do not reflect this emphasis, and are currently low.

The most recent available data for Great Britain[1] reports that in 2023, 330.8 billion vehicle miles were driven on roads of which cycle traffic only made up 3.6 billion. Furthermore, in England, an average of 272 miles and 278 trips were walked or cycled per person, versus 4684 miles and 548 trips as a car or van driver or passenger[2]. In terms of trends, the most recent available data[2] suggests that between June 2023 and

[1] https://www.gov.uk/government/statistics/road-traffic-estimates-in-great-britain-2023/road-traffic-estimates-in-great-britain-2023-headline-figures

[2] https://www.gov.uk/government/statistical-data-sets/nts03-modal-comparisons

June 2024, cycling traffic levels decreased by 7.0%, while motor traffic levels increased by 1.7%. Importantly, there is also a substantial body of evidence that levels of active travel differ by population groups, including those subject to disadvantage and to health and environmental inequities. In England in 2022, distance walked and cycled was negatively associated with income quintile, and a lower distance (and involving fewer trips) was walked and cycled by those who had never worked and the long-term unemployed, versus those in managerial and professional occupations (Sustrans et al, 2022).

A wide range of interventions have been developed and implemented at varying scales to attempt to increase the uptake and prevalence of active travel behaviours, applying both individual- and population-level approaches (Xiao et al, 2022; Love et al, 2019). Common types of active travel interventions encompass infrastructural changes to the physical or built environment, including specific active travel infrastructure such as cycle or pedestrian paths or pavement improvements, and streetscape or public realm improvements (e.g. lighting, signage, greening, street furniture). They also include marketing or information campaigns (e.g. education sessions); provision of skills training, equipment or structured opportunities (e.g. cycle training, cycle share or subsidy schemes, walking buses); and, incentives (e.g. financial or other rewards) (Cavill et al, 2019; Hansmann et al, 2022; Medeiros et al, 2021; Smith et al, 2017; Xiao et al, 2022).

Active travel interventions and equity

While active travel interventions, especially their impacts on physical activity, have been widely evaluated via primary outcome evaluation studies and at the level of evidence syntheses, this has been principally in relation to overall effects across populations. Differential impacts of interventions by population subgroups including those subject to disadvantage, have been relatively under-studied, including in a UK-specific context, despite such differences having the potential to reduce or exacerbate disparities in both levels of active travel and in health outcomes more generally. Our underlying assumption - as per above – is that interventions that increase active travel in disadvantaged population subgroups, and/or reduce disparities in levels of active travel, will in turn respectively improve, and/or reduce disparities in, health. At present, there is weak evidence for positive health equity impacts of active travel interventions (Hansmann et al, 2022) and the potential for negative health equity impacts cannot be excluded (Luan et al, 2019). The scope of previous reviews has been limited in terms of the comprehensiveness of search strategies, and due to the relatively narrow range of population subgroups and related analyses considered. It has been recognised by the Department of Health and Social Care (England) – the commissioners of this review and key stakeholders in its development – that the current evidence base is unable to optimally inform decision-makers in developing and implementing active travel interventions and policies that are both effective and equitable, including those aimed at specific communities and population subgroups. Without a comprehensive evidence-based assessment, there is a risk that interventions target whole populations inappropriately and/or target population subgroups ineffectively, and so risk widening existing health inequalities.

The proposed systematic review described in this protocol is embedded within a wider multi-stage programme of work[3], for which we have already produced an evidence

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map[4]. This has informed the parameters and processes of this systematic review[5] and so will be referred to below. The studies ultimately included in this systematic review will likely overlap substantially with those included in the map, but not completely (due to, for example, differences in eligibility criteria, and additional and updated searches). This degree of overlap in included studies and relatedly in study identification processes principally has implications for how we describe our methods for these processes in this protocol (see 'Study Identification' for details).

Aims

This review aims to investigate two related overarching aims concerning the absolute and relative potential effects of active travel interventions in relation to (in)equity:

i) Assess the extent to which active travel interventions increase active travel and improve health outcomes in population subgroups subject to inequity
ii) Assess the extent to which active travel interventions targeting general populations are more or less effective for subgroups subject to inequity relative to subgroups less subject to inequity

NB At the time of first registering this review protocol (27th February 2025), the current national policy priorities of the commissioners of this review (the Department of Health and Social Care (DHSC)), mean that these aims, as well as the review methods set out in the remainder of this protocol, will initially be applied to evidence from England only. Once this process is completed, a decision will then be made as regards extending the scope of the protocol to include evidence from outside of England.

Methods

Eligibility criteria

Registered at the Open Science Framework [https://osf.io/caf7g].

[4] A descriptive overview of a body of extant research evidence, often technically termed an Evidence and Gap Map (EGM). Maps of this kind are systematic and visual representations of the availability of evidence given a particular focus or domain relevant to a research question (Campbell et al, 2023; Shemilt et al, 2022). As of December 2024, the content and coding of the map has been completed, but the interactive map itself is being developed and is not yet publicly available.

