

Health Impact Assessment of Transport Initiatives A Guide

Health Scotland, MRC Social and Public Health Sciences Unit and Institute of Occupational Medicine



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About this guide

This guide has been written to help people doing a health impact assessment of a transport proposal. It:

- provides some background information on transport in Scotland and the policy context
- contains a review of literature evidence on transport and health
- suggests some questions to help apply literature findings to the context of a specific proposal
- outlines how to use the evidence to do a health impact assessment
- provides brief summaries of completed health impact assessments (HIAs) of transport-related topics
- highlights sources of information and data about transport.

Scope of the literature review

This guide offers an overview of the best available research evidence on the health impacts (both positive and negative) of transport initiatives. The focus of the review is on transport for access rather than transport as a leisure pursuit in itself (e.g. cycling or walking as a sport or leisure activity ^a). Therefore, this review does not include interventions to increase physical activity, unless through promoting walking and cycling as an alternative to using motorised transport. The document includes only a very short summary of the health impacts of climate change.

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^a Throughout this document the terms bicycle and cycling refer to pedal cycles as opposed to motorcycles, the terms motorcycles and motorcycling are used specifically.

Section 1: Background

Margaret Douglas, Jill Muirie and Martin Higgins

01

Chapter 01: Transport in Scotland

Scotland is characterised by a few large, built-up urban centres, a number of smaller towns, and vast remote and rural areas. Transport is therefore of great importance, particularly for those in remote and rural areas that have few, if any, local public transport services. The range of transport options available in Scotland includes aeroplane, ferry, train, motor vehicle (car, bus, coach, motorcycles or pedal cycle), walking or a combination of these.

National Travel Survey results for 2002/03 found that an average Scottish resident travelled around 6,670 miles per year within the UK and spent on average of just under one hour per day travelling. About 74% of the total distance travelled was by car.¹ The total distance travelled increased by 43% between 1985/86 and 2002/03 and reflects an increase in the distances people travel during each trip. The average length of a trip was 43% higher in 2002/03 than in 1975/76 but the average number of trips per person per year rose by only 12% in that time.

In 2003/04 the Scottish Household Survey² found that:

- 66.5% of Scottish households had one or more motor vehicles available for private use (i.e. 33.5% of households do not have a car available for private use)
- 22.7% of households had two or more cars

In commuting to workplaces in 2003/04:

- 63% usually travelled by car or van: 55% as driver, 8% as passenger
- 48% of these said they could use public transport
- 15% walked to work
- 14% travelled by bus
- 3% travelled by train
- 2% cycled to work

In travelling to school in 2003/04:

- 52% of pupils usually walked
- 23% travelled by bus
- 22% travelled by car/van
- 1% cycled

Underlying these figures is considerable variation according to the area in which people live. For example, car ownership was greater in rural areas (82%) than large urban areas (57%). In Aberdeenshire 84% of households have access to at least one car, whereas in Glasgow only 45% of households have access to a car. In 2003/04, 34% of households had one or more bicycles.³

The survey highlights how important car use is for access to important facilities. In total, 87% of people said they always use a car for supermarket shopping and 72% of people said they would find supermarket shopping fairly or very difficult without a car; 64% said they always use a car to visit their GP, 72% always use a car to visit friends and relatives, and 48% always use a car for leisure nights out. Overall, 54% said that they would find it fairly or very difficult to visit their GP without a car – this rose to 80% in remote rural areas but, even in large urban areas, 47% said they would find it fairly or very difficult to visit their GP without a car.

Public transport was described as ‘very convenient’ by 51% of adults in large urban areas, but by only 19% of those living in remote rural areas. Just over one-half (54%) of adults said that they had made a trip of more than a quarter of a mile by foot to go somewhere in the previous seven days.

Determinants of transport mode

Decisions around choosing to travel by car, public transport, bicycle or foot are complex and will often take into account a number of factors. A report published in 2003 by the Scottish Executive identified the barriers preventing car travellers from choosing to travel by rail, bus, foot or cycle, or not undertaking a journey at all.⁴ A summary of good and bad aspects of different modes of transport as perceived by residents in an affluent part of Glasgow is presented in [Table 1](#). This illustrates the imbalance of many ‘good’ perceptions of private car versus few ‘good’ perceptions of public transport.

