

Transport, health, and wellbeing: An evidence review for the Department for Transport

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Executive summary

Key findings

This evidence review was conducted to develop an understanding of the current knowledge base on the relationships between transport and health and wellbeing. Key findings include:

- There are three key themes within the wider topic of transport and health: **physical health, mental health and wellbeing, and noise.**
- There are three main mechanisms that link transport and health and wellbeing:
 - **Transport and access:** Transport plays a key role in improving access to health services, particularly for vulnerable groups like older people.
 - **Mode of transport:** Mode of transport affects physical and mental health, via mechanisms including physical activity and commuting time.
 - **Wider effects of transport and infrastructure:** Transport can facilitate social interactions and promote social inclusion.
- **Differences between groups:** Older people, younger people, economically disadvantaged people, and people with disabilities are more likely to experience the negative health impacts of transport, but interventions such as targeted bus services to improve access to healthcare were found to be effective in mitigating negative effects and improving health outcomes.
- Extensive evidence shows that **concessionary travel passes (CTPs) are instrumental in making bus transport more accessible and affordable**, which improves mental health and wellbeing.
- In relation to noise specifically, the evidence shows that policy and planning changes have effectively addressed traffic noise levels which can contribute to stress and lack of sleep.
- **An understanding of civic participation, connectivity, and health and wellbeing in relation to mobility is integral to addressing the wider societal challenges of exclusion and isolation.** Transport allows access to non-healthcare activities that are beneficial for physical and mental health and for social connection and wellbeing, and the reduction of social exclusion.
- **Transport policies can play an integral role in addressing health and wellbeing disparities through a broader, multi-stakeholder approach.** Transport policies cannot, however, effectively address these disparities in isolation. There is increasing recognition of the need to develop a more holistic view of health amongst researchers and policy makers.
- There is an increasing focus amongst researchers and policy makers to address issues on access to health services that account for both physical and mental health issues, as well as combinations of different health conditions. An inter-disciplinary approach could be useful in developing a richer understanding of holistic health and transport in the wider sense.

Background

Transport has an important role to play in meeting government aims to improve health and wellbeing. This report has a broader focus than the already substantive evidence base that illustrates the positive health impacts of active travel. Since the priority of the Department for Transport is to place users at the heart of the transport system, it is essential to develop a solid understanding of the impact that transport has on the mental and physical health of individuals. To date, research about the direct and indirect links between transport, health and wellbeing has been relatively scarce and has not been brought together to create a comprehensive evidence base.

There are many aspects of transport provision that can impact on health:

- transport availability has an effect on the accessibility of health services;
- travel choices can affect physical health in relation to body weight or traffic accidents;
- transport infrastructure can influence wellbeing levels by the extent to which it facilitates social connectedness
- transport noise can cause stress as well as a range of health conditions.
- Furthermore, the impact of transport choices can vary by different socio-demographic factors. For example, car ownership can impact on families differentially according to their level of income, with low income families more likely to be involved in an accident. Capturing different health outcomes between sub-groups is therefore useful for enabling more targeted and effective interventions.¹ Better targeted transport interventions can, in turn, improve health outcomes and reduce health inequalities.

Objective

This evidence review used systematic search, inclusion and synthesis processes to develop an understanding of the current knowledge base on the relationships between transport and health and wellbeing. Active transport (e.g. cycling or walking) also has a role to play in improving public health, but this is beyond the scope of this review as substantive evidence in this area already exists². Work on air pollution was also omitted for this reason.

Findings

There are both positive and negative impacts that transport can have on health and these impacts are experienced differently by different groups in society (see Table 1). There are three key themes within the wider topic of transport and health: **physical health, mental health and wellbeing**, and **noise**.

¹ Sub-groups: This refers to differences between demographic groups.

² Wallace, Rebecca & Green, Samantha & Agarwal, Gina. (2016). Promoting the Health Benefits of Walking and Bicycling to Work: A Qualitative Exploration of the Role of Healthcare Providers in Addressing Barriers to Active Commuting. *Sports and Exercise Medicine - Open Journal*. 2. 24-32. 10.17140/SEMOJ-2-135.

Table 1 Positive and negative effects of transport on physical health

Benefits of well-designed transport policy and infrastructure

Enables access to:
Employment, education, shops, recreation, social support networks, health services, countryside

Access to places for recreational activities, Opportunities to exercise

Negative impacts of poorly designed transport interventions

Inequitable distribution of access to:
Employment, education, shops, recreation, social support networks, health services, countryside

Collisions, Noise, Stress/anxiety, Danger, Loss of land, Community severance*, Pollution, Obesity

***Community severance** refers to limited accessibility of a community caused by transport infrastructure, such as motorways without pedestrian crossings or railway tracks that divide a community in half, or a high volume of traffic. Community severance can lead to increased distances to workplaces and facilities such as schools, parks, shops, leisure centres, and health services.

Physical Health

The studies in this review examine the relationship between transport and physical health in two ways. The first is the effect of transport availability on accessing health services and the second is the relationship between transport use on physical health status.

The evidence suggests that there is a bi-directional relationship between physical health and transport. The mode and frequency of transport used can impact the health status of individuals; for example, car use was found to negatively impact physical health as it is linked to a reduction in physical activity. Conversely, an individual's health can impact their mode choice and their frequency of transport use; those with mobility issues are more likely to experience negative transport impacts, as more active modes may not be suitable. These findings primarily relate to two of the mechanisms discussed above: transport and access, and mode of travel.

- **Transport and access:** Buses are instrumental in access to health services, but there is a lack of evidence examining other modes of public transport.
- **Mode of transport:** Investment in active travel and public transport reduces reliance on the car. Cars can have a positive impact on physical health when they facilitate access to healthy food suppliers and leisure/recreational activities, but cars are more likely to reduce physical activity and therefore have a negative impact. Increased car travel is linked with increased body weight and traffic accidents. Increased use of public transport could mitigate these negative impacts.
- **Differences between groups:** Older people, younger people, economically disadvantaged people, and people with disabilities are particularly vulnerable to the negative health impacts of transport such as noise or pollution. Transport can be particularly effective in improving health, such as through better access to services for these groups.
- **Transport, health and poverty:** Difficulty accessing transport limits access to health services, such as medical appointments. Combined with the findings for differences between groups, this indicates that there is a relationship between transport disadvantage and poverty and the inaccessibility of health services.

Mental Health and Wellbeing

- In exploring the relationship between transport and mental health and wellbeing, studies in this review examined relationships between transport and mental health, isolation and connectedness, and sub-group differences (older people and people with disabilities). There was also a focus on concessionary travel passes and bus transport. The wider effects of transport and infrastructure such as noise or the stress of traffic were found to have particular relevance to mental health and wellbeing.
- **Mental health:** Quality of transport provision affects stress and wellbeing because it affects the quality of the travelling experience. Public transport interventions can positively impact mental health in two ways: alleviating traffic and reducing commuting times. There is also a relationship between physical and mental health, and so interventions to improve physical health may also be beneficial for mental health, for example interventions that reduce road noise can improve sleeplessness and lower blood pressure but they might also have an effect on stress and mental wellbeing.
- **Differences between groups:** As with physical health, transport has been shown to be instrumental in improving mental health for disadvantaged groups. For example:
 - **Older people and people with disabilities:** These two groups can have mobility issues. Transport is a key mechanism in reducing social isolation and increasing connectivity for these groups, which has a positive impact on mental health and wellbeing.
 - **Concessionary travel passes and buses:** The evidence shows that concessionary travel passes are instrumental in making bus transport more accessible and affordable, which improves mental health and wellbeing. This is particularly true for older people and those with disabilities as they experience increased mobility and lower levels of social exclusion as a result.
- **Social connection:** Transport availability, particularly public transport, affects wellbeing because it facilitates social connectedness. A lack of access to transport or a withdrawal of public transport services has been found to reduce social networks and social relationships, as can transport infrastructure if it leads to individuals being disconnected from the community. By contrast, effective transport provision, such as reliable bus links, can help facilitate social interactions and promote social inclusion.

The findings demonstrate that transport plays an important role in maintaining and improving individuals' mental health and wellbeing. Effective transport provision has been found to be vital for accessing services, enabling social interaction, and preventing isolation. In addition, evidence shows that longer journeys and higher levels of traffic negatively impact mental health. By designing roads to facilitate slow traffic, walking, and pleasing aesthetics, transport policies can help to facilitate community support networks, promote physical activity, and create a pleasant living environment that is conducive to good mental health and wellbeing.

Noise

The evidence reviewed on the effects of noise on health typically explore both physical and mental health impacts.

-
- **Physical and mental health:** Evidence shows that transport noise has the primary effects of stress and sleep loss, which in turn are associated with health conditions for which these are risk factors (e.g. heart disease). For example, one meta-analysis found that relative risk of hypertension as a result of exposure to road traffic noise increased by 1.8% per 10 decibels.
 - **Differences between groups:** Risk of noise-related stress and sleeplessness varies between socioeconomic groups. Individuals and families in lower socioeconomic groups may live in housing near busy roads because it is cheaper than housing in quieter areas.
 - **Effects of policy:** Policy and planning change can address traffic noise levels that contribute to stress and lack of sleep. For example, laying porous asphalt road surfaces has been shown to reduce noise by 4-8 decibels.

Although the evidence demonstrates links between transport and health, the review identified limited quantitative evidence on the strength of these links. This suggests that we need better ways to monitor and evaluate transport intervention pilots and policies that look to improve health outcomes, to develop a stronger evidence base.

Conclusion

Government, NGOs and other stakeholders increasingly define health in broader terms to include physical and mental health alongside wellbeing. Transport often impacts more than one of these domains in tandem and noise is an example of an area where physical and mental health effects converge. This review of evidence has highlighted three main mechanisms that link transport and health and wellbeing:

- **Transport and access:** Transport availability affects the accessibility of health services. This has benefits for health budgets, by reducing missed appointments and enabling people to access the care they need when they need it. Transport plays a key role in improving access to health services, particularly for vulnerable groups like older people. For example, a case study of a specialist health facility in Wolverhampton found that **missed appointments dropped by 60%** after the transport and health sectors worked together to introduce a bus service. This led to not only more positive health outcomes for patients but also savings in the health sector.
- **Different modes of travel have different health impacts:** Different modes of transport affect physical and mental health in different ways. This is through mechanisms including physical activity and commuting time.
- **Wider effects of transport and infrastructure:** Transport can facilitate social interactions and promote social inclusion, but the findings highlighted the challenge of improving transport infrastructure without creating or exacerbating community severances³ and reducing social networks. New or adjusted bus services can provide access to employment for those without cars. For example, among job candidates for out-of-town employer in South Yorkshire, **over 75% did not drive or own a car** following such a change.

An understanding of civic participation, connectivity, and health and wellbeing in relation to mobility is integral to addressing the wider societal challenges of

³ Community severance refers to limited accessibility of a community caused by transport infrastructure, such as motorways without pedestrian crossings or railway tracks that divide a community in half, or a high volume of traffic. Community severance can lead to increased distances to workplaces and facilities such as schools, parks, shops, leisure centres, and health services.

exclusion and isolation. Transport allows access to non-healthcare activities that are beneficial for physical and mental health and for social connection and wellbeing, and the reduction of social exclusion.

Transport policies can play an integral role in addressing health and wellbeing disparities through a broader, multi-stakeholder approach. Transport policies cannot, however, effectively address these disparities in isolation. In line with this, there is increasing recognition of the need to develop a more holistic view of health amongst researchers and policy makers. There is a growing emphasis on providing health services that address both physical and mental health issues and combinations of different health conditions. An inter-disciplinary approach could be useful in developing a richer understanding of holistic health and transport in the wider sense.

The negative impacts of transport affect poorer, more vulnerable groups more. Equally, they are most in need of public transport to access healthcare and social networks. Older people, younger people, economically disadvantaged people, and people with disabilities are more likely to be disadvantaged regarding transport. This is because these groups are less likely to experience the health benefits from transport policy, such as road improvements for car users, and more likely to experience of the negative health impacts of transport and less effective mitigation, for example being exposed to increased noise and air pollution. More research is required to explore what greater support can be offered to these groups to increase their likelihood of experiencing the benefits that the transport system can offer.

In terms of further evidence gaps, this review of available literature identified:

- Limited quantitative evidence on the strength of links between transport, health and wellbeing. Better ways to monitor and evaluate transport intervention pilots and policies are needed that look to improve health outcomes, to develop a stronger evidence base.
- A need for more evidence on the strength of causal links, for example noise, stress and stress-related diseases.
- Limited evidence on how health and social care providers carry out their work and reach the people that may need it the most.
- There is substantial evidence about the health, wellbeing and transport links for older people, but less evidence on differences by age and gender, ethnicity, or socio-economic background.
- There was nothing explicitly focused on loneliness in the evidence reviewed here, however we anticipate that this will be a key area for future research.

1 Introduction

To date, transport research has been largely focused on objective factors such as length of journey or physical access to transport. In 2016 alone in Great Britain, 801 billion passenger kilometres were made on all modes of transport and in 2016/17 6,945 million trips were made on public transport modes only (Department for Transport 2017a). However, there are many ways in which transport can have an impact on people's lives, as transport choices are essential to a wide range of activities undertaken by individuals on a daily basis. Besides providing access to services and opportunities, transport has an important role to play in supporting or hindering social connections. Furthermore, transport has a multifaceted impact on social exclusion, which in turn influences health. This is an issue of equity: usually populations with limited access to transport services are those most affected by health inequalities (Mackett and Thoreau 2015).

1.1 Transport and health in the UK

Currently, the UK is facing several public health problems, such as growing rates of obesity, diabetes, and heart disease. These are all conditions linked to physical inactivity, and transport infrastructure interventions could play a role in encouraging people to be active. Transport interventions therefore have the potential to mitigate health problems borne out of inactivity, and in turn reduce health inequalities (Public Health England 2014). Active transport (e.g. cycling or walking) also has a role to play in improving public health, but this is beyond the scope of this review as a strong body of evidence in this area already exists. Work on air pollution was also omitted for this reason.

In addition to the physical health problems listed above, there has been an increase in issues relating to people's wellbeing, such as loneliness. It is estimated that up to 18% of all UK adults feel lonely most or all of the time (HM Government 2018: 8). Since transport plays an important role in supporting individuals' relationships, the Department for Transport is involved in a cross-government group working to tackle persistent loneliness as part of the Loneliness Strategy. This group aims to better understand how loneliness manifests and the role of social connections. As part of the Inclusive Transport Strategy, the Department for Transport is working in tandem with seven mobility centres in England to help them identify signs of loneliness or lack of social connections (HM Government 2018: 28).

1.2 The impact of transport on health and wellbeing

When referring to **health**, we use the definition provided by the World Health Organization (1948): "a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity." When discussing **wellbeing**, we refer to the emotional and psychological state as well as the ability to function socially, cope well with difficulties, develop potential, work productively and creatively, build strong and positive relationships with others and contribute to the community (Government Office for Science 2008). The report will provide insights on the multi-

faceted links between transport, health and wellbeing, also illuminating the various mechanisms through which transport can contribute to health inequality.

There is a clear link between transport and physical health. For example, transport plays a key role in facilitating people's access to health services such as GP surgeries, hospitals or dentist surgeries. This is particularly important for older people and disabled people, especially those living in rural areas, as public transport may be their only link with medical services. Poor transport links could therefore constrain people from accessing the services and support that they need. In addition, transport allows medical professionals to access their work places or visit their patients, including emergency services' workers such as paramedics to access people in life threatening situations. There are also direct links between active travel and air quality, but they are outside the scope of this review.

Transport has an impact on people's mental health and wellbeing. It allows people to connect and maintain relationships with others, access work opportunities, education or leisure activities outside their homes, and to be more autonomous. It enables older people to keep active lifestyles and be involved in their communities. Furthermore, it has been shown that shorter travel times improve wellbeing, while commutes lasting between 60 and 90 minutes have the biggest negative impact on wellbeing (Office for National Statistics 2014).

The impact of transport on wellbeing is also connected to the impact of transport on inequality. The literature on transport and inequality is addressed in detail in a separate report (Gates et al. 2019), but there are important aspects of the research presented in that report that inform this review. Relevant findings are highlighted throughout and are covered directly in the 'Discussion' section of this report.

1.3 Policy and intervention – a holistic approach

Currently, the DfT are involved in a number of interventions and policies addressing issues such as loneliness, ageing, accessibility for disabled people and understanding travellers' choices. Through their involvement in the Loneliness Strategy, the DfT are contributing to tackling persistent loneliness in the UK's population. Furthermore, DfT is concerned with the ageing of the UK's population and are making efforts to ensure that transport meets the evolving needs of older citizens.