[5] Through providing an interim overview of the characteristics of the broader evidence base, this has informed discussions with key stakeholders to refine the scope and aims of this review. Relatedly, this reduces the risk of spending undue time reviewing aspects that have already been well addressed by previous research, or of conducting an uninformative or inappropriately-focused review of studies that are too few in number and/or methodologically weak. Having produced the map will also likely increase efficiency of this systematic review, as much of the relevant evidence will be contained in the map and so will have already been dual-screened and some of its key characteristics annotated, as well as aiding in contextualising the findings of this review, such as in relation to areas of the broader evidence base not directly addressed by this more focused systematic review.

Studies will be assessed for inclusion based on the criteria summarised below:

Population	Population group(s) subject to disadvantage
Intervention	Any that focus on increasing active travel
Comparison	Absence of the active travel intervention
Outcome	Quantitative measure of active travel behaviour or linked health outcome
Study design	Outcome evaluation using a randomised, longitudinal, or other quasi-experimental design

Population: Eligible populations comprise specific disadvantaged groups, or general populations where outcomes are reported separately for at least one population subgroup subject to disadvantage (see also 'Outcome'). At minimum, population subgroups concerning the following dimensions of equity will be examined: sex/gender; race/ethnicity; age (specifically older adults); and socioeconomic status (e.g. categorisation via education, income, occupational status, geography), as these were identified in our prior evidence mapping work. We will exclude children and adolescents in relation to active school travel as our evidence mapping confirmed that there is already a very extensive existing literature on this topic, including multiple well-conducted systematic reviews (e.g. Fernandes et al, 2023). We will also exclude population subgroups that we do not agree by consensus reflect groups generally subject to inequity, such as employed occupational groups otherwise not differentiated from general populations (e.g. adult workers or commuters).

Intervention: Eligible interventions are those with a focus on increasing active travel. Active travel is defined as walking, cycling, wheeling (the use of mobility aids), or scootering activity, with the purpose of transport to a particular destination (i.e. getting from place to place), such as to work or the shops (Public Health England 2016; Saunders et al, 2013). Studies must indicate that the intervention focuses on, or aims to increase, active travel, either explicitly described in its intervention aims or content, or strongly suggested by its context (e.g. altering commuting, transport or travel behaviour) and/or its inclusion of active travel outcomes[6]. Eligible interventions may also include aims or components related to travel or physical activity for non-transport purposes (e.g. recreation or leisure, sport, fitness, exercise, performance, or rehabilitation) providing they do not constitute the predominant focus of the intervention, and/or are not implemented in contexts explicitly related to these kinds of activity (e.g. organised or prescribed sport or exercise programmes in leisure facilities). We will exclude interventions that focus mostly on altering uptake of other forms of transport (e.g. public transport provision or usage incentive schemes, or speed limits or economic disincentives for motor vehicles) without at least equivalent actions for enabling active travel.

Comparison: Eligible comparisons are the absence of the active travel intervention, which could include comparison to control groups not exposed to the intervention or to the same population at different timepoints in longitudinal designs.

[6] While based on the prior evidence map, we judge that these conditions will be able to be stringently applied for interventions that are delivered to individuals and groups, for (more complex or distal) population-level infrastructural and policy interventions we will necessarily have to apply more discretion because links to active travel aims may be implied but less explicitly stated. For example, infrastructural schemes such as cycle lanes and bike share schemes may be contextualised only in relation to increasing cycling but not specifically active travel cycling, but inevitably at least some of their use and purpose will involve active travel.

Outcome: Eligible outcomes are any quantitative measure of active travel behaviour or health outcome linked to performance of active travel behaviours, that is reported for at least one population subgroup. This could be 1) where the study sample is a specified group subject to inequity, or 2) a subgroup(s) derived from a general population study sample. Among general population studies, outcome data could be reported by subgroup(s), or represented by an interaction term in a statistical model, providing there is a statement specifying the direction of effect on that group(s)[7].

Active travel can be assessed via self-report, observation, or use an objective measure of participants' behaviour (e.g. accelerometer, geographic sensor). Health outcomes can be assessed via self-report or an objective measure of health or disease status, or physiological or psychological functioning, including quality of life and mental health.

Should outcome data linked specifically to active travel(e.g. walking, cycling, or composite active travel data) not be available, we will consider including generic physical activity outcome data, and then treat that as an active travel outcome, providing that first, we can reasonably infer or judge it likely that active travel makes up a major proportion of the physical activity measured[8], and second, the intervention is implemented and assessed at community or population level, such as infrastructural or other governmental policy interventions (e.g. bike sharing schemes, commuter cycle lanes, or broad public realm improvement strategies)[9].

We will exclude retrospective outcome measures assessed post-intervention within single cohorts i.e. without an appropriate comparison.

Study design: Any evaluative design e.g. randomised, longitudinal (e.g. simple pre/post comparison, interrupted time series, cohort or repeat cross-sectional) or other quasi-experimental design(e.g. non-randomised controlled trial, controlled before-and-after). To be deemed an outcome evaluation, there needs to be a specified intervention, policy, set of interventions/policies, and/or collection of primary data.

Publication type: Intervention outcome evaluation studies within empirical primary research reports i.e. not a preprint, protocol, registration, or otherwise not a full journal or report article.

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7 Therefore, for example, simply stating that a variable is included in a model as an adjustment covariate is insufficient for inclusion unless numeric data for its specific effect are reported and a corresponding explicit interpretation of its meaning is provided.