The most important barriers to using public transport, walking or cycling were reported cost, time and reliability. Other factors included lack of information about timetables and routes, comfort, security and a wide range of individual needs and attitudes. Complementary or lifestyle factors that influence transport choice included non-transport costs and taxes, limited amount of travel time and the need to carry goods. Measures recommended to promote a modal shift from car use to public transport, walking or cycling include improvements to alternative forms of transport – including improving information and reliability, and ways to make car travel less attractive.⁴ (For more specific determinants of physically active transport see Chapter 4.)

Table 1: Perceptions of different modes of transport that may influence choice of transport mode (summary of findings from residents in an affluent suburb of Glasgow).⁴

	Good	Bad
Car	<ul style="list-style-type: none"> Convenience Fast Comfort Personal safety Carry loads/equipment More economical for car owners to use car than pay for alternative transport 	<ul style="list-style-type: none"> Pollution Congestion Stress of driving – road rage, guilt about not using public transport Speed cameras Poor road maintenance and signage
Public transport (general)	<ul style="list-style-type: none"> No worry about parking 	<ul style="list-style-type: none"> Inconvenience – times, location of stations/stops, bus and train routes not well integrated Lack of comfort – vehicles often overcrowded and vandalised, walking to station/bus stop in bad weather is unappealing Personal safety – stations/bus stops are often unmanned
Train	<ul style="list-style-type: none"> Fast Environmentally friendly 	<ul style="list-style-type: none"> High cost Unreliable in poor weather
Bus	<ul style="list-style-type: none"> Low cost 	<ul style="list-style-type: none"> Unreliable Lack of timetable information Exact change for fare required Slow Affected by congestion Polluting
Walking/cycling	<ul style="list-style-type: none"> Healthy/exercise Low cost Predictable Environmentally friendly Weather dependent Not able to carry goods/equipment 	<ul style="list-style-type: none"> Danger Exposed to pollution Weather dependent Not able to carry goods/equipment

Chapter 02: Transport Policy Context

01

This chapter outlines recent transport policy in Scotland, and some of the influences on this area of policy.

Historical background

The first transport strategies in the UK emerged in the 1940s. In the 1950s and 1960s, the main emphasis was on constructing a road network. Motorways and trunk roads were established across England; the first parts of the motorway network in Scotland were built in the mid-1960s. At around the same time, the British rail network was substantially reduced in scope. The Beeching Report identified numerous unaffordable, unused stations and branch lines that were subsequently closed.⁵

The oil crisis of the mid-1970s caused large increases in petrol prices. Following this, the government became concerned about the costs of road transport and reduced the scope of road-building programmes. This change in policy was linked also to increasing awareness of the potential environmental impacts of vehicle movement.

A change in government in 1979 brought a new emphasis in transport policy. During the 1980s, bus services were deregulated and plans to privatise British Rail began. Deregulation of the rail network began in 1994 and was completed by 1997. Some major new roads were completed (most notably the M25 around London and the M40 between London and Birmingham) and, amid an economic boom in the late 1980s and a relative reduction in fuel prices, car numbers increased steadily. In 1989, National Road Traffic Forecasts predicted a 142% growth in traffic levels up to 2025.⁶ This led to a major road construction scheme known as the 'Roads for Prosperity' scheme.⁷ Although road-building was acknowledged to increase use and therefore congestion, it was argued that economic development was dependent on vehicle movement.

Car ownership has increased rapidly since the 1950s and although fuel prices have increased consistently in real terms (around 10% higher than 1980), the so-called real cost of motoring has steadily decreased and is now lower than the 1980 level (includes purchase, maintenance, fuel, tax and insurance).^{8,9} Meanwhile, the cost of rail and bus transport has increased and is now 37% higher in real terms than in 1980.⁹ Policy initiatives that seek to moderate vehicle movement were first suggested in the Smeed Report in the 1960s.¹⁰ Yet, taxation aside, very few preventive initiatives have been implemented. Road user charging in London and Durham, and bus lanes with punitive measures for other vehicles entering them, are recent developments.