To guarantee equal access to all modes of transport for disabled people, the DfT have developed the Inclusive Transport Strategy, which sets out key actions that need to be taken, providing a clear delivery monitoring and evaluation plan as well as a new governance accountability framework. Finally, DfT's priority to put users at the heart of the transport system is concerned with developing further understanding of the choices and decisions people make in terms of transport behaviours, and the impact these have on their lives. To develop targeted and accurate interventions that would help address these complex matters, the evidence base has to be expanded and comprehensively integrated to capture the overlap between transport disadvantage and health inequalities.

1.4 Purpose of the review

There has been relatively little focus so far on researching the impact of transport on health and wellbeing. Since there is a clear link between transport, health, and wellbeing, it is essential to fill the knowledge gap and create a solid evidence base. This research report will review and assess recent available evidence related to the relationship between transport, health, and wellbeing. It is hoped that the information provided in this report will enable:

- the development of further accurate and effective interventions;
- more informed policy decisions that can positively impact people's lives; and
- an evidence base to inform government in their aims of supporting the improvement of health and wellbeing in the UK.

2 Study objectives

The objectives of this research are to:

- Provide evidence of the links between transport and health and wellbeing; the different channels of impact (including whether they are direct or indirect); and evidence on the scale of those links.
- Produce high-level summary evidence of the impact of transport policies on health and wellbeing.
- Contribute to the evidence base that can inform the Department's policies and approach to the spending review as well as future decisions on social policy – including on loneliness and the Future of Mobility.

To achieve these objectives, this report will address the following **research questions**:

1. In what ways are transport and health and wellbeing linked?
 - a. What are the mechanisms by which transport impacts on health and wellbeing, and vice versa?
 - b. What does the evidence say on the strength of those links?
 - c. How does this vary across sub-groups (including, but not limited to age, income and urban-rural groups)?
2. What do we know about transport policies' effectiveness in improving health and wellbeing?
 - a. How does this vary across sub-groups?

3 Methodology

3.1 Overview

This review adapts the methodology and structure of a Rapid Evidence Assessment (REA).⁴ Our criteria and processes for determining inclusion of evidence, extracting data, and synthesising findings are summarised below. Both published and unpublished (grey) literature were considered for inclusion. See Appendix A for a comprehensive description of our methodology.

3.2 Inclusion criteria

To be included, studies had to meet the topic, study methodology, setting, language, and date criteria outlined below.

Studies had to address one of the following associations:

Transport use and/or access <i>and</i> :	1. Mental health
	2. Stress/anxiety/wellbeing
	3. To health services
	4. Access for disabled people
	5. Phobias, noise, traffic
	6. Isolation/loneliness/connectedness
	7. Access for care workers and health care professionals
	8. Physical health

The aim of this review is to provide evidence on the links between transport and health and wellbeing. This includes understanding the mechanisms by which transport impacts upon physical and mental health alongside examining the interplay between transport, objective and subjective measures of wellbeing, and disadvantage. Additionally, there is interest in how these mechanisms vary across sub-groups such as: gender, age, income, ethnicity, and urban-rural groups.

The papers that were eligible for inclusion were those that covered topics most relevant to the research questions being addressed. Studies that addressed multiple research questions were valued more highly. There is a long-standing tradition of conducting high quality reviews in the health sciences, and so focussing on review papers was deemed an efficient way to capture and evaluate more evidence. This approach also lends itself to a rapid review process such as this one. For these reasons, primary research was not included. The most relevant study designs for addressing the research questions were considered to be those that had more rigorous methods such as evidence reviews, meta-analyses, rapid evidence assessments, and other evidence syntheses.

⁴ "A Rapid Evidence Assessment (REA) is a tool for getting on top of the available research evidence on a policy issue, as comprehensively as possible, within the constraints of a given timetable." Government Social Research Service.

In terms of transport criterion, studies had to include data on the following modes of public or private land transport: cars, buses, trains, trams, and taxis (walking, cycling, and air transport were excluded). Finally, additional criteria were that included studies had to be published in English from 2008 onwards and have used data collected on individuals or interventions in Western Europe, North America and/or Australasia.

3.3 Search strategy

A systematic search of relevant databases and websites/online repositories was undertaken with a search string that was developed with independent expert, John Evers. In addition to results gathered from databases, we also searched websites such as Sustrans and the Transport Studies Research Group. Individual experts were contacted to solicit potentially relevant studies. Policy experts within NatCen were asked to contribute articles and studies that were within the remit of relevant topics. We also screened a limited number of search hits in Google and Google Scholar using a truncated version of our search string. Backwards citation tracking was conducted on screened articles, to find more relevant studies.

Lists of databases and websites/online repositories that were searched are provided in Appendix B and Appendix C respectively. We also set out an example of our full search string for database searches in Appendix C.

3.4 Screening and study prioritisation

Screening took place at two levels: (1) title and abstract and (2) full text. Screening tools were developed and piloted by more than one reviewer in the research team to promote inter-screener reliability. Abstrackr⁵ software was used to screen database results at the title and abstract level.

Due to the rapid nature of this review, the number of studies included for synthesis was limited to 30. To determine which studies to include in the review, a prioritisation heuristic was developed. Studies were prioritised for inclusion if they: (1) covered more than one association between transport and health and/or wellbeing; (2) included analyses of how axes such as age, gender, and ethnicity mediate these relationships; (3) were more recently published; and (4) presented UK data. The 30 studies that scored highest on this heuristic were included in the review (see Appendix A for more detail).

3.5 Data extraction and synthesis

Data extraction and synthesis tools were piloted before use, after which data extraction was undertaken by a single researcher with key aspects double-coded by a senior researcher. Data included basic descriptive information relating to included studies, as well as any findings relevant to the review's research questions. Appendix D provides an overview of our data extraction template. Following data extraction, we narratively synthesised the 30 prioritised studies. Evidence is reported separately by topic and

⁵ Abstrackr is software that uses machine learning to semi-automate citation screening by prioritising more relevant results. See Gates et al. (2018) for more detail about use and reliability of the software.

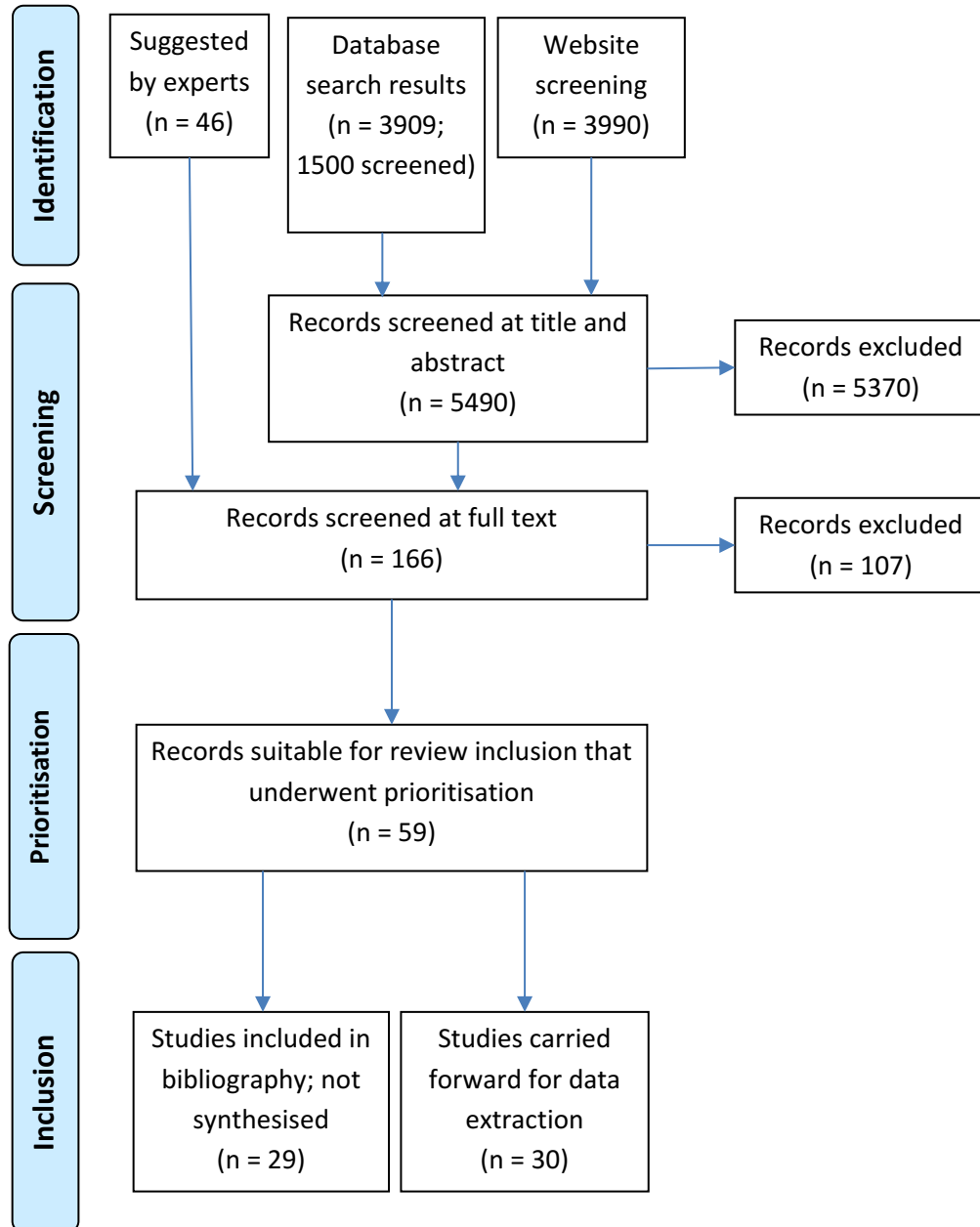
sub-topic and summarised in tables of characteristics presented in Appendix G. See Appendix A for greater detail on the data extraction and synthesis process.

4 Results

4.1 Screening, prioritisation, and inclusion

The flowchart (Figure 4.1) summarises the screening and inclusion processes.

Figure 4.1 Evidence review screening, prioritisation and inclusion process



We sourced documents from database searches, websites of organisations and research groups working on transport policy, recommendations from experts within and outside NatCen, and citation tracking of selected included papers. Screening for eligibility

was in two stages (title and abstract, followed by full text) for documents from all sources except those recommended by experts, which were only screened at full text. Where documents did not have an abstract, an appropriate summary of the document contents was screened. We searched 20 websites, yielding 65 documents for full text screening of which 21 were eligible for inclusion. In addition, 46 documents that were suggested by experts were also screened, of which 24 were eligible.

Searching the Medline and Scopus databases returned 3,909 unique results. Of these, 1,500 title and abstracts were screened using Abstrackr software, which uses machine learning to prioritise screening, presenting the reviewer with results like those they have already selected for full text screening. Of these 1,500, 55 were included for full text screening and nine were eligible. There were several documents that would otherwise have been eligible that had already been included through the website search and expert suggestions.

During the full text screening stage, reviewers identified documents for which citation tracking seemed likely to yield further eligible papers. From citation tracking of these documents, 16 further documents were screened of which six were eligible.

In total, 166 documents met the criteria for full text screening, and 59 of these met the criteria for inclusion in the review.⁶ In keeping with the need for an efficient process, and reflecting the protocol, two reviewers then conducted a quality appraisal and prioritisation exercise. This involved assigning scores to these 59 documents based on coverage of topics across the research questions. The top-scoring 30 of these, plus any with the same score as the 30th paper, were prioritised for data extraction and inclusion in the final review, a total of 30 documents.⁷

The remaining documents that met the inclusion criteria but were not synthesised are listed in Appendix F. Tables of characteristics summarising the location, methodology and summary from studies included for synthesis are provided in Appendix G.

4.2 Included studies: overview

In line with the rapid nature of this review, 30 of 59 eligible studies were included for synthesis. Therefore, the analysis of the results presented here, and the subsequent findings apply only to the 30 studies included for synthesis. The prioritisation was carried out using scoring criteria. Researchers prioritised review studies that contained at least one quantitative estimate related to the associations listed in.

In the 30 studies prioritised for synthesis 18 reviews focused on evidence from the UK only and 12 with an international focus which included data from the UK and Europe. Of the 30 studies, 3 studies were systematic reviews with meta-analysis and 2 were systematic reviews. There were 19 literature reviews, 1 narrative review, 1 REA and 4 other types of synthesis.

⁶ From each source, the total number of documents eligible for inclusion was 60 (21 from websites + 24 from experts + 9 from databases + 6 from citation tracking). However, there was one duplicate, and therefore, 59 distinct studies were eligible for inclusion.

⁷ Where a document was found during data extraction to not in fact be eligible, the next-highest scoring paper in the list was included.

Although the prioritisation process was intended to ensure that evidence for all of the above categories was synthesised by the evidence review, some categories are better evidenced than others. In part, this reflects the fact that the categories themselves are not equal in size – for example, transport use / access and isolation, loneliness, or connectedness covers a larger number of review topics than the other categories. However, this is also a reflection of the pattern of available evidence, with some topics better evidenced than others. Overall, there were more included reviews covering transport's direct impact on wellbeing and isolation, loneliness, or connectedness (combined number taken forward for synthesis = 15). This was followed by transport use and access to health services (n=8), and reviews concerning noise and health (n=9), disability (n=5), and mental health (n=2).⁸

For a number of topics, we were unable to find any includable studies among the prioritised studies for synthesis. Nothing was found on access to workplaces and patients for social care and health workers, or transport and work access for care workers. There were also minimal studies on personal safety, fear, and anxiety.

Given the rapid nature of this evidence assessment and the need to focus on a limited sub-section of the included evidence base for synthesis, we cannot conclude that there is no relevant evidence for these categories. However, it could indicate that there is unlikely to be a substantial number of relevant studies. Future studies could explore some of the intervention types listed above.

4.3 Limitations in the review process

This research project adapted a Rapid Evidence Assessment (REA) methodology that was designed to efficiently locate and synthesise a body of relevant literature. Only a proportion of all hits returned from our search of academic databases were screened. Inclusion decisions at title and abstract were undertaken by only a single reviewer. Therefore, it is possible that some relevant studies may have been missed. Due to the need for an efficient review process, it was only possible to synthesise a proportion of the most relevant studies meeting the inclusion criteria. Studies were prioritised for synthesis based on relevance (see section on methodology and appendices). The findings section and review conclusions are therefore based on a proportion of all includable studies and do not comprehensively summarise all relevant evidence. Neither qualitative or quantitative primary studies were included. The focus was solely on reviews in order to increase the amount of evidence included in this review. A full list of studies meeting inclusion criteria but not synthesised is provided in Appendix F.

⁸ Some reviews covered multiple outcome topics so the numbers listed equate to more than the 30 papers included as some were counted more than once.

5 Findings

This section describes the key findings of this report. As noted in Section 3, the report aims to answer the following research questions:

1. In what ways are transport and health and wellbeing linked?
 - a. What are the mechanisms by which transport impacts on health and wellbeing, and vice versa?
 - b. What does the evidence say on the strength of those links?
 - c. How does this vary across sub-groups (including, but not limited to age, income and urban-rural groups)?
2. What do we know about transport policies' effectiveness in improving health and wellbeing?
 - a. How does this vary across sub-groups?

To answer these questions, the findings are presented in three sections: physical health, mental health, and noise. Noise is presented in a separate section because there is a high degree of overlap in the effects of noise on physical and mental health.

5.1 Physical health

The studies in this review examine the relationship between transport and physical health primarily in two ways. The first is the effect of transport availability on accessing health services, such as medical appointments and rehabilitation services. The second is the relationship between transport use on physical health status, such as the increased risk of cardiovascular disease due to transport-related stress. There is a range of evidence examining different sub-groups, but less that clearly explores the effect of different modes of transport on physical health (although this will be drawn out where possible).

In total, ten studies evaluating the relationship between transport and physical health are included in the review for synthesis. Most of these studies examine the relationship between transport use and physical health in general, but three studies specifically explore the impact of transport accessibility on health and access to health services.

5.1.1 Transport use and physical health

The reviews in this section looked at the direct and indirect impacts that transport can have on physical health. They illuminate a range of findings, including positive and negative impacts on health and some variations for sub-groups including children and older people.