8 The degree to which AT can be considered to make up a major part of generic physical activity data could, for example, be determined by, for example, the specific content of measures or questions asked (e.g. wording emphasising active travel physical activity or emphasising recreational or non-active travel physical activity), the evaluation context and relatedly the way the data are interpreted in the study, or by the inclusion of complementary data in the paper that indicates the likely major purpose of people's activity.

9 This reflects the consideration that for interventions of large scale and scope, the purpose of any observed physical activity is usually less feasible to directly assess or assume. By contrast, for interventions that are implemented, and able to be assessed, directly with individuals or groups of limited size, we will require inclusion of a specific measure of active travel

Study identification

NB The searches as described below have already been conducted once in producing the aforementioned evidence map and the studies included in the map will be assessed for potential inclusion in this systematic review. These searches will be updated and re-run for this systematic review prior to completion. The future re-run searches may be made more efficient by, for example, potentially i) excluding those resources that comprise only systematic reviews and/or those resources that previously did not provide any eligible studies, and ii) using OpenAlex more widely, such as using Boolean searches and 'recommender searches' within EPPI Reviewer (which, at the time of writing in February 2025, we are evaluating). Any changes to the prior searches described below will be transparently recorded at the time of conducting the updated searches.

We will conduct comprehensive systematic searches for primary research reports of intervention outcome evaluation studies in published articles and other sources including technical, scientific, organisational or other policy focused reports (from local, national, or supra-national levels), as well as other forms of grey literature (e.g. conference proceedings). No publication date, language or geographical limits will be applied. Information sources will cover literature spanning transport and the built environment, health, psychological and behavioural sciences, social policy, social science and economics. The following electronic databases and other online resources will be searched:

<u>Built environment and transport</u>

- Transport Research International Documentation (TRID)
- ICE Virtual Library (Civil Engineering Resource)
- Geobase (OVID)
- Urbadoc
- ICONDA (OVID)

<u>Health, and psychological and behavioural sciences</u>

- CINAHL (EBSCO)
- Embase (OVID)
- MEDLINE (OVID)
- Public Health Database (Proquest)
- Health Management Information Consortium (OVID)
- PsycInfo (OVID)
- Cochrane Library - Databases of Systematic Reviews*, and controlled trials (CENTRAL)
- Database of promoting health effectiveness reviews (DoPHER)*
- The Trials Register of Promoting Health Interventions (TRoPHI)

<u>Social policy, social science and economics</u>

- Applied Social Sciences Index and Abstracts (ASSIA) (ProQuest)
- Econlit (EBSCO)
- ABI/Inform Global (Proquest)

- Socialogical Abstracts (Proquest)Social Policy and Practice (OVID)
- PAIS Index (Proquest)
- ERIC (EBSCO)
- IBSS (ProQuest)

Interdisciplinary, Web of Science

- Science Citation Index (Web of Science)
- Social Science Citation Index (Web of Science)
- Conference Proceedings Citation Index - Science (Web of Science)
- Conference Proceedings Citation Index - Social Science & Humanities (Web of Science)
- Emerging Sources Citation Index (Web of Science)

Other specialist resources

- SafetyLit
- Social Systems Evidence*
- Epistemonikos*
- Health Evidence Canada*

*=*resources not proposed to be used for future updated searches*

The search strategies for the databases have been developed in collaboration with an Information Specialist. Our searches are designed to target concepts of types of active travel (e.g. including terms relating to walking and cycling) and purpose (e.g. including terms relating to transport, commuting, utilitarian travel, active travel) and target only broad concepts for evaluation and study design. We have used a range of topic relevant terms and synonyms and searched the title and abstract fields of records as well as controlled vocabulary within individual databases, such as Medical Subject Headings (MeSH).

We will also search websites of key organisations in the area of health and transport to search for reports and evaluation documents, including the following: Department of Health and Social Care (DHSC), Department for Transport (DfT), Sustrans, Active Travel England, Transport Research Laboratory, Eltis (The Urban Mobility Observatory), Association for European Transport, and the WHO Transport webpages and included weblinks.

We will conduct backwards and forwards citation searching from included studies, using OpenAlex and Scopus.

Study selection

As we did with the evidence map, for our updated searches bibliographic records will be imported into EPPI Reviewer 6 (Thomas et al, 2022) (adding to the existing corpus of records in EPPI Reviewer 6 from the prior searches) and duplicates will be semi-automatically identified and discarded using its ‘manage duplicates’ tools.

Records will be prioritised for title-abstract screening using 'active learning' within EPPI Reviewer 6, where the list of unscreened records will be continually reprioritised by a machine learning classifier that is being trained to distinguish between eligible and ineligible records based on the growing corpus of eligibility decisions made by the researchers. Use of 'active learning' expedites study selection in systematic reviews by ensuring that records of eligible studies are more likely to be identified and selected early in the screening process, compared with screening records in a quasi-random order (e.g. alphabetical). Title-abstract screening will be truncated at a point where we judge it is unable to be justified in terms of significantly increased effort being required to identify each new relevant study. This will be informed by monitoring the rate of study inclusion into the full-text screening stage via screening progress data (captured by EPPI Reviewer) to observe when the rate of identifying potentially eligible studies slows significantly. Where feasible, manual screening will be undertaken for all records without an abstract and those identified from manual searching. Decisions to cease manual screening will be supported by comparing the inclusion rate with that from an initial randomly screened sample (baseline inclusion rate) and investigating the relevance ranking of the remaining unscreened references that is trained on the manually screened records.