Use of rail travel declined from a peak in 1964 to a low in 1982, but began rising again in the mid-1990s. Despite public concern following some high-profile rail crashes in the early 2000s, the number of rail journeys in 2004/05 was similar to the number in 1964.¹¹

A major change in travel patterns in recent years has been the dramatic increase in the availability of cheap airline tickets, largely attributable to a deregulated airline market. The substantial increased fuel use associated with the massive increases in airline traffic may have significant environmental impacts.¹²

Influences on current transport policy

The previous chapter noted increasing average distances travelled per person per year in Scotland.¹ Much of this increase reflects increased car ownership and an increase in people travelling by car for leisure and employment opportunities. There are several reasons for the increasing levels of car ownership and usage in Scotland in recent years. Economic growth has meant an increase in demand for transport. The real cost of motoring has dropped and transport users, particularly users of car and air travel, pay an artificially low price for travel that does not reflect the full cost of each journey.¹¹ Land use patterns have changed, with many services now dispersed and designed to be accessed and used by people in their cars.¹¹

Levels of rail and bus travel both fell in the 1960s but have increased in recent years.¹¹ Air travel has increased greatly in recent years, offering improved passenger value but with significant increases in fuel emissions that are inevitably associated with air travel. Despite growth in the use of public transportation, private car use also continues to increase and there are growing concerns about congestion and pollution attributable to road transport and doubts about the sustainability of both road infrastructure and fuel supplies if current trends continue. For this reason, current transport policy seeks to balance the benefits and harms of road transport by reducing car use and promoting other forms of transport, while recognising that an efficient road network is vital to much economic activity.⁸

Recent Scottish transport policy

In 2004, the Scottish Executive published its first transport white paper, Scotland's transport future.⁸ This was followed by the Transport (Scotland) Act 2005,¹³ which is the first legislation for transport that focuses on the needs and requirements of Scotland alone. Specific issues of importance to Scottish transport policy that were highlighted in the white paper include:

- more than 50% of the population is concentrated in Scotland's central belt
- dispersed rural population outside the central belt
- transport to the islands
- high levels of deprivation in major cities.

The white paper set out the following aim and objectives.

Aim: 'To promote economic growth, social inclusion, health and protection of our environment through a safe, integrated, effective and efficient transport system.'

Objectives:

- promote economic growth by building, enhancing, managing and maintaining transport services, infrastructure and networks to maximise their efficiency
- promote social inclusion by connecting remote and disadvantaged communities and increasing the accessibility of the transport network
- protect our environment and improve health by building and investing in public transport and other types of efficient and sustainable transport which minimise emissions and consumption of resources and energy
- improve safety of journeys by reducing crashes and enhancing the personal safety of pedestrians, drivers, passengers and staff
- improve integration by making journey planning and ticketing easier and working to ensure smooth connection between different forms of transport.⁸

To achieve these, the white paper suggested that traffic growth should be managed more effectively. It set a target that 70% of the transport budget should be spent on public transport by 2006, in order to improve public transport infrastructure. The paper also suggested that it would be essential to change people's attitudes to their transport choices. The paper identified road user charging as a 'critical part of demand management' to reduce congestion and address environmental concerns.

The Scottish Executive has established Transport Scotland as an independent agency to take responsibility for capital investment projects and concessionary travel schemes. In addition, statutory Regional Transport Partnerships (RTPs) have been formed, charged with identifying regional transport objectives and then identifying projects and initiatives to deliver these objectives. These priorities are to be published in the form of a Regional Transport Strategy (RTS). In turn, each of Scotland's 32 council areas is expected to produce a Local Transport Strategy (LTS). LTSs will contain more localised proposals such as traffic management schemes, road user charging schemes and home zone policies. Scotland's NHS boards are expected to engage with RTSs and ensure their own travel plans are in accordance with national and regional priorities.