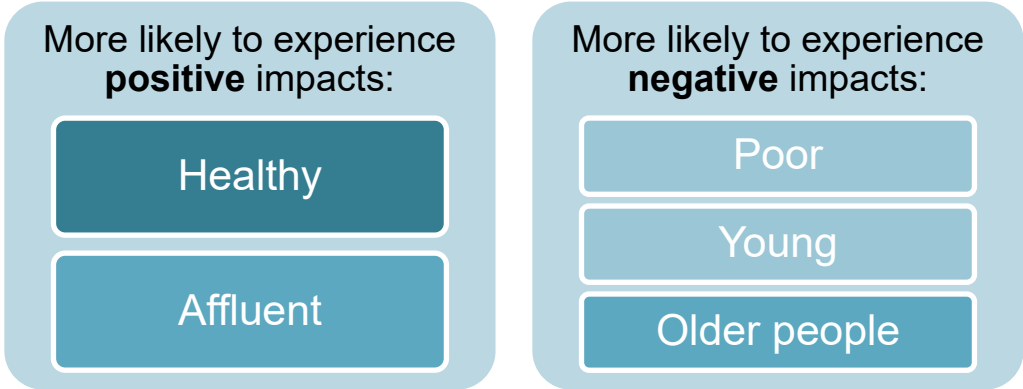
In a literature review, Mindell and colleagues (2011b) investigated the positive and negative effects that transport can have on health. On the whole, they found more impacts that are **health damaging rather than health promoting**. Positive benefits include improving access to employment and education opportunities, as well as recreation and exercise, which leads to better health outcomes. However, transport can be health damaging when there is inequitable access to health services, for example, as well as health consequences due to accidents, noise, and air pollution.

Table 5.1 Positive and negative effects of transport on physical health
<p>Benefits of well-designed transport policy and infrastructure</p> <p>Enables access to: Employment, education, shops, recreation, social support networks, health services, countryside</p> <p>Access to places for recreational activities, Opportunities to exercise</p>
<p>Negative impacts of poorly designed transport interventions</p> <p>Inequitable distribution of access to: Employment, education, shops, recreation, social support networks, health services, countryside</p> <p>Collisions, Noise, Stress/anxiety, Danger, Loss of land, Community severance, Pollution</p>

Source: Table adapted from Mindell et al. 2011b

After reviewing the positive and negative impacts transport can have on health, Mindell and colleagues concluded that the impacts are experienced differently by different groups in society. For example, they highlighted that although unskilled manual workers are less likely than professionals to own a car, they were three times as likely to die in a road crash (Mindell et al. 2011b: 581). In general, healthy and affluent groups are more likely to experience positive impacts whereas those on lower incomes, young, and older people are more likely to experience negative impacts. This relationship is summarised in Figure 5.1.

Figure 5.1 Effects of transport on physical health by sub-group

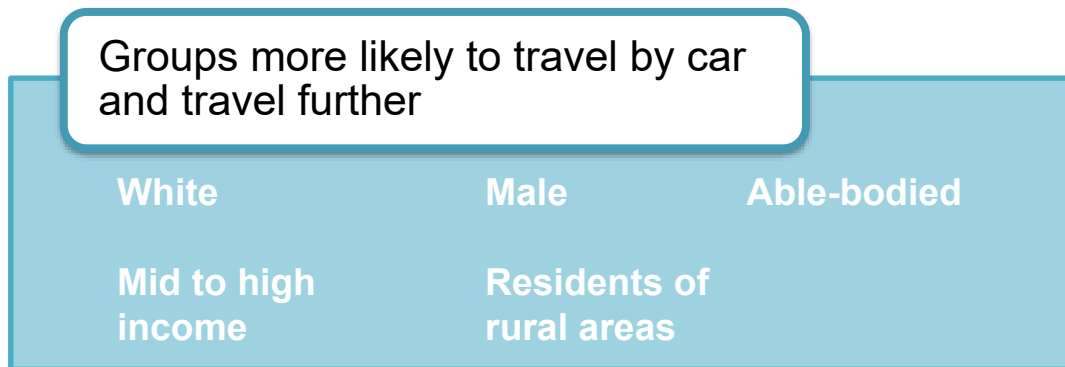


Source: Authors' own

Shedding more light on variation by sub-group, Mackett's (2014b) literature review examined the impact of transport inequality on health, with a focus on access to private motor vehicles. The author's findings were both general and relating to sub-groups. For example, car ownership was found to have both positive and negative effects on health status. On the one hand, car ownership can have a positive impact on health status by enabling people to access leisure facilities or healthy food providers more easily than they would be able to through public transport. However, on the other hand, car ownership can have a negative impact on health if it leads to road traffic accidents. Being concerned with health and transport inequality, the review highlighted that certain sub-groups were more likely to experience positive impacts of transport on

health. The sub-groups that were examined are different income groups, ethnicity, gender, rurality, and disability. The findings indicated that certain groups were more likely to travel by car and travel the furthest distance on average each year. Summarised in Figure 5.2, this includes those who are: white, male, able-bodied, middle to high income individuals, and individuals living in rural areas. These groups therefore have access to more opportunities that benefit their physical health. Relatedly, Mackett highlighted that car ownership has been shown to be a better predictor of health than income.

Figure 5.2 An example of transport inequality



A second literature review by Mackett (2012) highlighted one of the negative impacts of transport on physical health by focusing on another sub-group: **children**. By exploring the nature of children's travel behaviour, Mackett demonstrated how increased car use can have an adverse effect on children's physical health. This is because a greater reliance on car-use has contributed to a reduction in the amount of physical activity children engage in. Although in theory greater reliance on cars could mean more access to different physical activities, because children are reliant on adults for transport, car use actually has adverse effects on their physical health. Although not a focus of the current review, Mackett's findings illuminated how engaging in active travel is a key component in children's physical health: more car use means less active travel for children, and there is an overall positive relationship between the time children spent walking and cycling and the proportion of the day spent in moderate to vigorous physical activities.

As part of a review on the relationship between health and transport, Mindell and colleagues (2014) described the impact of transport on the health and wellbeing of **older people**. The authors found that functional impairments and other medical problems that generally increase with age, such as poor vision, can affect an individual's ability to drive: about 10-15% of older adults are presumed to be at risk. Being unable to drive or use public transport can lead to a loss of independence and a decline into dependency. In addition to the findings on older people, Mindell and colleagues' review also discussed a range of negative impacts of transport on health, and vice versa. For example, they noted that stress-related diseases such as cardiovascular disease may be exacerbated by transport, but also that heart diseases such as acute coronary syndrome can restrict your ability to drive.

McCormack and Virk (2014) conducted a systematized literature review on whether the reliance on private motor vehicles for transport is a contributor to obesity levels in the

adult population. The authors included studies that explored the association between time and distance travelled in a private motor vehicle and weight. Amongst the ten included studies, eight found a significant positive association indicating that the more time and distance travelled in private motor vehicles the more an individual is likely to weigh. A meta-analysis was not possible due to the heterogeneity of the study designs, but the authors nonetheless found the consistency of significant results across studies to indicate a real association.

Most of the reviews examine the impacts of transport on health, but some considered the link between transport and health in both directions. The mechanisms by which health impacts on transport were explored in a systematic review conducted by Wesselhoff and colleagues (2018), where they reviewed the effect that physical health status can have on transport use. In particular, they examined **community mobility**, which is the ability to move around the community using public or private transport. The review investigated the extent to which chronic stroke survivors – those who suffered a stroke three or more months prior – achieved community mobility when compared with individuals with similar ages who were not neurologically impaired. They found that the community mobility scores of stroke survivors are 30 to 83 percent lower than non-neurologically impaired individuals, indicating that stroke survivors travel significantly less than those who are not neurologically impaired.

Finally, there is further evidence to suggest car use has a negative impact on health, but that **multi-mode journeys can have a positive impact**, as they lead to different levels of physical activity. Cohen and colleagues (2014) found that increased use of car has led to a decrease in physical activity, largely because cars are used for journeys that used to involve walking. This has negative effects on a range of physical health characteristics, such as an increased risk of heart disease or chronic diseases like osteoporosis. However, when public transport is used, there is an increase in physical activity, and individuals are more likely meet the UK government recommendations for physical activity.⁹ This is because it is more likely to be multi-mode, incorporating active travel at the beginning and end of the journey as a way of accessing public transport.

5.1.2 Transport accessibility and access to health services

Three reviews discussed the direct positive impact of more affordable and accessible transport on the use of health services, particularly for older people and disabled people. This in turn can lead to more positive health outcomes. There are also some connections between transport, health, and inequality that emerge.

A literature review by the Urban Transport Group (pteg 2014) explored cross-sector impacts of bus use, including the health sector. As a significant proportion of people in the UK do not have access to private transport, the bus may be their only means for travelling to health services. Indeed, the report noted that 44% of people who do not own a car find it difficult to access health services. This is particularly true for older people and disabled people who have lower levels of access to private transport. The report found two key benefits of improving bus services: minimising hospital admissions, and minimising missed appointments. For example, better bus access improves wellbeing and increases the likelihood of vulnerable people keeping healthy.

⁹ The UK government recommends that “adults should aim to be active daily. Over a week, activity should add up to at least 150 minutes (2½ hours) of moderate intensity activity in bouts of 10 minutes or more – one way to approach this is to do 30 minutes on at least 5 days a week.” (Department for Health 2011: 32)

Furthermore, a case study of a specialist health facility in Wolverhampton found that missed appointments dropped by 60% after the transport and health sectors worked together to introduce a bus service. This leads to not only better health outcomes for patients but savings in the health sector too.

Mackett (2014a) also reviewed the impact of bus use on access to health services, focusing on concessionary travel passes (CTPs). CTPs provide discounted or free travel, and in Britain CTPs are offered for bus services to pensioners and some disabled people. The review found that CTPs impact the health of older and disabled people in particular. Not only do CTPs improve health through better access to health facilities, but they also improve wellbeing by offering more opportunities for social interaction (this will be revisited in Section 5.2.3 below). Without a CTP, it is unclear how pass holders would be able to afford travel and access medical services. Finally, while there was evidence to suggest that CTPs facilitated greater participation in physical activity amongst older people, the findings in this area were inconsistent.

Social exclusion, transport and health

- The theory of social exclusion suggests there is a relationship between transport disadvantage, transport poverty, inaccessibility to services, and ill-health.
- The value of this perspective is that it highlights not only the inaccessibility of transport to certain groups but also the consequence of this in terms of the inability to access life-enhancing opportunities, including health networks.

Lucas (2012)

In a literature review examining social exclusion, Lucas (2012) conducted a literature review demonstrating how the concept of **social exclusion** can and should inform research on **transport disadvantage**. Although the review does not focus on health, the findings have important implications for access to health services. Lucas notes that public transport improvements in deprived areas have delivered significant improvements in bus use and travel uptake, leading to an increase in healthcare visits. In addition, the review highlights an important connection between transport, health, and inequality. Lucas (2012) shows that access to health services are a dynamic of social exclusion, and so it is possible that when transport improvements enable better access to health services, then this can play a role in mitigating social exclusion. This relationship is depicted below in Figure 5.3.

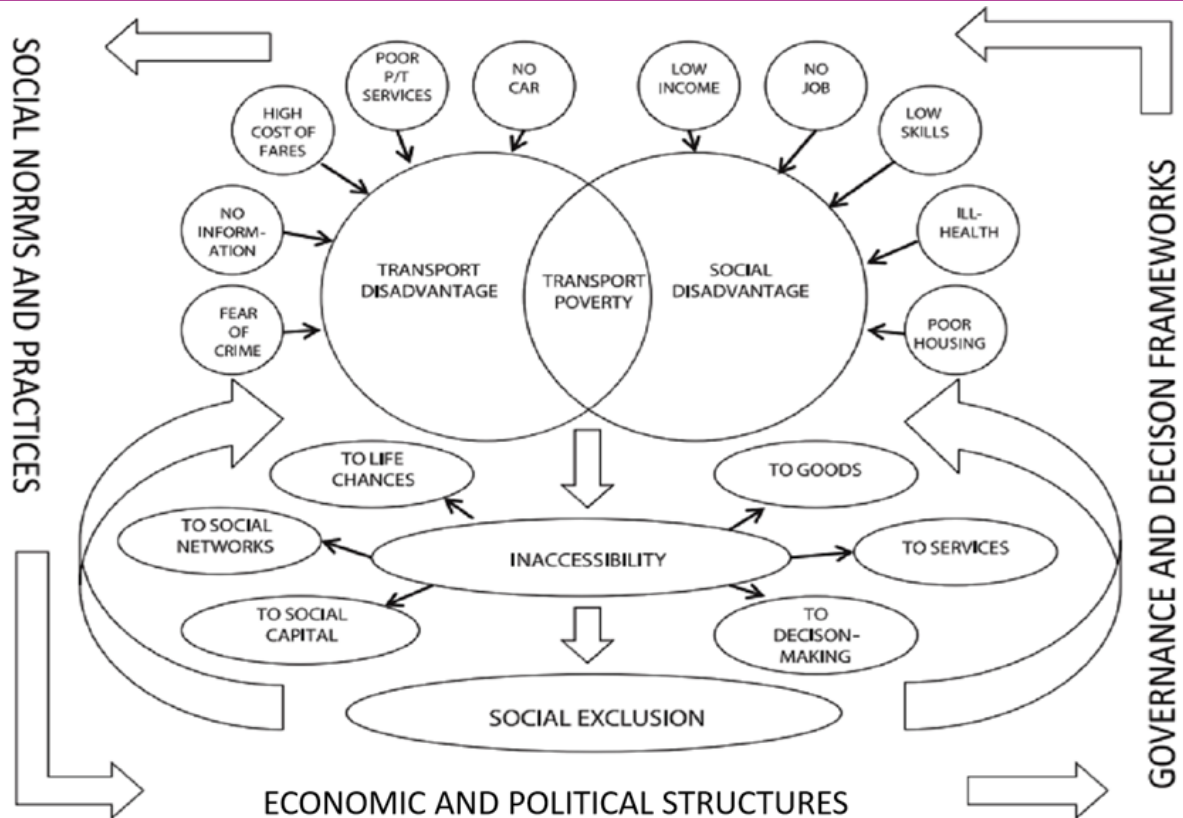
5.1.3 Summary

The findings presented in this section are complex. First, transport can have both positive and negative impacts on physical health. In addition, there is a bi-directional relationship between physical health and transport, in that the mode and frequency of transport used can impact the health status of individuals while the health status of an individual can also impact the mode and frequency of transport use. Finally, there is variation by sub-group, such that certain groups are more likely to be impacted negatively by transport.

Key findings include:

- **Access to health services:** Buses seem particularly instrumental in access to health services: when bus services are easily accessible, particularly through the

Figure 5.3 Diagram to illustrate the relationship between transport disadvantage, social disadvantage and social exclusion



Source: Lucas (2012) – reproduced with permission

provision of concessionary bus passes, access and use of health services and facilities, is higher (e.g. Mackett 2014a). While it might be concluded that buses are the best mode of transport for improving access, it is also possible that there is simply a lack of evidence (in this review and possibly in the wider literature) for modes of transport other than buses.

- **Access to health-related or physical activities:** Cars can have a positive impact on physical health when they facilitate access to healthy food suppliers and leisure/recreational activities. However, they are more commonly found to have a negative impact in that they tend to reduce overall levels of physical activity for both adults and children.
- **Variation by sub-groups:** Older people, younger people, economically disadvantaged people, and people with disabilities are more likely to see negative impacts of transport. It is possible that other sub-groups are negatively impacted too, such as ethnic minorities or different genders, but no findings discussed these groups of people.

- **Transport, health, and poverty:** Difficulty accessing transport limits access to health services, such as medical appointments (Lucas 2012, pteg 2014, Mackett 2014a). Combined with the findings for subgroups, this indicates that there is a relationship between transport disadvantage and poverty and the inaccessibility of health services. The links between transport, health, and inequality will be returned to throughout the review where relevant, and in more detail in Section 6.3.

5.2 Mental health and wellbeing

This section presents reviews that examine the relationship between transport and mental health and wellbeing, some of which also had findings on physical health above. The sections that follow examine relationships between transport and mental health, isolation and connectedness, and older people and people with disabilities respectively.

5.2.1 Mental health

Four reviews presented findings on mental health, each demonstrating different ways in which transport can impact mental health including increased stress levels from commuter traffic and isolation due to lack of transport.

Mindell and colleagues (2014) looked at the associations between transport and mental health. They found that some mental illnesses may prevent the use of transport because of fear of travel or restrictions on the use of vehicles. For example, those with agoraphobia (a fear of entering open or crowded spaces) may need to travel with a companion and may otherwise restrict their travel. They also found that a lack of transport leads to feelings of **isolation**. Individuals who suffered isolation due to transport were three times as likely to have a GHQ score (general health questionnaire score, which measures minor psychiatric health conditions) which indicated a risk of depression.

In a review of literature Cohen and colleagues (2014) investigated the health effects of transport planning. The review found that transport can impact mental health, specifically **stress**. By designing roads to facilitate slow traffic, walking, and pleasing aesthetics, transport policies can help to facilitate community support networks, promote physical activity, and create a pleasant living environment that is conducive to good mental health and wellbeing, both leading to lower levels of stress.