Eligibility screening will proceed from examination of the prioritised title-abstract records to assessment of corresponding full-text articles for those title-abstract records assessed as potentially eligible.

Title-abstract screening: Once a high degree (≥90%) of mutual agreement on inclusion/exclusion decisions for a random sample of 100 records, is achieved by all reviewers, the remaining title-abstract records will be screened by one reviewer only. If there is uncertainty regarding the eligibility of a record, it will be discussed with a second reviewer to reach a joint consensus decision.

Full-text screening: Full-texts of all potentially relevant records will be screened independently by two reviewers. Any disagreements that arise will be resolved by consensus or if necessary by consulting a third reviewer as arbiter.

Any papers not written in English will be translated using Google Translate and then screened.

Data extraction

Key study characteristics (including risk of bias) and outcome data will be extracted independently by two reviewers and agreed by consensus, involving a third reviewer as necessary.

We plan to, at minimum, extract the following data, but this may be expanded or revised as we encounter new evidence. While we anticipate that the characteristics listed will each be extracted in some way, for some their precise formulation and categorisation may further develop iteratively via both bottom-up (useful categorical distinctions emerging as new evidence is encountered) and top-down processes (applying existing knowledge from the active travel and other literatures and new conceptual knowledge as it is encountered via the literature and discussion). However, we anticipate changes will be few because much of this conceptual development and organisation occurred in the process of generating the prior evidence map.

Study and publication characteristics: Study design (e.g. randomised controlled trial; interrupted time series; controlled before and after; prospective cohort; repeated cross-sectional; other longitudinal design); Year; Type of publication.

Setting characteristics: Country; Contextual information including geographical and delivery setting (e.g. delivered in community; delivered via an institution such as a workplace).

Participant characteristics: Focus on general population(s) with eligible subgroups, or on eligible specific subgroup population(s); Population subgroup(s) that are specified and represented with related data, at minimum related to one or more of sex/gender; race/ethnicity; age (elderly); socioeconomic status (e.g. categorisation via education, income, occupational status, geography).

Intervention characteristics: A broad categorisation of intervention types according to the Behaviour Change Wheel (Michie et al, 2011), assigning[10] its nine intervention functions (Education; Persuasion; Incentivisation; Coercion; Training; Enablement; Modelling; Environmental Restructuring; Restrictions). Categories are not mutually exclusive (i.e. some interventions may require multiple codes). We will supplement this with a detailed classification of intervention components using the Behaviour Change Technique Taxonomy (v1) (Michie et al, 2013).

Outcome characteristics: Active travel outcomes assessed (e.g. walking; cycling, wheeling, scootering; composite measure); Measure(s) of active travel used (e.g. duration, distance, frequency; via observation, via self-report; time of assessment); If and how differential impact data for active travel reported (e.g. absolute outcome value(s) for subgroup(s)); Health outcome(s) assessed; Measure(s) of health outcome(s) used; If and how differential impact data for health outcome(s) reported.

Risk of bias: We will appraise the risk of bias of included studies using the Effective Public Health Practice Project (EPHPP) tool (EPHPP, 2024). We judge that this tool will be most appropriate as it can be applied to a wide range of study designs. Furthermore, we anticipate that there is a low likelihood of generating high-certainty quantitative summary findings across the review scope, and so consider a more rapidly and broadly applied tool better suited to this task and the requirements of our key stakeholders. Additionally, the EPHPP tool, and variants thereof, is the most commonly used assessment tool amongst the pool of systematic reviews of active travel interventions that we identified in our prior evidence map. These reviews also note specific limitations of other risk of bias tools for this topic given the types of study designs often used in evaluations (e.g. Xiao et al). We will consider adapting the tool, for example, to add or remove items we deem particularly relevant (or irrelevant) to the specific evidence base.

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10 This also aligns well with categorisations used in previous reviews focused specifically on active travel interventions (e.g. Cavill et al, 2019; Hansmann et al, 2022; Medeiros et al, 2021; Smith et al, 2017; Xiao et al, 2022) which commonly include but with varying terminology: changes to the physical/built environment (including e.g. specific active travel infrastructure such as cycle or pedestrian paths or pavement improvements, and streetscape or public realm improvements (e.g. lighting, signage, greening, street furniture); marketing/promotion/information campaigns to encourage or increase awareness/knowledge of the benefits of and opportunities/resources for, active travel (e.g. education sessions); provision of skills training, equipment or structured opportunities (e.g. cycle training, cycle share or subsidy schemes, walking buses); and, incentives (e.g. financial or other rewards for behaviour).

Approach to synthesis

Based on our prior mapping work, we anticipate that synthesising extant evidence will be complex and wide-ranging, with a disparate literature known to have substantial heterogeneity across many dimensions including outcomes and outcome measures, study designs, population subgroups and variation in reporting relevant results. Our approach will necessarily be pragmatic and intended to synthesise as much useful data as possible and to reflect the developing priorities and ongoing dialogue with our key stakeholders. As such, while we propose conducting the following analyses (should sufficient data be available) and set out their guiding principles as a series of components below, some aspects may change. We will record and report significant deviations from our protocol.