Spatial planning policy is also relevant to transport. The Scottish Executive produces Scottish Planning Policies (SPPs) that state policy on land use and other planning matters. SPP17 is on Planning for Transport.¹⁴ It is accompanied by a planning advice note (PAN 75) to provide advice on good practice.¹⁵ These documents note that transport and accessibility should be included in development plans from the outset. SPP 17 also emphasises that health benefits should be one of the key objectives of transport planning. It states that mode of personal travel should be prioritised as follows: walking, cycling, public transport and, finally, motorised modes. Major developments that are likely to produce significant travel movement require a transport assessment, the basis for which is analysis of the number of person-trips the development is likely to generate.

Developments that require Scottish Executive approval or funding may also be subject to Scottish Transport Appraisal Guidance (STAG). STAG is an objective-led process that provides guidance on how to appraise and justify all transport projects and policies.¹⁶ Local authorities are further encouraged to require developers to produce travel plans as part of the development planning application process. Travel plans are described as 'documents that set out a package of positive and complementary measures for the overall delivery of more sustainable travel patterns for specific development'.¹⁵

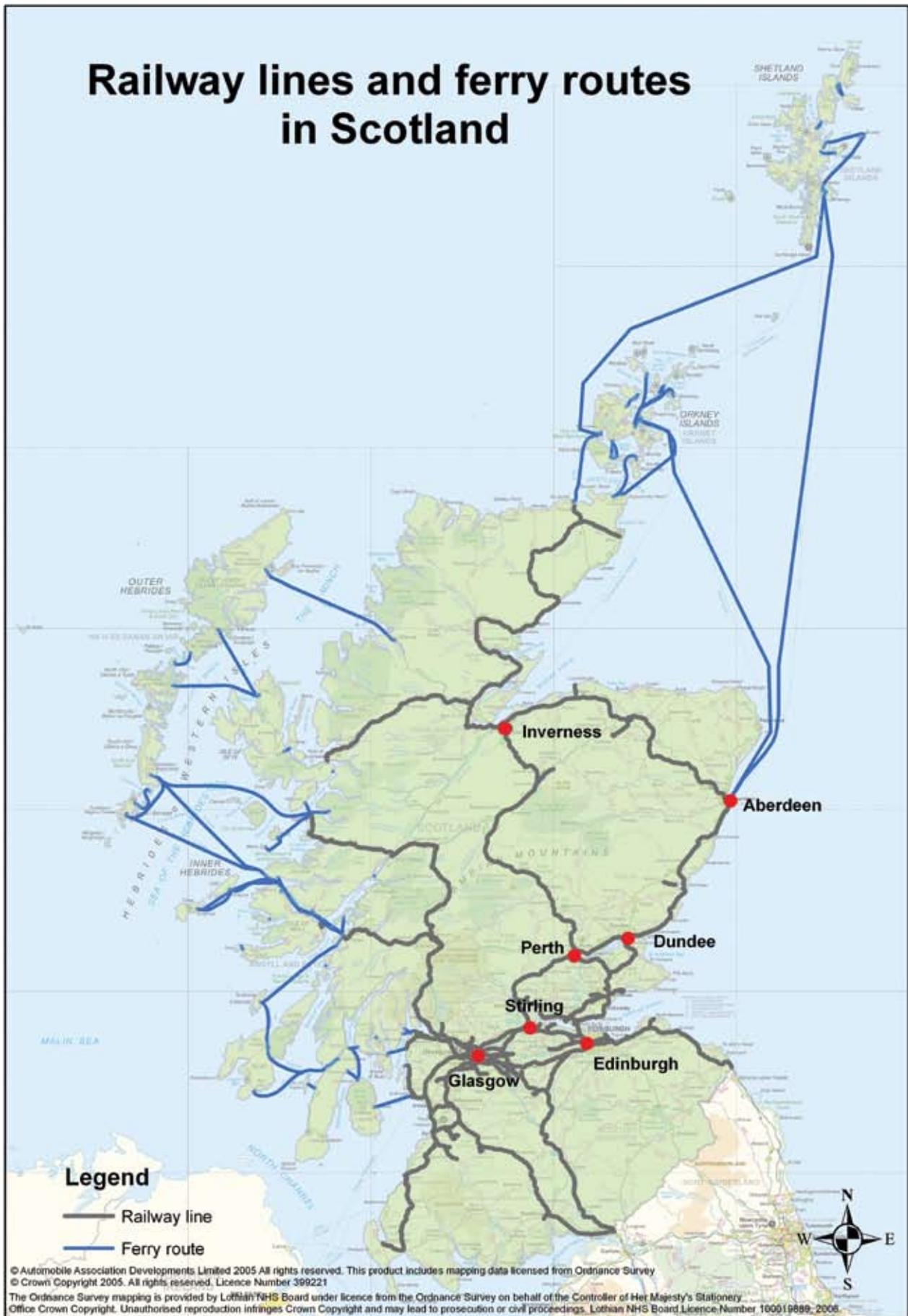
Health issues are linked to the environmental objectives of all recent transport policy. Sustainable transport is a recurring theme in SPP 17.¹⁴ Green transport plans are often recommended as a way to achieve this. Green transport plans are described as 'a way by which organisations and business manage the transport needs of their staff and visitors. The aim of any plan should be to reduce the environmental impact of travel associated with work, whether by plane or car'.¹⁷