A literature review and content analysis of long-range transport plans by Lee and Sener (2016) investigated the association between transport and quality of life. The authors reported that long commute times have a negative impact on mental wellbeing, as they can cause high levels of stress and for many are a primary source of life stress. This is particularly true for motor vehicle commuters who report higher levels of commuter stress compared to train commuters. The authors highlighted **the relationship between physical activity and mental wellbeing**; physically active forms of transport (e.g., walking or cycling) can have mental health benefits, such as lower levels of depression or stress.

Geurs and colleagues (2008) conducted a synthesis of literature to create a theoretical framework that describes the relationship between the social impacts of transport. The authors found that as well as its physical benefits, the promotion of walking and cycling is a public health goal as it reduces stress. In addition, they reported that there is an

intrinsic value of travel because it fills the psychological needs of curiosity and information seeking. However, they also find that traffic can have an impact on psychosocial wellbeing of individuals if high main road density and exposure to traffic causes stress and depressive symptoms.

5.2.2 Isolation and connectedness

Following the launch of the Jo Cox Commission on Loneliness in 2017, there has been increasing interest in the ways in which we can reduce loneliness in the United Kingdom. Although none of the reviews returned in the current search addressed loneliness directly, many related transport effects were discussed, including connectedness, isolation, and social exclusion. In addition, the findings in this section, particularly regarding social exclusion, are where the links between transport, health and wellbeing, and inequality more fully emerge (see Section 6.3 for discussion).

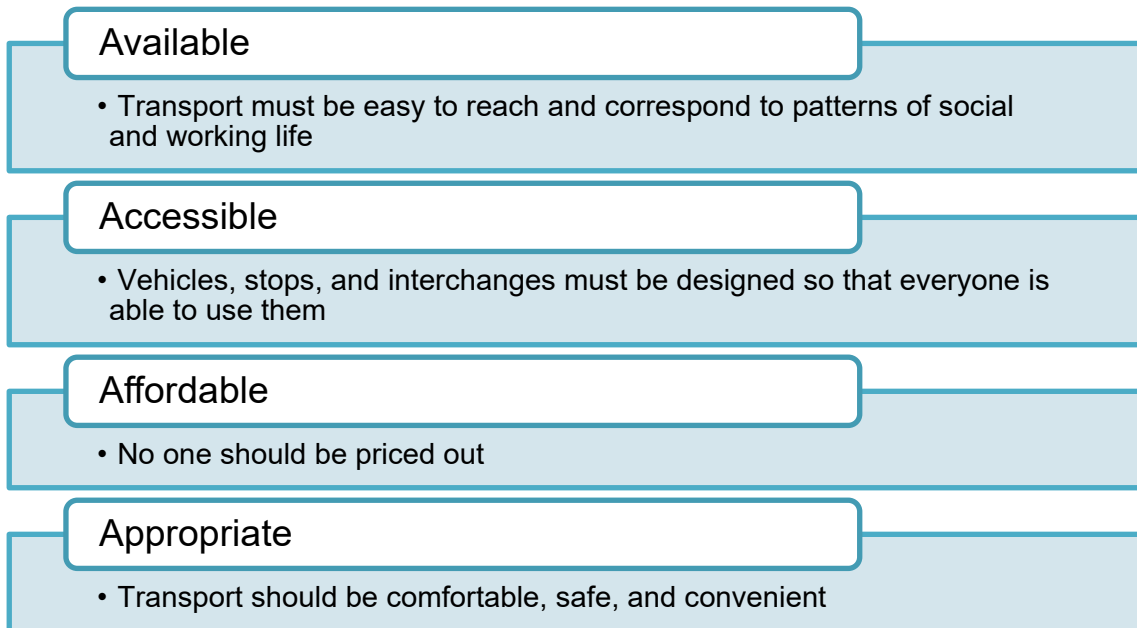
In their review of transport and wellbeing, Reardon and Abdallah (2013: 641) noted that “being part of a social group and having the ability to take part in wider community activity are strong determinants of wellbeing.” Their review is discussed below, but this quote is an indication that transport can be an important facilitator or barrier to accessing the community. Consequently, transport can have both positive and negative impacts on feelings of **isolation** and **connectedness**, and relatedly social exclusion and wellbeing. The discussion that follows examines these impacts in more detail.

A literature review by the Urban Transport Group (pteg 2010), reviewed how transport is used to, and how it can better, promote social inclusion. The review argued that in order for public transport to promote social inclusion there are four key factors: it must be **available**, **accessible**, **affordable**, and **appropriate** (see Figure 5.4 below). When public transport does not meet these criteria, it can leave individuals and groups stranded and cut off from opportunities, making them vulnerable to social exclusion. The review explained that people without a car, people on low-incomes, people living on isolated housing estates or in deprived areas, people with physical or sensory impairments, older people, children and young people, and people living in remote areas are most at risk for being socially excluded due to a lack of access to public transport.

It is not enough for transport to be available and affordable. In order to positively impact health outcomes, it must also be accessible so that everyone can use them, and appropriate (convenient, comfortable, and safe).

The importance of transport for connectedness was also highlighted by pteg’s (2011) evidence review. In particular, they described how free off-peak travel is vital to older and vulnerable people’s independence, allowing them to leave home and see other people. Providing access to out-of-home activities is one of the ways De Vos identifies by which travel can affect wellbeing (2018). Poor travel accessibility therefore carries a risk of social isolation, with negative effects for wellbeing.

Figure 5.4 Four key factors in transport promoting social inclusion



Source: Authors, informed by pteg (2010)

In a systematic review of 51 studies, Bagnall and colleagues (2018) reviewed interventions that improve or create the community infrastructure that impacts on social relations, community wellbeing, and individual wellbeing. Bagnall and colleagues defined community infrastructure as: public places designed for people to meet (e.g. squares, play areas, village halls); places where people meet informally (e.g. cafes, libraries); and services that improve access to these places. These services include transport, bus routes, and public health organisations. Transport is therefore an integral part of community infrastructure.

The evidence presented by Bagnall and colleagues, however, was not robust enough to make any recommendations of one approach over another. Transport and the physical infrastructure that supports it (such as cycle routes) were found to be important for enabling individuals to stay connected with their communities. For example, neighbourhood design that included easy parking, bike paths, and easy transport options increased social relations for residents. In addition, transport and physical infrastructure increase levels of individual and community wellbeing by facilitating community connection. However, interventions were not necessarily seen as positive. The authors reported that in two studies, residents feared that “changes to make an urban area more conducive to active travel would result in raised taxes, gentrification, and the exclusion of existing residents” (Bagnall et al. 2018: 66).

Mindell and colleagues (2011a) reviewed the synergies between low-carbon and healthy transport policies. They found that low-carbon transport policies centred around reducing emissions, can also take social inclusion into account. For example, urban design of mixed-use spaces intended to reduce trip length can include the removal of physical barriers which can promote social inclusion. Furthermore, lower speed limits can encourage the use of streets for social purposes. As part of examining the health effects of transport, they also highlight that **community severance** can be a

determinant of health as it contributes to social isolation and causes stress, which in turn impacts social exclusion and ill-health.

Community severance

- Community severance refers to limited accessibility of a community caused by transport infrastructure, such as motorways without pedestrian crossings or railway tracks that divide a city in half, or a high volume of traffic.
- Community severance can lead to increased distances to workplaces and facilities such as schools, parks, shops, leisure centres, and health services.

A literature review by Boniface and colleagues (2015) reviewed the impact of transport on social interactions and health. Their findings confirm the findings of Mindell and colleagues (2011a), indicating that community severance can contribute to quality of life and social cohesion, as well as social exclusion – from the number of neighbours people know, to the level of outside play by children. They suggest that new approaches are needed to measure the effect of community severance on health, as it is not currently possible to evaluate the effectiveness of interventions to reduced community severance. In addition, the review reports that access to transport is important to prevent social exclusion and to build social networks through face-to-face relationships. This is because a lack of access to transport or a withdrawal of public transport services has been found to reduce social networks and social relationships. For example, they found that increased trip making indirectly increased wellbeing through reducing social exclusion. They conclude by highlighting the complexities of the relationship between transport and social interaction: transport such as reliable bus links can help facilitate social interactions and promote social inclusion, but transport infrastructure that leads to community severance can reduce social networks.

There has to be a balance between improving transport links, without creating new barriers through community severance.

Mackett and Thoreau (2015) investigated how transport contributes to social exclusion and subsequently mental health, and how transport interventions can help address this. They found that specific subgroups are more at risk of **transport-related social exclusion** than others; these groups and the effects are outlined in Figure 5.5. For example, while transport-related social exclusion can be detrimental to anyone's mental health as it can make you feel isolated or dependent on others, this is worse for older people who can no longer drive.

In their discussion of interventions, Mackett and Thoreau (2015) examined travel in terms of **affordability, availability, psychological barriers, physical barriers, infrastructure, and information**. The review found that by improving transport access, the wellbeing of many groups in society is improved. For example, new bus services and/or timetable changes can provide access to employment for those without cars; following such a change in South Yorkshire, the ASOS Unipart distribution park found that **over 75% of job candidates did not drive or own a car**. Although improving transport alone will not reduce social exclusion, transport can provide access to solutions such as jobs and training. These findings also again highlight the connection between transport, health, and inequality.

Figure 5.5 Transport-related social exclusion by sub group

Income	<ul style="list-style-type: none">• Lower income groups are most likely to be transport poor, and government spending is biased towards higher income groups.
Disability	<ul style="list-style-type: none">• Those with mobility issues take half as many trips as those without mobility difficulties.
Age	<ul style="list-style-type: none">• Mobility issues increase with age, from 3% of those under 50 to 31% of those aged 70+.
Gender	<ul style="list-style-type: none">• Fewer women than men hold a driving licence, but more women than men do not use buses because they feel unsafe.
Ethnicity	<ul style="list-style-type: none">• BAME groups make 15% fewer trips and have lower car ownership than White groups.

Source: Authors' own

In a literature review of the effect of transport policy on wellbeing, Reardon and Abdallah (2013) found that transport can have both positive and negative effects on wellbeing. Transport can have a positive effect on wellbeing as it allows individuals and groups to access services and engage in social and leisure activities that lead to higher levels of wellbeing. However, when transport access is poor, mobility is low, or travel causes stress and anxiety, it can lead to lower levels of wellbeing. The authors explain that mobility is an important factor that contributes to an individual's wellbeing, particularly amongst older people and people with disabilities, as it allows them to participate in social networks. Public transport plays an important role in maintaining mobility as it allows individuals who may otherwise be excluded, to maintain and engage with social contacts.

5.2.3 People with disabilities and older people

Some of the studies discussed in this review thus far, e.g. Mackett (2014b), found variation of transport impacts on health by subgroup. Two subgroups are discussed more frequently than others: people with disabilities, and older people. This section summarises these findings in order to highlight the ways in which transport can differentially impact the wellbeing of those that are disabled as well as older people. A recurrent theme in the findings here is that these groups are more likely to physically struggle with mobility, and therefore struggle to access communities, social interaction, and services. Therefore, transport is key in ensuring older people and disabled people's wellbeing.

Transport policy was found to be instrumental in the wellbeing of older people and people with disabilities. Delbosc (2012) produced an evidence review exploring how transport policy influences **life satisfaction** and **wellbeing**. After reviewing nine studies, she concluded that transport has a measurable impact on psychological wellbeing. This is because transport improves mobility to allow more time to be spent out of the home engaging in social activities. This is particularly true for older people. In addition, Delbosc showed that CTPs for buses and policies that prolong driving amongst older people or reduce the need for them to give up driving both improve older people's mobility. As a result, older people experience lower levels of social exclusion and higher levels of psychological wellbeing, because their mobility, and in turn, wellbeing, is not restricted or limited.

Case study

Concessionary travel passes prevent social isolation (Mackett, 2014a)

- CTPs for bus travel help to improve the wellbeing of older people and those with disabilities.
- Multiple studies demonstrate **the introduction of CTPs increased bus use by 25-60%**.
- CTPs therefore enable older people and those with disabilities to stay more connected and participate in a wider range of activities, such as shopping or leisure activities, that would otherwise be less or in-accessible.
- With such a tangible impact, CTPs can play a key role in preventing social isolation.

The work of Roger Mackett (2014a, 2014b, 2015) is particularly informative in this area and builds on the findings of Delbosc (2012). As discussed Mackett (2014b) also investigated the health implications of inequalities in travel. The report found that, for people with disabilities and older people, transport facilitates their independence; when appropriate adjustments are made, the mobility and independence of these groups are improved. Finally, Mackett (2015) directly examined how we can improve accessibility for older people. The mobility of older people effects their ability to contribute to society, therefore Mackett assessed value of mobility for older people in terms of how it affects their wellbeing as well as their contributions, such as working in paid employment or volunteering. He found that increased mobility is associated with higher levels of wellbeing and life satisfaction. This is because mobility is linked with feelings of independence, connectedness with the community, and a higher quality of life in general.

Concessionary bus passes improve connectivity and reduce isolation for older people and those with disabilities, improving mental health and wellbeing for these groups.

The findings of Delbosc (2012) and Mackett (2014a) relating to CTPs are reinforced in a review by Ormerod and colleagues (2015). The review explored the connection between mobility and the wellbeing of older people, with a focus on how this connection is impacted by the availability of a concessionary bus pass. Through their review, the authors found that the loss of mobility due to age can have a negative

impact on the wellbeing of older people, as a loss of mobility is often accompanied by lower levels of independence and a fear of dependency on others. In particular, driving cessation is found to be associated with a decrease in wellbeing, an increase in depression and feelings of isolation, and increased mortality. By providing an alternative to driving, concessionary bus passes are found to increase the mobility of older people. Similar to Mackett (2014a), Ormerod and colleagues found that older people with concessionary bus passes make more frequent and longer trips to do their shopping, take part in social and leisure activities, and visit friends. This increase in mobility helps to improve the quality of life and wellbeing of older people.

In addition to the positive effects of CTPs on mobility, wellbeing, and mitigating social isolation amongst older people and people with disabilities by providing access to services and leisure and social activities, bus travel specifically can have a positive effect on wellbeing. Using survey data and a review of literature, the Urban Transport Group (pteg 2014), found that bus travel enables individuals to access facilities and services (such as grocery stores offering healthy food), stay connected with others, learn new things, and enjoy their surroundings (as it is less stressful than traveling by car). The benefits of bus use on wellbeing are particularly pertinent for older and disabled people; the review reports that concessionary bus passes help to improve the wellbeing of these groups by helping to prevent social isolation. However, as this review focused on bus travel specifically, it is not possible to say conclusively that bus transport is more effective at improving wellbeing than other modes of transport.

Better access to transport improves the wellbeing of older people and those with disabilities in multiple ways, such as access to facilities, staying connected with friends and family, and facilitating every-day interactions on the bus itself.

As discussed in Section 5.2.2, Mindell and colleagues (2011a) highlighted that **community severance** can be a determinant of health as it contributes to social isolation. This is especially true for older people. The authors found that travel is important for maintaining social connections amongst older people and transport enables them to travel independently and maintain their social connections. However, community severance means that some older people may be excluded from their communities and social networks due to heavy traffic or a lack of safe road crossings. As their review focused the synergies between low-carbon and healthy transport policies, this highlights that low-carbon transport policies can have beneficial effects for the wellbeing of older people in particular.

Musselwhite et al. (2015) conducted a literature review of the **impact of mobility** on the health and wellbeing of older people. The authors found that increased levels of mobility amongst older people are linked to higher levels of wellbeing. The reason being that mobility allows older people to maintain their independence and protect against social isolation. Older people use public transport to access services and facilities and stay connected with their communities. When there is limited or no access to public transport, this can result in loneliness, isolation, and lower levels of wellbeing and mental health amongst older people.

Lee and Sener (2016) conducted a content analysis and a literature review. The content analysis examined 148 long-range transport plans in the USA. The literature

review investigated the association between transport and quality of life, and whether municipal planning organisations in the USA address transport and quality of life issues. The review found that transport, particularly for older people, is important for maintaining an acceptable level of mobility and that when there is a reduction in levels of mobility this is associated with social isolation and reduced community activity. This reduction can then lead to lower levels of quality of life because mobility and staying socially active is a primary quality of life determinant. The authors concluded that while transport plans addressed quality of life related to physical wellbeing, aspects related to mental wellbeing were widely neglected.

The Campaign for Better Transport (2012) conducted a literature review on the relationship between transport and poverty. The review found that poor transport provision and car-based land use planning can contribute to social isolation. However, transport provision can improve accessibility and subsequently reduces social exclusion and improves wellbeing. This happens because improving the access to and affordability of transport services can help to address social exclusion. Improving access to public transport is particularly important for people in the lowest income quintile, people with disabilities and older people as they are more likely to rely on public transport.