We plan to synthesise results separately by population subgroup because their defining characteristics are conceptually distinct. We anticipate there will be sufficient data to usefully synthesise evidence concerning the following domains:

- Sex/gender
- Age (older adults)
- Race/ethnicity
- Socio-economic status

We failed to identify a sufficient number of studies for any other population subgroup in our prior evidence map to specify a priori that they will be included as a specified subgroup. We will, however, consider any further subgroups that meet our criteria[11], should we deem that there is sufficient available evidence whereby its assessment could meaningfully contribute to our understanding of intervention impacts for that group.

So, for example, our overall aims will be formulated for the set of analyses concerning sex/gender as follows:

i) *Assess how effective active travel interventions are for increasing active travel and improving health outcomes in women/female populations*

ii) *Assess the extent to which active travel interventions are more or less effective for women/female populations relative to for men/male populations*

Within each of the sets of analyses by population subgroup, we will examine either or both of the two review aims and linked research questions. Addressing the first question can draw on outcome data available from studies that focus only on single groups (e.g. women/female populations) as well as outcome data available from studies focusing on general populations that disaggregate outcome data by

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As illustration of the range of possible population subgroups we could consider are linked to inequity, current and developing guidance in the NIHR Policy Research Programme's Evidence Reviews Facility (Shemilt et al, 2024) considers the following as potentially linked to equity considerations: Age; Sex; Gender; Race, ethnicity and ancestry; Religion; Social hierarchy (caste, tribes); Socio-economic status; Level of education; Place of residence; Location; Sexual orientation; Disability; People experiencing homelessness; Drug or alcohol dependence; Language minority groups; Vulnerable migrants, or internally displaced people; Gypsy, Roma and Traveller communities; Slum dwellers / vulnerable tribal group(s); Sex workers; People in contact with the justice system; Victims of modern slavery; Other marginalised, at-risk, socially excluded and/or inclusion health group(s).

subgroup(s) (e.g. for women/female populations). The second question can draw only on outcome data available from studies focusing on general populations that disaggregate outcome data and provide a comparison to at least one other population subgroup that is less generally subject to disadvantage (e.g. data for both women/female populations and men/male populations as subgroup data or represented by a gradient of effect).

We anticipate synthesising evidence for each of three behavioural outcomes with potentially sufficient data: for walking; cycling; and, composite or generic active travel. In addition, we will synthesise available data on health outcomes, although based on our prior mapping work we anticipate these will be limited. For each behavioural outcome, where there are multiple measures, we will select, in order of priority, that measure which captures most explicitly and specifically data about active travel; that which captures data on amount of active travel rather than frequency; and if those aspects do not discriminate sufficiently, the most similar measure that is most common across studies in that analysis. If there are insufficient data to justify separate analyses for the three behavioural outcomes (walking, cycling, and composite or generic active travel outcomes), we will consider performing a single main analysis that combines behavioural outcomes (if necessary making allowances for multiple observations from single studies, either statistically or by deriving a single study-level effect).

For any given behavioural outcome, we will combine measures that we judge to reflect conceptually coherent effects on behaviour. At minimum, we will combine measures that reflect the amount of active travel performed (e.g. distance, time spent, number of people using a facility) and make decisions by consensus on other aspects of active travel that may or may not reflect the amount performed (e.g. frequency of active travel). If the available data means that we judge it most appropriate to synthesise only one outcome per study, we will prioritise generic or composite active travel, and then walking, being those active travel domains that encompass the most potential activity for the widest possible population and the lowest general barriers to qualification. For any selected outcome, if this is reported at multiple timepoints, we will select the longest available follow-up period.

If data are available we will conduct additional assessment of potential effect modifiers. Based on our prior mapping work, this will most likely be limited to an assessment of the effect of intervention type, and consist of a subgroup comparison of the effect of infrastructural population-level interventions (broadly conceptualised as Environmental Restructuring within the Behaviour Change Wheel (Michie et al, 2011) versus informational interventions targeted at individuals or groups (broadly conceptualised as Education, Persuasion and/or Enablement within the Behaviour Change Wheel).

It is unlikely that sufficient data will be available for all of these potential analyses outlined above. For example, it is advised that formal subgroup analyses in meta-analysis require at least ten studies (Deeks et al, 2023). Should we judge that insufficient data are available to derive credible conclusions from proposed syntheses, we will either not conduct those analyses or we will conduct and report them for completeness but make it explicit that we do not consider the specific analyses reliable for interpretation.

Analysis approach

For each potential synthesis outlined above, we will conduct the following analyses, in order of priority:

1) While we do not anticipate this will be widely feasible based on known heterogeneity of the evidence base, we will conduct a meta-analysis of studies that have a control group and sufficient homogeneity in key aspects of their study design (e.g. randomisation, use of post-intervention outcomes or change scores).
2) Where meta-analysis is not viable for any or all studies, we will follow current 'Synthesis without meta-analysis' (SWiM) guidance (Campbell et al, 2020) to determine the most appropriate approach to synthesising those data. For example, should we conclude that for a set of studies there is inconsistency in the effect measures or data reported and/or we are only able to ascertain the direction of effect, we will consider vote counting based on the direction of effect, and this may be accompanied by an effect direction plot or harvest plot to visually represent results.
3) Should there be any remaining individual studies unable to be synthesised in accordance with the above, they will be tabulated and their results described narratively.