Scotland's National Transport Strategy was published in December 2006.¹⁸ The strategy is intended to be consistent with the aims of the 2004 white paper. It focuses on three main areas of work:

- *improving journey times and connections*, to tackle congestion and the lack of integration and connections in transport which impact on our high level objectives for economic growth, social inclusion, integration and safety
- *reducing emissions*, to tackle the issues of climate change, air quality and health improvement which impact on our high level objective for protecting the environment and improving health and
- *improving quality, accessibility and affordability*, to give people a choice of public transport, where availability means better quality transport services and value for money or an alternative to the car.¹⁸

It also states that 'sustainable development principles will form the basis of our approach to this strategy'.¹⁸ This is intended to ensure that social inclusion, the environment and the economy are accorded equal importance in transport policy.

Map 1: Railway lines and ferry routes in Scotland.



Map 2: Motorways and trunk roads in Scotland.



Section 2: Evidence

Ruth Jepson, Hilary Thomson, Fintan Hurley and Margaret Douglas

02

Scope of the research reviewed

Transport research has focused predominantly on road transport. As a result, this review of research evidence presents limited evidence on train, ferry or air travel and their possible links to health.

This chapter includes information on transport, access and health. The research evidence presented in Chapter 4 focuses on the observed associations between transport and health as well as links between different modes of transport and health. Chapter 5 provides an overview of the available research evidence of the health impacts of transport interventions. Evidence of associations from cross-sectional studies can indicate potential ways to make transport healthier. However where possible, predictions of health impacts of an intervention should draw on research evidence that demonstrates the actual impacts of an intervention or initiative. (See Appendix 2 for details of the searches used to identify literature for this review.)

The focus of this report is policy interventions related to transport. The following are not included in this report:

- walking, cycling or driving for leisure or sport purposes only (e.g. competition cycling, hill walking)
- ways to increase physical activity unless this is to promote walking or cycling instead of car use
- health impacts of transport policies that may promote different modes of transport to move freight, for example roads versus trains.

In HIA it is important to look for impacts on the whole population, not simply the intended recipients of an intervention. An individual's transport behaviour may affect their own health but also that of other people. For example, an individual who chooses to drive may reduce his/her level of physical activity, subject him/herself to in-vehicle pollutants and risk crashes with other vehicles. But he/she also increases pollution for the whole community and increases the risk of crashes for other road users, including cyclists and pedestrians. This is often not well addressed in research that looks only at impacts on people who are the recipients of an intervention, or on the impact of individuals' transport choices on those individuals. When available, we have included research findings showing impacts on the whole community but often this is not available. For example figures are available showing the risk of death or serious injury for people using different modes of transport, but not the 'killed by' rates for each of those modes. This issue should be borne in mind when using the evidence for HIA.

Appendix 4 contains a summary of the findings of the review.

Chapter 03: Transport, Access and Health

The primary function of transport is the movement of people and goods between places, enabling access to social and leisure activities, goods and services. As such, transport is an important determinant of health, particularly by facilitating access to key socio-economic determinants of health.