5.2.4 Summary

The findings presented in this section demonstrate the important role that transport plays in maintaining and improving individuals' mental health and wellbeing. Not only is transport vital for accessing services, enabling social interaction, and preventing isolation, but the amount of traffic and length of a journey can directly impact mental health as well.

- **Mental health:** Although we examined physical and mental health separately, connections between the two still emerged. This suggests that transport interventions that target physical health may also have positive mental health benefits. In addition, a contradiction emerged: although longer commute times were found to increase stress, so was fast-moving traffic. This suggests that more efficient public transport could have positive mental health effects, by alleviating traffic and also reducing commute times.
- **Sub-groups:** Although not a focus of the reviews, variation by sub-group was highlighted in places. These findings highlight that those who are already more privileged in society – white, male, able-bodied, mid-high income – are also more likely to see the positive health effects of travel.
- **Older people and people with disabilities:** These two sub-groups were a focus of many reviews. Findings indicate that transport plays a key role in improving mental health and wellbeing of older people and people with disabilities. This is because these two groups can struggle with mobility more than younger and/or able-bodied adults, as fewer transport options are available and accessible to these groups. These groups are therefore at greater risk of isolation and social exclusion (to which loneliness is connected, although not explicitly discussed by the studies reviewed here). Therefore, improving transport provisions along the four dimensions above can have particularly positive impacts on mental health and wellbeing for these subgroups.

- **CTPs and buses:** The literature included in this review focused on CTPs and bus transport. CTPs were found to be instrumental in making bus transport more accessible and affordable, which in turn improved wellbeing by providing access to services, activities, and the wider community. However, it did not emerge from the reviews included here whether better access to other modes of transport would also improve wellbeing, so it is not clear whether other types of CTPs would be equally as effective.

5.3 Noise

The evidence reviewed with regards to this outcome topic looks at the interactions between health and transport related noise. All of the studies reviewed focus on road traffic noise, with some referencing rail or aircraft noise as an additional factor. The studies reviewed highlight how transport policies can affect noise levels and the consequences for health and wellbeing.

Building on the evidence reviewed above regarding the separate physical and mental health implications of transport, noise is an area where these health effects converge. Several of the reviews discuss how exposure to road traffic and other transport related noise can occur alongside, or in some cases potentially lead to, physiological conditions such as heart disease.

For example, Van Kamp and Davies (2013) examined noise effects for vulnerable populations and high-risk groups. They defined vulnerability as the susceptibility of a person, group, society, or system to physical or emotional injury or attack. High-risk groups are those people in the community with a higher-than-expected risk for developing a particular disease, lifestyle, habit, or environment (for example). Noise sensitivity refers to the “internal states of any individual that increase their degree of reactivity to noise in general”, and a noise sensitive area has a level of noise that interferes with normal activities. The focus on vulnerable groups in the review is particularly relevant in the context of health inequalities. The physiological and wellbeing effects of transport noise should be considered across populations to assess group differences in risk of exposure to road traffic noise (i.e. housing near busy roads is cheaper than those in quieter areas) and therefore have a higher risk of stress and sleeplessness.

5.3.1 Physical effects of transport noise

Dzhambov and Dimitrova (2018) carried out a systematic review and meta-analysis (as an update to an earlier WHO systematic review)¹⁰ which looked at the association between hypertension and road traffic noise. As part of the meta-analysis, the relative risk in an exposure-response relationship was delivered by pooling individual risk estimates. The review found that there was a linear exposure-response relationship between residential road traffic noise and the risk of hypertension in adult urban residents. The systematic review element of the study focused only on analytic studies looking at residential road traffic noise and the risk of hypertension in adult urban residents. The review concluded that residential road traffic noise was associated with higher risk of hypertension in adults. The meta-analysis found a linear exposure-response relationship, with a relative risk of 1.8% per 10 dB(A). They also found an

¹⁰ World Health Organization (2013).

exposure-response relationship between noise and coronary heart disease that increases above 50 dB(A). The risk was lower than previously reported in the systematic review literature, but this could be due to methodological differences.

Stansfeld and Crombie (2011) reviewed studies conducted in the UK that examined environmental noise and cardiovascular disease. It looked at whether there is an association between traffic noise and hypertension and found there is a possible, tentative positive relationship between road traffic noise exposure and hypertension. The tentative nature of the relationship found by Stansfeld and the conflict between Dzhambov's results and those of other reviews show why there is a distinct need for more research to establish a causal link.

Kempen and colleagues (2018) presented the main results of a systematic review of the literature dealing with observational studies on the association between environmental noise exposure (from road and air traffic) and the cardiovascular and metabolic systems. The noise sources looked at in the review included air, road, rail traffic, as well as wind turbine. Noise exposure was expressed in line with the European Noise Directive. A positive association was found between road traffic noise and the incidence of Ischemic Heart Disease (IHD). The main conclusion of the review was that not enough studies of good quality are available that investigated the impact of noise on the cardiovascular and metabolic system.

While there is some evidence that noise can impact physical health, such increased risk of hypertension, findings are inconsistent.

There were also reviews that examined the effects of noise in children, but findings were inconsistent. Van Kamp and Davies (2013) found the associations between aircraft noise and children's blood pressure were inconsistent. Similarly, for road traffic noise there is no consistent evidence of an effect on cardiovascular health in children. For adults, they report significant findings that environmental noise leads to an increase in blood pressure, but do not expand on the level of significance. Finally, they review four studies in four different countries that found a relationship between noise exposure and quality of life – fatigue and lack of concentration were the most prevalent noise-related health problems among children.

Similarly, Dzhambov and Dimitrova's (2017) systematic review and meta-analysis explores the association between children's blood pressure and road traffic noise. They found an increase in systolic and diastolic blood pressure per 5 decibels increase in road traffic noise at school or kindergarten, but results were not significant. Their analysis also found there to be an increase in systolic and diastolic blood pressure per 5 decibels increase in road traffic noise at home, but again results were not significant. There were various factors that affected these results, including the method of measuring blood pressure, children's age, and the way noise was assessed. However, as findings were not significant these effects were considered weak. The authors suggested more methodological consistency might provide a more robust estimate. Dzhambov and Dimitrova concluded that even if the effect of road noise on blood pressure is small, it may have important long-term consequences.

5.3.2 Wellbeing effects of transport noise

The reviews illuminated a range of wellbeing and psychological effects of noise, primarily relating to stress, sleep disturbance, and stress-related physical health problems. For example, as discussed in Section 5.2, Reardon and Abdallah (2013) reviewed the positive and negative effects of transport policy on wellbeing. As part of this review, Reardon and Abdallah examined studies on traffic noise. They assessed whether those who are exposed to high levels of traffic noise are likely to suffer from various psychological and health conditions. They found that traffic noise can cause annoyance and/or stress as well as a range of health conditions such as hypertension, cardiovascular disease, and sleep disturbance.

Similarly, Mindell and colleagues (2011a) found that ambient noise impedes sleep, affects concentration and performance and can increase blood pressure. This was also supported by Mindell and colleagues' (2011b) review, which found that traffic noise contributes to minor psychiatric illness, sleep loss, diminished performance. In addition, Mindell and colleagues (2011b) found the potential for increased risk of stress-related health problems such as hypertension, gastrointestinal diseases, as well as heart disease, infections, and cancer.

**Primary effects of noise are stress and sleep loss.
Children are less frequently annoyed by road
traffic and air traffic noise than adults.**

Annoyance and sleep disturbance also emerged as two key themes in the review by Van Kamp and Davies (2013). They examined the difference between children and adults and found that children are less frequently annoyed by road traffic and aircraft noise than adults. For sleep disturbance, there was only anecdotal evidence that older people are more at risk for sleep disturbance due to noise. Van Kamp and Davies (2013: 3) also found that "earlier suggestions that long-term health effects of sleep disturbance depend on the person's vulnerability or sensitivity are not supported by more recent evidence". This evidence demonstrates that primary effects of noise are stress and sleep loss, which in turn are associated with conditions such as heart disease (for which stress and sleep loss are risk factors).

Finally, Cohen, Boniface, and Watkins (2014) provided an overview of health benefits and disbenefits of travel as well as suggestions for health promoting transport policy to address some of the primary effects. The authors, like those mentioned above, concluded that constant traffic noise outside the home can contribute to stress and impair health by causing lack of sleep. The review also presented potential policy and planning changes to address these issues. Cohen and colleagues suggested that porous asphalt road surfaces could reduce noise by 4-8 decibels, equivalent to almost halving the volume of traffic. However, these proposed policy changes would require further study to assess the (long-term) impact on health.

5.3.3 Summary

This section covered evidence on the relationship between transport related noise and health and wellbeing. This is an area where physical and mental health effects converge. Key take-away messages include:

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- **Physical and mental health** – Traffic noise can cause annoyance and/or stress as well as a range of health conditions. Examples of these include hypertension, cardiovascular disease, and sleep disturbance.
 - **Sub-groups** – The physiological and wellbeing effects of transport noise can be examined across populations to understand how the risk of exposure to road traffic noise and subsequent higher risk of stress and sleeplessness varies between socioeconomic groups. That individuals and families in lower socio-economic groups may be living in housing near busy roads because it is cheaper than those in quieter areas is an illustration of this.
 - **Effects of policy** – In terms of policy and planning changes that can address traffic noise levels outside the home contributing to stress and impairing health by causing a lack of sleep, laying porous asphalt road surfaces can reduce noise by 4-8 decibels. Longitudinal studies can be useful in assessing changes in the prevalence of noise related health conditions for those living in proximity to roads where policies like these have been implemented.

6 Discussion

This section synthesises the findings of this review, addressing the questions set out at the beginning of this report, and giving suggestions for future research.

6.1 In what ways are transport and health and wellbeing linked?

6.1.1 What are the mechanisms by which transport impacts on health and wellbeing, and vice versa?

Three main mechanisms linking transport and health and wellbeing emerge from the findings:

- transport and access;
- intrinsic effects of use of specific modes; and
- wider effects of transport and infrastructure.

Transport and access

It was widely found that availability of transport, particularly public transport, is valuable for accessing healthcare. This was particularly the case for older people, who have greater healthcare needs than younger people¹¹ and more restriction on their mobility. Transport also allows access to non-healthcare activities that are beneficial for physical and mental health, social connection and wellbeing, and the reduction of social exclusion (e.g. pteg 2014, Mackett 2014a, Lucas 2012, Delbosc 2012, Reardon and Abdallah 2013). Most evidence related to bus use (pteg 2014, Mackett 2014a) rather than car use. There was also a focus on transport dedicated to healthcare or to supporting mobility for older people.

Mode of transport

Specific modes of transport carry risks and benefits for health and wellbeing. These particularly relate to the different effects of active transport (cycling and walking), public transport (involving some walking to access stops and stations), and sedentary, car-based transport. There were also some findings on the mental health effects of specific modes, including the mental health benefits of cycling and walking (Lee and Sener 2016) and the potential negative mental health effects of public transport use (Mindell et al. 2011b, Reardon and Abdallah 2013). Regarding health effects on transport use, we can note explicitly that poorer health is a fundamental mechanism that restricts the options and capacities for mobility among older people, which gives rise to the case for support for mobility in the first place.

Wider effects of transport and infrastructure

Transport modes and infrastructure can have wider or passive effects, and this review found evidence relating to impacts of noise, community severance and stress. There is clearly evidence of some effects of noise on both the physical and mental health of

¹¹ NHS England, Figure 1.

adults and children, but the strength of the effects is not settled (Dzhambov and Dimitrova 2018, Van Kamp and Davies 2013, Stansfeld and Crombie 2011, Kempen et al. 2018).

Another wider mechanism is the phenomenon of community severance, that is the disruption to the life of the local community by transport practices and infrastructure (Mindell et al. 2011a, Cohen et al. 2014). New roads or layouts can disrupt the physical spaces in which people live and through which people move, but at a much smaller scale, levels and speed of traffic affect the amount children (can) play outside, with further associations for adults' social connectedness (Boniface et al. 2015, Geurs et al. 2009).

Stress is a negative mental health effect in itself, as well as a risk factor for multiple physical health conditions (Mindell et al. 2014, Mindell et al. 2011b). Traffic is associated with stress both for those exposed to high levels of traffic (Geurs et al. 2008) including through noise (Reardon and Abdallah 2013, Cohen et al. 2014, van Kamp and Davies 2013), and also for those on the road, for example through long commute times (Lee and Sener 2016).

6.1.2 What does the evidence say on the strength of those links?

There is widespread, consistent evidence on the benefits of mobility for wellbeing, although this particularly relates to older people (e.g. Ormerod et al. 2015, Musselwhite et al. 2015, pteg 2014). This focus may well be justified, given the higher likelihood of restricted mobility amongst older people compared to the general population. Nonetheless, it is a notable contrast with the absence of evidence on wellbeing effects for other groups that experience transport disadvantage. The relative importance of transport for healthcare may diminish if the NHS moves some advice and care online¹² but given continued ageing of the UK population the absolute need for healthcare-related transport is likely to remain high or growing.

Despite quite a large number of primary studies informing the reviews in this report, the conclusions on the effects of noise on physical and mental health are mixed. The evidence of negative effects of noise on mental health and wellbeing is strong, and links between stress and physical health is also well established. By contrast, the evidence on physical health impacts of noise is more tentative, and several authors highlighted the need for better studies (Kempen et al. 2018, Dzhambov and Dimitrova 2017, Cohen et al. 2014). This difference is despite the relative ease of measuring markers of physical health such as blood pressure and disease, compared to less easily measured outcomes such as stress, wellbeing or community severance.

The report found a range of evidence on community severance (Cohen et al. 2014, Mindell et al. 2011a, Geurs et al. 2009, Boniface et al. 2015). The consistency of evidence points toward the importance of policy attention on this phenomenon, even though the studies that refer to it do not employ a standard definition of community severance or use common measures.

The strong links between physical activity and physical and mental health are already well documented.

¹² As discussed in the NHS Long Term Plan, NHS 2019

6.1.3 How does this vary across different population groups?

Consideration of different sub-groups in the population was very limited, with the evidence referring almost entirely to older people and people with disabilities, and occasionally to children. None of the papers reviewed here reported findings by gender, ethnic group, or other sub-groups.

Older people and people with disabilities consistently emerge as sub-groups that are particularly affected by the relationship between transport and health and wellbeing. For example, the benefits of bus use on wellbeing were found to be particularly pertinent for older and disabled people, and concessionary travel passes help to improve the wellbeing of these groups by enabling people to go out and meet people and participate in community life thus helping to prevent social isolation. However, these policies tend to target these groups, which may underlie the absence of evidence related to other groups experiencing transport disadvantage. Mindell et al. (2011) reported that healthy and affluent groups are more likely to experience positive impacts of transport whereas those on lower incomes, young, and older people are more likely to experience negative impacts.

There was also evidence reported about differences in outcomes by social class (Mindell 2011b, Mackett 2014b), although this was limited to risk of road traffic collisions and observations about the socioeconomic profile of people with access to cars. The relationship between inequality and health and wellbeing is discussed further in Section 6.3.

6.2 What do we know about transport policies' effectiveness in improving health and wellbeing?

Due in part to the fact that all included studies were review articles, consideration of specific policies was rare in the evidence we reviewed. Some of the interventions reviewed by Bagnall and colleagues (2018) included transport-related aspects. However, those authors concluded that the studies they considered were often not very robust and were not able to make strong conclusions about what interventions worked. Mindell and colleagues (2011a) examine low-carbon transport policies, but rather than investigate their effectiveness in improving health, they look at impacts on health. They make three policy recommendations for improving health:

- transport policy should promote lower carbon and healthy choices;
- spatial and transport planning and urban design should focus on lower traffic speeds and incorporating and encouraging multiple modes of transport, particularly public transport and cycling and walking, rather than focusing on cars;
- and better information about improvements to transport infrastructure and services.

One strong area of evidence is that on concessionary travel passes (Mackett et al. 2014a, Ormerod et al. 2015, Mindell et al. 2011a). These passes are an effective way of increasing mobility for older people and people with disabilities, with substantial benefits for the wellbeing of people in these groups.