For principal syntheses of outcome data, we will conduct GRADE assessments (Guyatt et al, 2011) to assess the certainty of the summarised effects. We will consider domains relating to risk of bias (study limitations), imprecision, indirectness, inconsistency, and publication bias, with each body of evidence being assigned one of four standard GRADE levels of certainty - high, moderate, low and very low.

Equity issues

Health inequities are unfair, socially produced, and systematic disparities in health outcomes between population groups, associated with their social, economic or personal characteristics (Dahlgren and Whitehead, 2006; Hollands et al, 2024). Reducing health disparities forms a core component of the UK Government's 'Levelling Up' agenda (Department for Levelling Up, Housing and Communities, 2022), and considerations of equity impacts are entwined with active travel. Where dimensions of equity are associated with lower prevalence of active travel, this has the potential to directly exacerbate inequalities in health outcomes, given adverse effects of physical inactivity. Lower population prevalence of active travel may also exacerbate inequalities via various indirect pathways (Gössling et al, 2022). For example, lower socio-economic status people are more affected by the externalities of predominant non-active modes of travel, such as being subject to disproportionate exposure to the pollution, safety and social connectivity impacts of motor vehicle infrastructure (Rutter et al, under review).

Our consideration of equity for this review is informed by ongoing development of a checklist that we (within the NIHR PRP Reviews Facility) are developing as part of a new suite of tools for use to help guide consideration issues of health equity in systematic reviews and related forms of evidence synthesis. In developing this protocol we have applied the current version (v1.0) of the checklist (Shemilt et al, 2024). The key implications of completing this checklist are that we will systematically seek to identify, synthesise and report (in accordance with PRISMA-Equity (Welch et al, 2012) the evidence (or a lack thereof) in relation to each of our currently specified

population subgroup foci, i.e. concerning sex/gender; race/ethnicity; older age; and socioeconomic status. *See Appendix 1 for further details*.

Stakeholder engagement

Ongoing policy stakeholder involvement of DHSC colleagues in developing and finalising research questions and methods. No public involvement is planned.

Provisional Timetable

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10
Screening of records included in the prior evidence mapping work (title/abstract & full text screening)										
Data extraction										
Additional and updated searches, screening, data extraction										
Analysis										
Draft review report; Circulate to stakeholders for comments; Finalise report										

Registration

This protocol will be registered on both PROSPERO and the Open Science Framework.

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References

Campbell M, McKenzie JE, Sowden A, Katikireddi SV, Brennan SE, Ellis S, Hartmann-Boyce J, Ryan R, Shepperd S, Thomas J, Welch V, Thomson H (2020). Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guideline. BMJ; 368:l6890. doi: 10.1136/bmj.l6890

Campbell F, Tricco AC, Munn Z, Pollock D, Saran A, Sutton A, White H, Khalil H (2023). Mapping reviews, scoping reviews, and evidence and gap maps (EGMs): the same but different - the "Big Picture" review family. Systematic Reviews; 12(1):45. https://doi.org/10.1186/s13643-023-02178-5

Cavill N, Davis A, Cope A, Corner D (2019). Active Travel and Physical Activity Evidence Review. Sport England.

Dahlgren G, Whitehead M (2006). Levelling up (part 2): a discussion paper on European strategies for tackling social inequities in health. World Health Organization: Studies on social and economic determinants of population health. Available from: https://iris.who.int/handle/10665/107791

Deeks JJ, Higgins JP, Altman DG (2023). Chapter 10: Analysing data and undertaking meta-analyses. In: Higgins JP, Thomas J, Chandler J, Cumpston M, Li T,Page MJ, Welch VA, editor(s). Cochrane Handbook for Systematic Reviews of Interventions Version 6.4 (updated August 2023). Cochrane, 2023.Available from training.cochrane.org/handbook.

Department for Levelling Up, Housing and Communities (2022). Levelling Up the United Kingdom. HM Government.

Dinu M, Pagliai G, Macchi C, Sofi F (2019). Active commuting and multiple health outcomes: A systematic review and meta-analysis. Sports Medicine; 49(3):437-452. https://doi.org/10.1007/s40279-018-1023-0

EPHPP (Effective Public Health Practice Project). Quality Assessment Tool for Quantitative Studies. Available from (accessed December 2024): https://www.ephpp.ca/quality-assessment-tool-for-quantitative-studies/

Fernandes A, Ubalde-López M, Yang TC, McEachan RRC, Rashid R, Maitre L, Nieuwenhuijsen MJ, Vrijheid M (2023). School-Based Interventions to Support Healthy Indoor and Outdoor Environments for Children: A Systematic Review. International Journal of Environmental Research and Public Health; 20(3):1746. doi: 10.3390/ijerph20031746

Friel C, Walsh D, Whyte B, Dibben C, Feng Z, Baker G, Kelly P, Demou E, Dundas R, Weller J (2024). Health benefits of pedestrian and cyclist commuting: evidence from the Scottish Longitudinal Study. BMJ Public Health; 2:e001295.

Gössling S, Kees J, Litman T (2022). The lifetime cost of driving a car. Ecological Economics; 194:107335.