One challenge for policy responses is that many actions related to transport undermine and promote different areas of health and wellbeing simultaneously. For example, as Boniface and colleagues put it:

*“[L]iving near reliable and frequent bus links could facilitate access to friends and relatives, which may reduce the risk of social exclusion (health promoting). However, this may also entail living near a busy trunk road causing community severance, which may result in knowing fewer neighbours and having a smaller social network (detrimental to health). These effects will also vary across the life course, as well as in different groups, depending on demographic and socio-economic characteristics, lifestyles, geography, and transport preferences. Therefore, **these effects should not be considered in isolation, rather, they should be considered more broadly in terms of wider determinants of health.**”* (Boniface et al. 2015: 444-445, our emphasis)

Another example of this need for careful consideration is in responding to the stress caused by long commutes. Higher speed limits do not necessarily make traffic travel faster¹³ and have knock-on effects for actual and perceived road safety for other users including pedestrians. Increasing vehicle occupancy to improve overall journey times, for example through car-sharing, demand-responsive transport, or multi-modal options such as park-and-rides, may increase road capacity but may be less convenient for individuals. Enough potential users have to be willing to make the trade-off in order to make a scheme viable.

6.3 Links between inequality and health and wellbeing

Risk of transport-related social exclusion is in part defined by socioeconomic position – having limited mobility options is in part a function of poverty, as well as ill-health, disability, geographic location and transport availability. Such exclusion is then associated with negative wellbeing.

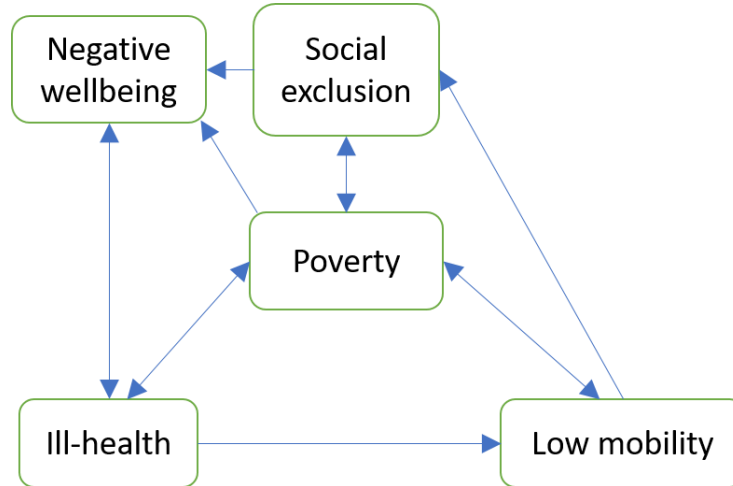
Factors including social exclusion, wellbeing, ill-health, and poverty affect one another and interact with mobility and transport (Figure 6.1). This report has a companion report on transport and inequality that explores these relationships in more detail. One aspect of social disadvantage and transport highlighted in that report is the role of transport links and access in determining social opportunity. This is complicated by the findings in this report regarding negative effects of nearby transport, including through community severance and noise. Of course, nearby transport doesn't necessarily mean affordable or accessible transport, and proximity to busy roads does not mean use of those roads. Nonetheless, infrastructure promoting opportunities for mobility has potential downsides related to physical and mental health. Conversely, the downsides of living near transport in terms of noise and pollution exist alongside upsides in terms of mobility options.

Many of the negative effects of transport infrastructure relate to its interaction with people's housing – the “community” in community severance is primarily presented as a residential one, while effects of noise, for example, often relate to where people sleep. It is likely that for any given piece of transport infrastructure, the housing with worse impacts for health and wellbeing will be cheaper than housing that also benefits

¹³ Llewellyn 2018.

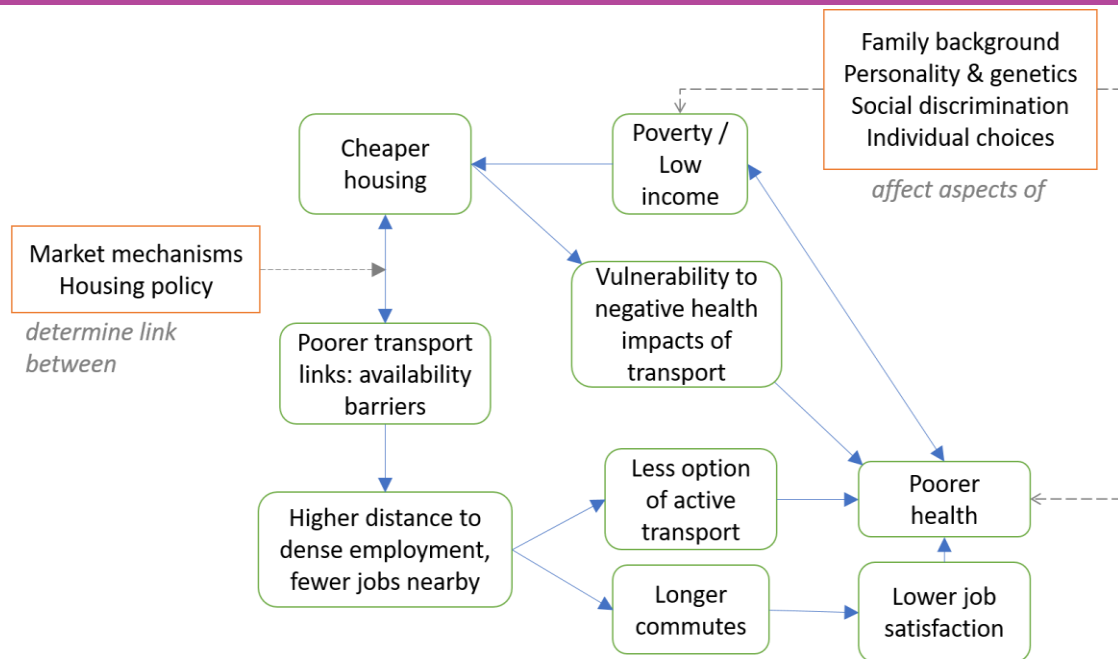
from the amenity of the infrastructure without those negative impacts. Figure 6.2 below illustrates some aspects of the relationship between transport, housing, health and poverty. The centre of the figure highlights the connection between cheaper housing, vulnerability to negative health impacts of transport, and poorer health. Examples of negative health impacts include community severance, noise, and pollution.

Figure 6.1 Interrelations between mobility, wellbeing, health and poverty



Source: Authors' own

Figure 6.2 Interrelations between transport, housing, health and poverty



Source: Authors' own

As noted, one reason for the focus on older people and disabled people in policies to encourage mobility is that people in these groups are particularly likely to have limited

mobility. Another reason is that disabled people especially are more likely to be on lower incomes.

6.4 Limitations

This review took a systematic approach, adapting the methodology of a Rapid Evidence Assessment. However, the 30 studies included in the review inevitably do not encompass all relevant evidence. The review addressed a broad research question, and while that broad overview is a strength it also means that it was not possible to consider all narrower sub-aspects of the questions in detail.

All the findings were from review articles, which has the advantage of bringing together a breadth of previously reported findings. Restriction to reviews has downsides as well, including the fact that summary estimates, derived for example through meta-analyses, are difficult to calculate and therefore these are uncommon.

6.5 Research recommendations

There is a great deal of research on the positive effects of concessionary travel on the wellbeing of people whose mobility is limited through older age and/or disability, but little on the potential to improve wellbeing for other people with mobility issues. The need for more robust, consistent studies on the effects of noise on physical health was noted several times.

Despite community severance being a useful and well-established concept, there is nonetheless limited prospective evidence on its occurrence when new transport infrastructure is established (Mindell et al. 2011). The Department for Transport's Transport Analysis Guidance provides guidance on assessing the severance impacts of transport schemes,¹⁴ via a set of qualitative categories "None–Slight–Moderate–Large". Use of this framework in research might provide consistent evidence to aid in operationalising research findings in policymaking. At the same time, quantitative measures such as minutes of pedestrian waiting time exist in literature (Cohen et al. 2014, Geurs et al. 2009) and might be useful for appraisal purposes, although we note that in 2006 DfT guidance "moved from quantitative estimation to monetary valuation" (Geurs et al. 2009: 83).

There is also limited quantitative evidence on the strength of links between transport, health and wellbeing¹⁵. Better ways to monitor and evaluate transport intervention pilots and policies are needed that look to improve health outcomes, to develop a stronger evidence base. Such interventions should be looked at with regards to their causal links, for example noise, stress and stress related diseases. They should also look at differences in these links by age and gender, ethnicity, or socio-economic background.

Further, there is a need to understand how health and social care providers carry out their work and reach the people that may need it the most as well as research into loneliness.

¹⁴Department for Transport (2017b)

¹⁵ Though we note a new publication on this topic that was not available at time of search and screening for this review: Chatterjee, K., Clark, B. Nguyen, A., Wishart, R., Gallop, K., Smith, N., Tipping, S. (2019) Access to Transport and Life Opportunities, Department for Transport

7 Conclusion

There is a move towards defining health in broader terms including physical and mental health alongside wellbeing. Transport often impacts more than one of these domains in tandem and noise is an example of an area where physical and mental health effects converge. The evidence included in this review has covered a number of different aspects of health and wellbeing and covers studies that focus on different modes including both public and private transport. It should be noted, though, that much of the evidence reviewed here related to bus use rather than personal vehicles or transport dedicated to healthcare or supporting mobility for older people.

There is a more direct relationship between transport, health, and wellbeing than there is with inequality as wider factors are more at play with the latter which can render the potential of transport to alleviate disadvantage an important yet secondary policy lever. With health and wellbeing, the relationship is more directly measurable, for example through the number of accessible local health providers.

This review of evidence has highlighted three main mechanisms that link transport and health and wellbeing:

- transport and access;
- intrinsic effects of use of specific modes; and
- wider effects of transport and infrastructure.

An understanding of civic participation, connectivity, and health and wellbeing in relation to mobility is integral to addressing the wider societal challenges of exclusion and isolation. Transport allows access to non-healthcare activities that are beneficial for physical and mental health and for social connection and wellbeing, and the reduction of social exclusion.

Transport policies cannot address health and wellbeing disparities effectively on their own. They can however play an integral part in a broader, multi-stakeholder approach. In line with this, a more holistic view of health is being appreciated by researchers and policy makers. This is placing an increasing emphasis on addressing access issues that account for both physical and mental health issues and combinations of different health conditions. An inter-disciplinary approach that draws upon transport, geography, health sciences and gerontology could be useful in developing a richer understanding of holistic health and transport in the wider sense.

In terms of further evidence gaps, there is some work yet to be done on the strength of causal links, for example noise, stress and stress related diseases. Furthermore, whilst evidence was available on accessing health services, there was nothing that explicitly covered how health and social care providers carry out their work and reach the people that may need it the most. In addition, while there was substantial evidence on older people, there was little by way of exploring differences by age and gender, ethnicity, or socio-economic background.

Finally, loneliness is a key cross-government department priority area for focus. There was nothing explicitly focused on loneliness in the evidence reviewed here. As a concept it is relatively new and discussions by researchers in the field on how it should be defined and can be understood for the purposes of policy making are still at an early stage. However, community severance, social exclusion and access to other non-healthcare related activities are related to loneliness and have been analysed through

the papers included in this review. We anticipate that this will be another key area for future research.

8 References

References for papers cited in the introduction and footnotes that do not form part of the review. Full lists of studies meeting the review's inclusion criteria that were and were not included in the review are included in Appendix E and Appendix F respectively.

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Appendix A. Detailed methodology

Inclusion criteria

Study designs

Studies using an evidence review methodology were eligible for inclusion in this review. This includes the following type of evidence reviews:

- Systematic reviews
- Meta-analyses
- Rapid reviews
- Rapid evidence appraisals
- Literature reviews
- Other forms of evidence reviews

To understand the direction and magnitude of the relationship between transport and health and wellbeing, only reviews that included quantitative estimates, rather than qualitative descriptions, were included in this review.

Participants

Inclusion of studies was not determined according to participant criteria.

Interventions

Systematic reviews and meta-analyses often synthesise studies that measure the effect of a specific intervention on an outcome or outcomes. For example, a study that measures the effect of an intervention to promote walking to school by comparing the number of students walking to school before and after the intervention. This evidence review did not require that studies be evaluations of interventions in order to be included, as we are interested in the relationship between transport and health and wellbeing more generally.

Associations measured

To be included, studies had to examine the association between public and private transport use and/or access and at least one of eight outcomes. **Appendix Table A.1** below describes each association.

Transport

To be included studies had to include the following modes of public or private land transport: cars, buses, trains, cycling, walking, trams, and taxis. Studies relating only to air or maritime transport were excluded.

Setting

Studies had to use data collected on individuals or interventions in Western Europe (United Kingdom, Ireland, Denmark, Sweden, Norway, Germany, Netherlands, Belgium, France, Spain, Portugal, Italy, Austria, and Switzerland), North America (Canada and the United States) and/or Australasia (Australia and New Zealand).

Language

Studies had to be published in English.

Date

Studies had to be published from 2008 or afterwards.

Appendix Table A.1 Description of included associations

Association	Description	Example
Mental health and transport use and/or access	Investigate if there is an association between the use of and/or access to transport and mental health status of individuals.	A literature review that surveys the literature on barriers to public transit use amongst people with mental health disorders.
Stress, anxiety and wellbeing and transport use and/or access	Investigate if there is an association between the level of stress, anxiety, and/or wellbeing experienced by an individual or group and their use of or access to transport.	A meta-analysis of studies that measure the stress levels of individuals before and after their commute to work.
Access to health services and transport use and/or access	Investigate if there is an association between the use of and/or access to transport and accessibility of health services.	A systematic review of intervention that provide free shuttle busses to health clinics for residents in a low-income neighbourhood.
Transport use and/or access for disabled people	Investigate the transport use and/or access amongst disabled people.	A rapid evidence appraisal of transport services provided by councils for disabled people across England.
Phobias, noise and traffic and transport use and/or access	Investigate if there is an association between transport use and/or access and phobias, noise and traffic amongst individuals.	A systematic review of the psychological and health conditions caused by exposure to high levels of traffic noise.
Isolation, loneliness and connectedness and transport use and/or access	Investigate if there is an association between transport use and/or access and isolation, loneliness and connectedness amongst individuals and groups, such as older people.	A rapid review of the experience of isolation and loneliness amongst older people without access to private transport.
Transport use and/or access for care workers and health care professionals	Investigate the transport use and/or access amongst care workers and health care professionals.	A systematic review of workplace interventions that provide transport to and from work for health care professionals that aim to reduce the commute length of employees.

Appendix Table A.1 Description of included associations

Physical health and transport use and/or access	Investigate if there is an association between the physical health of individuals and groups and transport use and/or access.	An evidence review of studies that investigate the relationship between length of commute and obesity.
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Inclusion and exclusion process

Screening took place at two levels: (1) title and abstract and (2) full-text level. Where documents did not have an abstract, we screened an appropriate summary of the document contents. Prior to screening at each stage, screening tools were developed and piloted by a group of reviewers to promote inter-screener reliability. Differences in screening results amongst researchers were discussed and any differences in interpretations clarified before official screening began. Documents suggested by experts were only screened at full-text.

Abstrackr was used to screen database results at the title and abstract level. Abstrackr is software that uses machine learning to semi-automate citation screening by prioritising more relevant results. See Gates et al. (2018) for more detail about use and reliability of the software. This allowed us to prioritise the most relevant results from the database results.

Study prioritisation

Due to the *rapid* nature of this review, the number of studies included for synthesis was limited to 30. To determine which 30 studies to include in the review, a prioritisation heuristic was developed. Each study screened at full text was scored on five criteria. **Appendix Table A.2** outlines and describes the five criteria. The 30 highest scoring studies were prioritised for inclusion.

Appendix Table A.2 Prioritisation criteria

Criteria	Description	Example	Highest possible score
Association	A study was given one point for each of the eight associations covered, meaning the more associations covered, the greater number of points awarded.	A study covering the association between transport use and wellbeing, transport and access to health services, and transport noise and health would be given three points.	8
Analysis of axes	A study was given one point if it included one or more analyses of how individual and group characteristics mediated the association between transport and inequality.	A study covering the association between transport use and phobias related to transport included sub analyses of how this association varied between men and women and older and	1

Appendix Table A.2 Prioritisation criteria

	Characteristics included any status covered by the Equalities Act (for example, race or gender), as well as any indicators of social class and education level.	younger people would be given one point.	
Publication date	Studies were given a score between 0.69 and 2.48 based on the year it was published, with the most recent studies retrieving the highest scores.	A study published in 2017 would be given a score of 2.40 (the natural logarithm of 2017-2006=2.40)	2.48
Geographic setting	Studies were given one point if they presented data from the United Kingdom.	A study presenting data from Italy, Sweden and the UK would be given one point.	1
Total Possible Score			12.48

Data extraction

Data extraction was done using a data extraction tool that was piloted before use. Two researchers extracted data from the same two studies. Differences in the data extracted were discussed and the data extraction tool was amended and clarified to ensure inter-researcher reliability. See Appendix 5 for the data extraction template.

The data extraction tool included an appraisal of study quality. The rigour and reliability of the search process and appraisal of the quality of included studies was assessed.¹⁶

Synthesis

After completing the data extraction, the 30 included studies were narratively synthesised using the ‘framework method’. This method involves creating a matrix in which the columns represent the key thematic areas and research questions of the review, and the rows represent the included studies. The key information of each study was summarised in the relevant cells with a link or reference to the original source. The key thematic areas were the eight associations between transport and inequality. The advantage of this presentation method is that it links the synthesised evidence explicitly to the thematic areas, allowing for the evidence of each research question to be easily viewed and interpreted.

¹⁶ A study was considered to have performed a systematic search if the resources searched and the search string(s) used were clearly reported. A study was considered to have performed a quality appraisal if the quality of each included study was assessed using a recognised risk of bias or quality appraisal tool, such as those outlined in Chapter 8 of Higgins and Green 2011.

Appendix B. Searched Online Repositories

Appendix Table B.1 List of searched online repositories		
Source	Link	Date searched
Sustrans	https://www.sustrans.org.uk/policy-evidence/evidence	01.11.2018
International Transport Forum	https://www.itf-oecd.org/	01.11.2018
Transport Studies Research Group	https://www.westminster.ac.uk/transport-studies-research-group	01.11.2018
Transport Studies Unit, Oxford University	https://www.tsu.ox.ac.uk/research/	01.11.2018
UK Department for Transport	https://www.gov.uk/government/publications?departments%5B%5D=department-for-transport	01.11.2018
Joseph Rowntree Foundation	https://www.jrf.org.uk/search	01.11.2018
Chartered Institute for Highways and Transportation	https://www.ciht.org.uk/knowledge-resource-centre/resources/transport-mobility-and-wellbeing/	01.11.2018
Swedish National Road and Transport Research Institute	http://www.vti.se/en/	01.11.2018
Equality Trust	https://www.equalitytrust.org.uk/	01.11.2018
Campaign for Better Transport	https://bettertransport.org.uk/research	01.11.2018
Association of Directors of Public Health (UK)	http://www.adph.org.uk/category/policy/atpa/	02.11.2018
The Health Foundation	https://www.health.org.uk/blog/infographic-transport-and-health	02.11.2018
Urban Transport Group	http://www.urbantransportgroup.org/resources/	02.11.2018
What Work Centre for Local Economic Growth	http://www.whatworksgrowth.org/	02.11.2018
Bus Users	https://www.bususers.org/publications/	02.11.2018
What works wellbeing	https://whatworkswellbeing.org/	02.11.2018
Women's Budget Group	https://wbq.org.uk/	02.11.2018
Transport and Environment	https://www.transportenvironment.org	02.11.2018
Resolution Foundation	https://www.resolutionfoundation.org	02.11.2018
ITS Leeds	https://environment.leeds.ac.uk/publications/104/social-political-sciences	02.11.2018

Appendix C. Search Strategy

Databases strategy search:

Ovid MEDLINE(R) and In-Process & Other Non-Indexed Citations and Daily <1946 to November 05, 2018> Searched 6th November 2018

- 1 transportation/ or motor vehicles/ or automobiles/ or motorcycles/ or off-road motor vehicles/ or railroads/
- 2 (bicycl* or cycling or road* or car or cars or autos or automobile* or vehicle* or transport* or taxi or taxis or minicab* or coach or coaches or tram or trams or bus or buses or rail or commut* or railway* or metro or tube or underground or (train adj3 (travel* or journey* or ride*)) or trains or driving or motoring or cyclist* or bike* or pedal-power or motorised or motorized).ti,ab,kw.
- 3 or/1-2
- 4 health status/ or personal satisfaction/ or happiness/ or "quality of life"/ or work-life balance/ or health services accessibility/ or health equity/ or healthcare disparities/ or "health services needs and demand"/ or medically underserved area/ or "Social Determinants of Health"/ or Health Facilities/sd
- 5 exp Anxiety Disorders/ or social behavior disorders/ or phobia, social/ or social segregation/ or social discrimination/ or social stigma/
- 6 (anxiety or anxieties or anxious* or panic or phobi* or fear* or GAD or apprehens* or worr* or nervous*).ti,ab,kw.
- 7 (wellbeing or wellbeing or health or sickness absence* or work life balance or "quality of life" or ((personal or life) adj2 satisfaction) or happiness or happy).ti,ab,kw.
- 8 (mental* adj (ill* or sick* or disab* or disease*)).ti,ab,kw.
- 9 (discriminat* or "social* exclu*" or "social* inclu*" or lonely or loneliness).ti,ab,kw.
- 10 social isolation/ or social marginalization/ or loneliness/
- 11 ((access* or accept* or need* or demand*) adj3 (healthcare or "health care" or "health service*")).ti,ab,kw.
- 12 disabled persons/ or amputees/ or disabled children/ or mentally disabled persons/ or mentally ill persons/ or persons with hearing impairments/ or visually impaired persons/ or mobility limitation/ or dependent ambulation/
- 13 or/4-12
- 14 (meta-analysis or "review").pt.
- 15 ("research synthesis" or "scoping review" or "rapid evidence assessment" or "systematic literature review" or "Systematic review" or "Meta-analy*" or Metaanaly* or "meta analy*" or (evidence adj2 review) or "review of review*").ti,ab,kw.
- 16 evaluation studies/ or program evaluation/ or meta-analysis/ or "Review Literature as Topic"/
- 17 or/14-16
- 18 exp United Kingdom/ or ("united kingdom" or UK or britain or british or english or scottish or scots or welsh or england or scotland or wales or "northern ireland" or ulster).ti,ab,kw.
- 19 exp canada/ or exp united states/ or exp france/ or exp germany/ or netherlands/ or exp denmark/ or sweden/ or exp australia/ or new zealand/ or (australia* or canada or canadi* or denmark or danish or france or french or german* or netherlands or dutch or "new zealand*" or sweden or swedish or USA or "united states" or american).ti,ab,kw.
- 20 3 and 13 and 17 and 18
- 21 limit 20 to yr="2008 -Current"
- 22 3 and 13 and 17 and 19
- 23 limit 22 to yr="2008 -Current"

Scopus Database – Searched 6th November 2018

Health (Other Countries) (2008-)

(TITLE-ABS-KEY (bicycl* OR cycling OR road* OR car OR cars OR autos OR automobile* OR vehicle* OR transport* OR taxi OR taxis OR minicab* OR coach OR coaches OR tram OR trams OR bus OR buses OR rail OR commut* OR railway* OR metro OR tube OR underground OR (train W/3 (travel* OR journey* OR ride*)) OR trains OR driving OR motoring OR cyclist* OR bike* OR pedal-power OR motorised OR motorized)) AND (TITLE-ABS-KEY (australia* OR canada OR canadi* OR denmark OR danish OR france OR french OR german* OR netherlands OR dutch OR "new zealand*" OR sweden OR swedish OR usa OR "united states" OR american)) AND ((TITLE-ABS-KEY (wellbeing OR wellbeing OR health OR "sickness absence*" OR "work life balance" OR "quality of life" OR ((personal OR life) W/2 satisfaction) OR happiness OR happy)) OR (TITLE-ABS-KEY ((mental* W/1 (ill* OR sick* OR disab* OR disease*)))) OR (TITLE-ABS-KEY (discriminat* OR "social* exclu*" OR "social* inclu*" OR lonely OR loneliness)) OR (TITLE-ABS-KEY (((access* OR accept* OR need* OR demand*) W/3 (healthcare OR "health care" OR "health service*"))))) OR (TITLE-ABS-KEY ((anxiety OR anxieties OR anxious* OR panic OR phobi* OR fear* OR gad OR apprehens* OR worr* OR nervous*)))) AND ((TITLE-ABS-KEY (("research synthesis" OR "scoping review" OR "rapid evidence assessment" OR "systematic literature review" OR "Systematic review" OR "Meta-analy*" OR metaanaly* OR "meta analy*" OR (evidence W/2 review) OR "review of review*")))) OR (TITLE-ABS-KEY (evaluation W/2 (stud* OR program*)))) AND (LIMIT-TO (PUBYEAR , 2010) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2009) OR LIMIT-TO (PUBYEAR , 2008)))

Health (UK) (2008-)

(TITLE-ABS-KEY (bicycl* OR cycling OR road* OR car OR cars OR autos OR automobile* OR vehicle* OR transport* OR taxi OR taxis OR minicab* OR coach OR coaches OR tram OR trams OR bus OR buses OR rail OR commut* OR railway* OR metro OR tube OR underground OR (train W/3 (travel* OR journey* OR ride*)) OR trains OR driving OR motoring OR cyclist* OR bike* OR pedal-power OR motorised OR motorized)) AND (TITLE-ABS-KEY (("united kingdom" OR uk OR britain OR british OR english OR scottish OR scots OR welsh OR england OR scotland OR wales OR "northern ireland" OR ulster))) AND ((TITLE-ABS-KEY (wellbeing OR wellbeing OR health OR "sickness absence*" OR "work life balance" OR "quality of life" OR ((personal OR life) W/2 satisfaction) OR happiness OR happy)) OR (TITLE-ABS-KEY ((mental* W/1 (ill* OR sick* OR disab* OR disease*)))) OR (TITLE-ABS-KEY (discriminat* OR "social* exclu*" OR "social* inclu*" OR lonely OR loneliness)) OR (TITLE-ABS-KEY (((access* OR accept* OR need* OR demand*) W/3 (healthcare OR "health care" OR "health service*"))))) OR (TITLE-ABS-KEY ((anxiety OR anxieties OR anxious* OR panic OR phobi* OR fear* OR gad OR apprehens* OR worr* OR nervous*)))) AND ((TITLE-ABS-KEY (("research synthesis" OR "scoping review" OR "rapid evidence assessment" OR "systematic

literature review" OR "Systematic review" OR "Meta-analy*" OR metaanaly* OR "meta analy*" OR (evidence W/2 review) OR "review of review*")) OR (TITLE-ABS-KEY (evaluation W/2 (stud* OR program*))) AND (LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010) OR LIMIT-TO (PUBYEAR , 2009) OR LIMIT-TO (PUBYEAR , 2008))

Appendix D. Data extraction tool

Appendix Table D.1 Data extraction tool		
Broad Category	Category	Further Guidance
Descriptive information	ID	
	Researcher	
	Title	
	Authors	
	Publications date	
	Country	Briefly summarise study
Study/Intervention	Summary of study	Non-exhaustive list of examples: * Transport (general, undefined) * Concessionary travel * Car ownership * Bus funding etc.
	Transport variables	Non-exhaustive list of examples: * Transport (general, undefined) * Concessionary travel * Car ownership * Bus funding etc.
	Population	Describe any target groups that the study focuses on/intervention targets, e.g. older people, healthcare workers, people with disabilities or specific health conditions
Quality appraisal: reviews	Study design	Choose from list: * systematic review (SR) * rapid evidence assessment * rapid review * literature review * meta-analysis * SR with meta-analysis * other synthesis
	Systematic search	This should focus on the rigour and reliability of the methods used: Do they list the resources (databases and websites) searched? Do they provide a search string for databases? For quantative estimates (meta-analysis) * description of sampling technique * sample size * discussion of limitations and potential bias * presentation of (un)certainty

		around estimate (e.g. confidence interval/p value, narrative description, graphical or numerical presentation of variance)
Outcome	Outcome topics	List all outcomes that apply from the following list: Access to health services for patients/clients Access to workplaces/patients for social care and health workers Transport's direct impact on wellbeing (e.g. commute length, access to friends, family or leisure activities) Personal safety, fear, anxiety Isolation, loneliness, connectedness Disability Mental health Noise
	How outcome is measured	How outcome is measured (list all outcome measures separately) Include page numbers citing page where outcome is defined.
	Relationship of outcome to transport	Describe how the health/wellbeing outcome relates to the transport variable.
	Location of quantitative estimate	Page number, table number, section number.
	Quantitative estimate	* Prevalence estimate (e.g. prevalence of transport as a barrier to wellbeing) * Association (e.g. time to hospital and type of transport available) * Impact estimate Size of impact or association between variables. Report all mentions of an outcome construct in text, tables or figures.
	Location of narrative data	Page number or section number
	Narrative summary	From paper if sufficient. Otherwise summarise in 2-3 sentences narrative conclusion.
	Outcome notes	Any other notes

Analysis: In what ways are transport and health and wellbeing linked?	What are the mechanisms by which transport impacts on health and wellbeing, and vice versa?	This should include how the outcomes is achieved, what are they key drivers and mechanisms that cause, for example, a 10% decrease in reported fear and anxiety of using transport
	What does the evidence say on the strength of those links?	This should be an assessment of the weight of the evidence based on the significance of the coefficient (?) results
	How does this vary across sub-groups	This should include subgroups such as: Location Employment status Age Gender Education
Analysis: What do we know about transport policies' effectiveness in improving health and wellbeing?	How does this vary across subgroups?	Again, This should include subgroups such as: Location Employment status Age Gender Education

Appendix E. Documents included in review for data extraction and synthesis

Appendix Table E.1 List of documents included	
	Full citation
1	Bagnall, A., South, J., Di Martino, S., Southby, K., Pilkington, G., Mitchell, B., Pennington, A., Corcoran, R. for What Works Wellbeing (2018). Places, spaces, people and wellbeing: full review.
2	Boniface, S., Scantlebury, R., Watkins, S. J., & Mindell, J. S. (2015). Health implications of transport: evidence of effects of transport on social interactions. <i>Journal of Transport & Health</i> , 2(3), 441-446.
3	Campaign for Better Transport (2012). <i>Transport and Poverty: A Literature Review</i> .
4	Cohen, J. M., Boniface, S., & Watkins, S. (2014). Health implications of transport planning, development and operations. <i>Journal of Transport & Health</i> , 1(1), 63-72.
5	Delbosc, A. (2012). The role of wellbeing in transport policy. <i>Transport Policy</i> , 23, 25-33.
6	De Vos, J (2018) <i>Towards happy and healthy travellers: A Research agenda</i>
7	Dzhambov, A. M., & Dimitrova, D. D. (2017). Children's blood pressure and its association with road traffic noise exposure—A systematic review with meta-analysis. <i>Environmental research</i> , 152, 244-255.
8	Dzhambov, A. M., & Dimitrova, D. D. (2018). Residential road traffic noise as a risk factor for hypertension in adults: Systematic review and meta-analysis of analytic studies published in the period 2011–2017. <i>Environmental Pollution</i> , 240, 306-318.
9	Geurs, K.T., Boon, W., & Van Wee, B. (2008). Social Impacts of Transport: Literature Review and the State of the Practice of Transport Appraisal in the Netherlands and the United Kingdom. <i>Transport Reviews</i> , 29(1), 69-90. https://doi.org/10.1080/01441640802130490
10	Lee, R. J., & Sener, I. N. (2016). Transportation planning and quality of life: Where do they intersect?. <i>Transport policy</i> , 48, 146-155.
11	Lucas, K. (2012). Transport and social exclusion: Where are we now?. <i>Transport policy</i> , 20, 105-113.
12	Mackett, R. (2014a). The impacts of concessionary travel passes for older and disabled people: a review of the evidence.
13	Mackett, R. (2015). Improving accessibility for older people—Investing in a valuable asset. <i>Journal of Transport & Health</i> , 2(1), 5-13.
14	Mackett, R. L. (2012). Children's travel behaviour and its health implications. <i>Transport policy</i> , 26, 66-72.
15	Mackett, R. L. (2014b). The health implications of inequalities in travel. <i>Journal of Transport & Health</i> , 1(3), 202-209.
16	Mackett, R. L., & Thoreau, R. (2015). Transport, social exclusion and health. <i>Journal of Transport & Health</i> , 2(4), 610-617.
17	McCormack, G.R., & Virk, J.S. (2014). Driving towards obesity: a systematized literature review on the association between motor vehicle travel time and distance and weight status in adults. <i>Preventive medicine</i> , 66, 49-55.
18	Mindell, J.S., Cohen, D.L., Shelton, N.J., Sutaria, S., Hayward, A., Watkins, S.J. (2014). Transport and clinical practice. <i>Journal of transport and health</i> . 1: 73-80.