Guyatt G, Oxman AD, Akl EA, Kunz R, Vist G, Brozek J, Norris S, Falck-Ytter Y, Glasziou P, DeBeer H, Jaeschke R, Rind D, Meerpohl J, Dahm P, Schünemann HJ (2011). GRADE guidelines: 1. Introduction – GRADE evidence profiles and summary of findings tables. Journal of Clinical Epidemiology; 64(4):383-94.

Hansmann KJ, Grabow M, McAndrews C (2022). Health equity and active transportation: A scoping review of active transportation interventions and their impacts on health equity. Journal of Transport & Health; 25:101346. https://doi.org/10.1016/j.jth.2022.101346

Hollands GJ, South E, Shemilt I, Oliver S, Thomas J, Sowden AJ (2024). Methods used to conceptualize dimensions of health equity impacts of public health interventions in

systematic reviews. Journal of Clinical Epidemiology; 169:111312. https://doi.org/10.1016/j.jclinepi.2024.111312

Love R, Adams J, van Sluijs EMF (2019). Are school-based physical activity interventions effective and equitable? A meta-analysis of cluster randomized controlled trials with accelerometer-assessed activity. Obesity Reviews; 20(6):859-870. https://doi.org/10.1111/obr.12823

Luan H, Ramsay D, Fuller D (2019). Household income, active travel, and their interacting impact on body mass index in a sample of urban Canadians: a Bayesian spatial analysis. International Journal of Health Geographics; 18(1):4. https://doi.org/10.1186/s12942-019-0168-x

Marteau TM, Chater N, Garnett EE (2021). Changing behaviour for net zero 2050. BMJ; 375:n2293. https://doi.org/10.1136/bmj.n2293

Medeiros A, Buttazzoni A, Coen SE, Clark SF, Wilson K, Gilliland J (2021). Review of gender, socioeconomic status, and ethnic background considerations reported in active school travel intervention studies. Journal of Transport & Health; 21:101035. https://doi.org/10.1016/j.jth.2021.101035

Michie S, Richardson M, Johnston M, Abraham C, Francis J, Hardeman W, Eccles MP, Cane J, Wood CE (2013). The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. Annals of Behavioral Medicine; 46(1):81-95. https://doi.org/10.1007/s12160-013-9486-6

Michie S, van Stralen MM, West R (2011). The behaviour change wheel: a new method for characterising and designing behaviour change interventions. Implementation Science; 6:42. https://doi.org/10.1186/1748-5908-6-42

Public Health England (2016). Working together to promote active travel: A briefing for local authorities.

Rutter H, Wabnitz K, Nambiar D, Garde A, Benton TG, Heymann DL, Yates R, Friel S, Hollands GJ, Cai W, Chater N, Bloom DE, Guinto RR, El Omrani O, Wilsdon J, Amuasi JH, Nishtar S, Butler C, Tlou S, Marteau TM (under review). The Lancet-Chatham House Commission on improving population health post COVID-19.

Saunders LE, Green JM, Petticrew MP, Steinbach R, Roberts H (2013). What are the health benefits of active travel? A systematic review of trials and cohort studies. PLOS ONE; 8(8):e69912. https://doi.org/10.1371/journal.pone.0069912

Shemilt I, Hollands GJ, Stansfield C, Thomas J (2022). Debunk, Inform, Avoid? Debunking vaccine-related misinformation: a rapid evidence review. London: EPPI Centre, UCL Social Research Institute, University College London. Report produced for the International Public Policy Observatory (IPPO). Available from: https://eppi.ioe.ac.uk/CMS/portals/0/Debunking%20RER_Final%20Report_Final%20Version_12-2022.pdf

Shemilt I, Hollands GJ, D'Souza P, Macdowall W, Sutcliffe K (2024). Considering and reporting methods for investigating health equity issues in systematic reviews and other evidence syntheses. (Version 1.0. October 2024). London: EPPI Centre, Social Science Research Unit, UCL Institute of Education, University College London. Available from: https://eppi.ioe.ac.uk/cms/Default.aspx?tabid=3939

Smith M, Hosking J, Woodward A, Witten K, MacMillan A, Field A, Baas P, Mackie H (2017). Systematic literature review of built environment effects on physical activity and active transport – an update and new findings on health equity. International Journal of Behavioral Nutrition and Physical Activity; 14(1):158. https://doi.org/10.1186/s12966-017-0613-9

Sustrans, Arup, Living Streets (2022). Walking for everyone: Making walking and wheeling more inclusive.

Tcymbal A, Demetriou Y, Kelso A, Wolbring L, Wunsch K, Wäsche H, Woll A, Reimers AK (2020). Effects of the built environment on physical activity: a systematic review of longitudinal studies taking sex/gender into account. Environmental Health and Preventive Medicine; 25(1):75. https://doi.org/10.1186/s12199-020-00915-z

Thomas J, Graziosi S, Brunton J, Ghouze Z, O'Driscoll P, Bond M, Koryakina A (2022). EPPI-Reviewer: advanced software for systematic reviews, maps and evidence synthesis. EPPI Centre, UCL Social Research Institute, University College London

Warburton DER, Bredin SSD (2017). Health benefits of physical activity: a systematic review of current systematic reviews. Current Opinion in Cardiology; 32(5):541-556. https://doi.org/10.1097/hco.0000000000000437

Welch V, Petticrew M, Tugwell P, Moher D, O'Neill J, Waters E, White H; PRISMA-Equity Bellagio group (2012). PRISMA-Equity 2012 Extension: Reporting Guidelines for Systematic Reviews with a Focus on Health Equity. PLoS Medicine; 9(10):e1001333.

Xiao C, Sluijs EV, Ogilvie D, Patterson R, Panter J (2022). Shifting towards healthier transport: carrots or sticks? Systematic review and meta-analysis of population-level interventions. Lancet Planetary Health; 6(11):e858-e869. https://doi.org/10.1016/S2542-5196(22)00220-0

Appendix 1 – Provisional assessment of equity considerations

The current checklist (v1.0; Shemilt et al, 2024) comprises a set of six signalling questions, and we considered in turn whether these potentially apply to studies eligible for inclusion in this review:

1a. Is the intervention under investigation targeted at specific marginalised, at-risk, socially excluded and/or inclusion health group(s) of people?

We judged this as sufficiently known and/or plausible to justify a 'Yes' response across all groups. This judgement is informed by our prior evidence mapping work identifying a substantive body of evidence evaluating active travel interventions targeted at specific disadvantaged population subgroups.

1b. Is the intervention under investigation aimed at reducing social gradients across populations or among subgroups of the population?

We judged this as sufficiently known and/or plausible to justify a 'Yes' response across all groups.

The implication of our responses to questions 1a and 1b, after following the corresponding decision tree, is that PRISMA-E should be used (in conjunction with PRISMA and PRISMA-P) for this review, as should PRO-EDI (if available, as it is currently being developed).

2a. Is the health condition, public health issue, or phenomenon, being addressed by the review (and/or map) more likely to be experienced by one or more specific marginalised, socially excluded and/or inclusion health group(s) of people?

Given there appears to be some evidence for each of the set of population subgroups specified for this review that membership may be associated with reduced active travel (Sustrans et al, 2022), we considered this to be 'Yes' in relation to groups concerning: sex/gender, race/ethnicity, older age, and socioeconomic status (e.g. categorisation via education, income, occupational status, geography), each of which we specify we intend to examine in this review.

2b. Are aspects of the intervention(s) and/or comparator(s), including how they are provided, expected to make it harder for some specific marginalised, at-risk, socially excluded and/or inclusion health group(s) of people to take part in eligible studies?

We judged 'Unsure' to be the most appropriate response across all groups. We do know at outset that at least some of the eligible studies specifically target these groups to take part, meaning that at least in these studies these groups are not clearly disadvantaged from taking part in eligible studies. However, this does not address relative difficulty of participation, and at outset we are not aware of specific evidence on the participation of these groups relative to that of less disadvantaged groups.

2c. Are elements of study design, such as eligibility criteria or recruitment and consent processes, expected to make it harder for some specific marginalised, at-risk, socially excluded and/or inclusion health group(s) of people to take part in eligible studies?

We judged 'Unsure' to be the most appropriate response across all groups. We do know at outset that at least some of the eligible studies specifically target these groups to take part, meaning that at least in these studies these groups are not clearly disadvantaged from taking part in eligible studies. However, this does not address relative difficulty of participation, and at outset we are not aware of specific evidence on the participation of these groups relative to that of less disadvantaged groups.

The implications of our responses to questions 2a, 2b and 2c, after following the corresponding decision tree, are as follows:

PRISMA-E should be used (in conjunction with PRISMA and PRISMA-P) for this review, as should PRO-EDI (if available, as it is currently being developed); a 'Characteristics of Included Studies' table should be used; where possible and appropriate, data on the

numbers and percentages of participants from each specified subgroup in a) each study sample and b) in total across all studies included in the review should be extracted and reported; such data assessing the extent of applicability of review findings to target populations (e.g. highlighting over- and under-representation) should be summarised and discussed, including being used when interpreting data as well as highlighting related uncertainty; related data should be considered when assessing 'indirectness' in the planned GRADE assessment; should any logic models be developed for the review, theory/evidence regarding the potential impacts of inequities in access, participation, or involvement in interventions should be considered for inclusion in that model

3. Are the impacts of, or responses to, the intervention(s) / exposure(s), or the experiences of the phenomenon, under investigation, expected to differ among specific marginalised, at-risk, socially excluded and/or inclusion health group(s) of people in important or meaningful ways?

This signalling question necessitated a judgement on how confident we are that effects differ, which we considered to be 'Unsure (whether effects differ)' for all groups. This is because known evidence from multiple reviews of the patterning of intervention impacts for different population subgroups (e.g. Hansmann et al, 2022; Medeiros et al, 2021; Tcymbal et al, 2020, Smith et al, 2017), suggested no clearly consistent and reliable differences in impacts. The principal justification for conducting the current review is that we are not currently confident about whether effects differ.

The implication of our response to question 3, after following the corresponding decision tree, is that the review will be reported in accordance with PRISMA-E. In line with this, we intend at outset to conduct and report separate sets of analyses by specified population subgroups and for each of those we intend to consider absolute and relative effects in our analyses (where possible). However, we were unable to identify and justify further more specific actions in line with the decision tree for this signalling question due to the degree of uncertainty both about whether effects differ (which as mentioned is the main justification for the review) and the considerable uncertainty about the methods we will ultimately apply given we know at outset that the included data will be particularly challenging to synthesise.