19	Mindell, J. S., Cohen, J. M., Watkins, S., & Tyler, N. (2011a). Synergies between low-carbon and healthy transport policies. In Proceedings of the Institution of Civil Engineers-Transport (Vol. 164, No. 3, pp. 127-139). Thomas Telford Ltd.
20	Mindell, J., Rutter, H., & Watkins, S. (2011b). Urban transportation and human health.
21	Musselwhite, C., Holland, C., & Walker, I. (2015). The role of transport and mobility in the health of older people.
22	Ormerod, M., Newton, R., Phillips, J., Musselwhite, C., McGee, S., & Russell, R. (2015). How can transport provision and associated built environment infrastructure be enhanced and developed to support the mobility needs of individuals as they age. Future of an ageing population: evidence review Foresight, Government Office for Science, London, UK.
23	pteg (2010). Transport & Social Inclusion: Have we made the connections in our cities?
24	pteg (2011). Total Transport: Working across sectors to achieve better outcomes.
25	pteg (2014). Making the connections: The cross-sector benefits of supporting bus services.
26	Reardon, L., & Abdallah, S. (2013). Wellbeing and transport: Taking stock and looking forward. <i>Transport Reviews</i> , 33(6), 634-657.
27	Stansfeld, S., & Crombie, R. (2011). Cardiovascular effects of environmental noise: research in the United Kingdom. <i>Noise and Health</i> , 13(52), 229.
28	van Kamp, I., & Davies, H. (2013) Noise and Health in vulnerable groups: a review. <i>Noise & Health: a bimonthly inter-disciplinary international journal</i> , 15(64), 153-159.
29	van Kempen, E., Casas, M., Pershagen, G., & Foraster, M. (2018). WHO environmental noise guidelines for the European Region: a systematic review on environmental noise and cardiovascular and metabolic effects: a summary. <i>International journal of environmental research and public health</i> , 15(2), 379.
30	Wesselhoff, S., Hanke, T. A., & Evans, C. C. (2018). Community mobility after stroke: a systematic review. <i>Topics in stroke rehabilitation</i> , 25(3), 224-238.

Appendix F. Documents reviewed that were not included for data extraction or synthesis

Appendix Table F.1 List of documents not included

Full citation
Aldred, R., & Woodcock, J. (2008). Transport: challenging disabling environments. <i>Local Environment</i> , 13(6), 485-496.
Andrews, N., Clement, I., & Aldred, R. (2018). Invisible cyclists? Disabled people and cycle planning—A case study of London. <i>Journal of Transport & Health</i> , 8, 146-156.
Bagnall, A., South, J., Mitchell, B., Pilkington, G., Newton, R., & Di Martino, S. (2017). Systematic scoping review of indicators of community wellbeing in the UK. <i>What Works Wellbeing Centre</i> .
Boon, W., Geurs, K. T., & Van Wee, B. (2009). Social impacts of transport: literature review and the state of the practice of transport appraisal in the Netherlands and the United Kingdom. <i>Transport reviews</i> , 29(1), 69-90.
Buning & Karg. (2011). School bus transportation for students seated in wheelchairs. <i>Journal of Paediatric Rehabilitation Medicine: An Interdisciplinary Approach</i> , 4 (2011), 259-268.
Chatterjee, K., Clark, B., Martin, A., & Davis, A. (2017). The commuting and wellbeing study: Understanding the impact of commuting on people's lives. <i>UWE Bristol</i> .
Clery, E., Kiss, Z., Taylor, E., & Gill, V. (2017). Disabled people's travel behaviour and attitudes to travel.
DfT (2018). The Inclusive Transport Strategy: Achieving Equal Access for Disabled People.
Dzhambov, A. M., & Dimitrova, D. D. (2016). Exposure-response relationship between traffic noise and the risk of stroke: a systematic review with meta-analysis. <i>Arhiv za higijenu rada i toksikologiju</i> , 67(2), 136-151.
Ettema, D., Gärling, T., Eriksson, L., Friman, M., Olsson, L. E., & Fujii, S. (2011). Satisfaction with travel and subjective wellbeing: Development and test of a measurement tool. <i>Transportation Research Part F: Traffic Psychology and Behaviour</i> , 14(3), 167-175.
Frier, A., Barnett, F., & Devine, S. (2017). The relationship between social determinants of health, and rehabilitation of neurological conditions: a systematic literature review. <i>Disability and rehabilitation</i> , 39(10), 941-948.
Hjorthol, R. J., Levin, L., & Sirén, A. (2010). Mobility in different generations of older persons: The development of daily travel in different cohorts in Denmark, Norway and Sweden. <i>Journal of Transport Geography</i> , 18(5), 624-633.
HM Government (2018). A connected society: A strategy for tackling loneliness-laying the foundations for change.
Inayathusein, A. & Cooper, S. (2018). London's Accessibility Indicators: Strengths, Weaknesses, Challenges.
ITF (2018). Women's Safety and Security A Public Transport Priority.
Leung, Y. W., Brual, J., Macpherson, A., & Grace, S. L. (2010). Geographic issues in cardiac rehabilitation utilization: A narrative review. <i>Health & place</i> , 16(6), 1196-1205.
Levin, L., Ulleberg, P., Siren, A., & Hjorthol, R. (2012). <i>Measures to enhance mobility among older people in Scandinavia: a literature review of best practice</i> . Statens väg- och transportforskningsinstitut.

Lucas, K., Tyler, S., & Christodoulou, G. (2008). The value of new transport in deprived areas. *Joseph Rowntree Foundation, ISBN, 978(1), 85935.*

Metz, D. (2011). A delicate balance: Mobility and access needs, expectations and costs. International Transport Forum Discussion Paper.

Sacker, A., Ross, A., MacLeod, C. A., Netuveli, G., & Windle, G. (2017). Health and social exclusion in older age: evidence from Understanding Society, the UK household longitudinal study. *J Epidemiol Community Health, 71(7), 681-690.*

Sherer, M., Davis, L. C., Sander, A. M., Caroselli, J. S., Clark, A. N., & Pastorek, N. J. (2014). Prognostic importance of self-reported traits/problems/strengths and environmental barriers/facilitators for predicting participation outcomes in persons with traumatic brain injury: a systematic review. *Archives of physical medicine and rehabilitation, 95(6), 1162-1173.*

Swärdh, J. E., & Genell, A. (2016). Estimation of the marginal cost for road noise and rail noise.

Transport and Environment (2011). Better health through strong EU regulation.

Transport and Environment (2012). New EU vehicle noise limits.

UCL (2017). Street Mobility Project – Introduction.

UWE (2017). The Commuting and Wellbeing Study: Understanding the Impact of Commuting on People’s Lives.

van Kempen, E., Casas, M., Pershagen, G., & Foraster, M. (2017). Cardiovascular and metabolic effects of environmental noise: Systematic evidence review in the framework of the development of the WHO environmental noise guidelines for the European Region.

Vella-Brodrick, D. A., & Stanley, J. (2013). The significance of transport mobility in predicting wellbeing. *Transport Policy, 29, 236-242.*

de Vos, J., Schwanen, T., Van Acker, V., & Witlox, F. (2013). Travel and subjective wellbeing: a focus on findings, methods and future research needs. *Transport Reviews, 33(4), 421-442.*

Appendix G. Characteristics of included documents

* Number of papers listed in reference list, exact number of papers reviewed not stated,

** Number of papers listed in reference list, but chapter/ section examined in this review does not include all

Appendix Table G.1 Table of characteristics					
<i>Citation</i>	<i>Population/Setting</i>	<i>Transport aspect</i>	<i>Health/wellbeing aspect</i>	<i>Study design</i>	<i>Number of studies</i>
Mackett, R. L., & Thoreau, R. (2015). Transport, social exclusion and health. <i>Journal of Transport & Health</i> . 2(4), 610-61	General population in the UK	Transport (general)	Isolation, loneliness, connectedness	Narrative review	79*
Ormerod, M., Newton, R., Phillips, J., Musselwhite, C., McGee, S., & Russell, R. (2015). How can transport provision and associated built environment infrastructure be enhanced and developed to support the mobility needs of individuals as they age? Foresight, Government Office for Science, London, UK.	Older population in the UK	Transport (general)	Transport's direct impact on wellbeing; Isolation, loneliness, connectedness	literature review	Study reports a paucity of evidence-based articles
Mackett, R. (2015). Improving accessibility for older people—Investing in a valuable asset. <i>Journal of Transport & Health</i> . 2(1), 5-13.	Older people	Transport (general)	Transport's direct impact on wellbeing: effect of increased mobility on life satisfaction	literature review (or analytical essay)	33**
Mackett, R. (2014a). The impacts of concessionary travel passes for older and disabled people: a review of the evidence.	Disabled and older people in England	Concessionary bus travel	Access to health services for patients/clients; Transport's direct	literature review	63**

			impact on wellbeing; Isolation, loneliness, connectedness; Disability		
Abdallah, S. & Reardon, L., (2013). Wellbeing and transport: Taking stock and looking forward. <i>Transport Reviews</i> . 33(6), 634-657.	General population (older people are emphasised)	Transport (general)	Transport's direct impact on wellbeing; Isolation, loneliness, connectedness	literature review	166*
Musselwhite, C., Holland, C. and Walker, I. (2015). The role of transport and mobility in the health of older people. <i>Journal of Transport & Health</i> . 2(1), 1-4.	Older people	Transport (general)	Transport's direct impact on wellbeing; Isolation, loneliness, connectedness	literature review	44*
Mackett, R. L. (2014). The health implications of inequalities in travel. <i>Journal of Transport & Health</i> . 1(3), 202-209.	general population; Emphasises variance by sub-groups in relation to: gender, ethnicity, area of residence (rural/urban) and disability	Transport (general)	Transport's direct impact on wellbeing; Disability	literature review and use of data from various surveys	38 *
pteg (2014). Making the connections: The cross-sector benefits of supporting bus services.	General population in the UK; Focus on older people and disabled people	Bus use	Transport's direct impact on wellbeing; Access to health services for patients/clients	literature review (report)	24* (number of studies referenced in the chapter on health)
Mindell, J., Rutter, H., & Watkins, S. (2011). Urban transportation and human health.	General population	Transport (general)	Noise (contributing to minor psychiatric illness, sleep loss, diminished	literature review	12*

			performance); Isolation, loneliness, connectedness- traffic can contribute to isolation; Transport's direct impact on wellbeing (positive impact of bus travel);		
Bagnall, A., South, J., Di Martino, S., Southby, K., Pilkington, G., Mitchell, B., Pennington, A., Corcoran, R. for What Works Wellbeing (2018). Places, spaces, people and wellbeing: full review.	General population	Transport (general)	Transport's direct impact on wellbeing; Personal safety, fear, anxiety; Isolation, loneliness, connectedness	systematic evidence review	51
Lee, R. J., & Sener, I. N. (2016). Transportation planning and quality of life: Where do they intersect?. <i>Transport policy</i> . 48, 146-155.	Metropolitan areas	Transport (general)	Transport's direct impact on wellbeing; Isolation, loneliness, connectedness	literature review; content analysis of 148 transportation plans	148
Cohen, J. M., Boniface, S., & Watkins, S. (2014). Health implications of transport planning, development and operations. <i>Journal of Transport & Health</i> . 1(1), 63-72.	General population in the UK	Transport (general)	Mental health	literature review	110*
Mindell, J., Cohen, D.L., Shelton, N.J., Sutaria, S., Hayward, A., & Watkins, S.J. (2014). Transport and clinical practice. <i>Journal of Transport & Health</i> . 1(1), 73-80.	General population in the UK	Transport (general)	Mental health; Disability (Impact of transport on the	literature review	90*

			wellbeing of disabled individuals)		
Campaign for Better Transport (2012). Transport and Poverty: A Literature Review.	General population in the UK	Transport (general)	Transport's direct impact on wellbeing; Isolation, loneliness, connectedness; Access to health services for patients/clients	literature review	34*
Delbosc, A. (2012). The role of well-being in transport policy. <i>Transport Policy</i> , 23, 25-33.	General population	Transport (general)	Transport's direct impact on wellbeing; Isolation, loneliness, connectedness	literature review	9
Mindell, J. S., Cohen, J. M., Watkins, S., & Tyler, N. (2011b). Synergies between low-carbon and healthy transport policies. In: <i>Proceedings of the Institution of Civil Engineers-Transport</i> (Vol. 164, No. 3, pp. 127-139). Thomas Telford Ltd.	General population	Transport (general)	Isolation, loneliness, connectedness	literature review	84*
Dzhambov, A. M., & Dimitrova, D. D. (2018). Residential road traffic noise as a risk factor for hypertension in adults: Systematic review and meta-analysis of analytic studies published in the period 2011-2017. <i>Environmental Pollution</i> , 240, 306-318.	Adults in Europe and Canada - almost all studies conducted in Europe; the other one in Canada	Road traffic noise	Noise (increasing the risk of hypertension)	systematic review with meta-analysis	9
Wesselhoff, S., Hanke, T. A., & Evans, C. C. (2018). Community mobility after stroke: a systematic review. <i>Topics in stroke rehabilitation</i> , 25(3), 224-238.	Rehabilitating chronic stroke patients	Transport (general)	Access to health and other services for patients	evidence review	14

Dzhambov, A. M., & Dimitrova, D. D. (2017). Children's blood pressure and its association with road traffic noise exposure - A systematic review with meta-analysis. <i>Environmental research</i> . 152: 244-255.	Children and adolescents (< 18 years of age)	Road traffic noise	Transport's impact on health (increased blood pressure)	systematic review with meta-analysis	13
Boniface, S., Scantlebury, R., Watkins, S. J., & Mindell, J. S. (2015). Health implications of transport: evidence of effects of transport on social interactions. <i>Journal of Transport & Health</i> , 2(3), 441-446.	General population	Transport (general)	Isolation, loneliness, connectedness (Lack of access to transport can reduce social networks)	literature review	44
Lucas, K. (2012). Transport and social exclusion: Where are we now? <i>Transport policy</i> , 20, 105-113.	General population in the UK and Australia	Public transport	Isolation, loneliness, connectedness	Qualitative analysis supplemented by survey data; Intervention evaluation	63*
Mackett, R. L. (2012). Children's travel behaviour and its health implications. <i>Transport policy</i> , 26, 66-72.	Children (under the age of 17) in the UK	Car transport; walking; cycling; bus	Transport's direct impact on wellbeing	Other synthesis (primary data source used is National Travel Survey; other primary evidence comes from the CAPABLE study at UCL and another UCL research study;	28*

pteg (2011). Total Transport: Working across sectors to achieve better outcomes.	General population in the UK	Public transport, walking and cycling	Access to healthcare	literature review	8* (citations in the chapter on health)
Stansfeld, S., & Crombie, R. (2011). Cardiovascular effects of environmental noise: research in the United Kingdom. <i>Noise and Health</i> . 13(52), 229.	General population from the UK; focus on those with pre-existing heart disease	Traffic noise	Transport's impact on health (hypertension and risk of cardiovascular disease)	systematic review	14
van Kempen, E., Casas, M., Pershagen, G., & Foraster, M. (2018). WHO environmental noise guidelines for the European Region: a systematic review on environmental noise and cardiovascular and metabolic effects: a summary. <i>International journal of environmental research and public health</i> . 15(2), 379.	General population in Europe	Transportation noise from road and air traffic	Transport's impact on health (cardiovascular metabolic effects); Noise	systematic review with meta-analysis	15
pteg (2010). Transport & Social Inclusion: Have we made the connections in our cities?	Focus on people at risk of social exclusion in the UK (individuals without a car, on a low income, living in isolated estates, deprived areas or remote rural areas, older people, children and youngsters, people with health problems)	Public transport	Access to health services; Personal safety; Isolation, connectedness; Disability	literature review (policy paper)	47**

McCormack, G.R., & Virk, J.S. (2014). Driving towards obesity: a systematized literature review on the association between motor vehicle travel time and distance and weight status in adults. <i>Preventive medicine</i> . 66, 49-55.	Adults (> 16 years of age) Studies look at evidence from the United States, the United Kingdom, Spain, Columbia and Canada	Car use	Transport's direct impact on health and wellbeing (association between driving and weight status)	systematized literature review	10
van Kamp, I., & Davies, H. (2013) Noise and Health in vulnerable groups: a review. <i>Noise & Health: a bimonthly inter-disciplinary international journal</i> . 15(64), 153-159.	Vulnerable individuals (children, older people, chronically ill and people with a hearing impairment, shift workers, people with mental illness, foetuses and neonates)	Traffic noise		systematic literature review	62
Geurs, K.T., Boon, W., & Van Wee, B. (2008). Social Impacts of Transport: Literature Review and the State of the Practice of Transport Appraisal in the Netherlands	General population - comparison between Netherlands and the UK	Traffic; Presence of Parked Vehicles; Presence of Transport Facilities	Transport's direct impact on health and wellbeing (increased risk of diseases as a result of respiratory problems, noise nuisance, sleep disturbance)	literature review: analysis of policy documents linked to transport appraisal guidance	3
Vos, J (2018) Towards happy and healthy travellers: A Research agenda	General population in Western countries	Travel satisfaction; Travel behaviour	Transport's direct impact on health and wellbeing	literature review	51*