The relationship between transport, access and health is complex. The relative importance of different types of transport will vary across different contexts and for different groups; therefore, reasons for choosing a particular mode of transport may vary by area and individual. For example, in an area with excellent public transport links, car dependency may be reduced and vice versa. There will also be specific groups, for example those with mobility problems, for whom public transport is not a feasible alternative to a private car. Transport that is affordable and accessible is necessary to enable essential economic and social activities. Situations in which transport provision or access is not equal for all groups may lead to social exclusion and inequality; the links between transport and social exclusion are discussed below.

In the UK, where good access to essential economic and social activities is often dependent on car travel, access to a car may lead to improved health. Two separate studies have shown a link between 'access to a car' and both physical and mental health; this link is independent of social class. Improved access to essential services facilitated by 'access to a car' may explain this link to better health.^{19,20}

Transport, social exclusion and inequalities

Data from Scotland and the UK reporting links between poor transport and social exclusion are summarised below:

- two out of five jobseekers say lack of transport is a barrier to getting a job
- nearly half of 16- to 18-year-old students say they find their transport costs hard to meet
- over a 12-month period, 1.4 million people miss, turn down or choose not to seek medical help because of transport problems.²¹

In Scotland, 67% of households own a car, but ownership is highly related to social class and income. For example, in Scotland 37% of households with an annual net income of under £10,000 own a car, compared with 98% of those with an annual net household income of over £40,000; 40% of households in the most deprived 20% of areas had access to a car compared with 86% in the least deprived 20% of areas.²²

Although poor transport is only one aspect of deprivation,²³ it may affect other important factors related to social exclusion and deprivation.²⁴ In urban Scotland, women, the unemployed, the elderly, people with health problems and those in low income groups are more likely to experience transport-related social exclusion.²³

Excluded groups are heavily reliant on walking, public transport and lifts from family, friends and neighbours.²³ Those living in households without a car report finding it harder to travel to get to shops, employment, healthcare and other services.^{21,25,26} Elderly people, people who are disabled and others with health problems find it difficult to use public transport, taxis or to walk.²¹ This suggests that in Scotland and the UK, lack of a car or access to a car may worsen existing levels of individual deprivation and social exclusion. A study of mothers living on low incomes, who relied heavily on walking, reported restricted access to essential services, amenities, shops and social networks. Although walking is a good form of physical activity with health benefits, if walking is the only affordable form of transport there may be important negative effects on the welfare of families, such as exclusion from a range of services and facilities that are located in edge-of-town, car-friendly retail parks.²⁷

In terms of health, access to a car has been linked to improved health, irrespective of socio-economic status (see Chapter 4). Rising levels of car ownership have led to increasing concerns about harmful effects on the quality of life for groups without regular access to a car. In a context in which public transport does not provide good access to essential services and amenities, it may be that access to a car leads to improved health through providing convenient access and reducing an individual's level of social exclusion. It has been suggested that planning decisions in the UK are often based around the expectation of car use by all, and that transport planners rarely think about how their decisions impact on less advantaged people, the elderly, and the disabled.²⁸

Not only are less well-off people less likely to have access to a car but also, in addition, the less well-off and those living in deprived areas experience a disproportionate amount of the harmful effects of cars:

- disadvantaged groups are more likely to be involved in a road crash²⁸
- the pedestrian death rate for children from families in social class V is four times that children of social class I²⁹
- the road crash rate for children in Social Class V is falling more slowly than for children in social class I²⁹
- speeding is more common in less affluent areas³⁰.

Urban–rural differences

People in rural areas in Scotland have a greater reliance on cars and are more likely to hold a full driving licence, have access to a car, drive every day and drive to work.³¹ The high levels of car ownership and car dependence may be explained by the greater distances required to travel to access jobs, essential services and leisure opportunities, as well as the reduced access to public transport compared with urban areas. Although those in rural areas with access to private transport may be able to choose the services they access, for others, especially those without access to a car, issues of transport-related social exclusion may be compounded by their rural location.

A total of 369 deaths were registered in Scotland in 2001 as a result of injuries sustained in road crashes. Rural areas account for less than 20% of Scotland's population, but 66% of road traffic deaths are registered in rural areas; a disproportionately high level compared with the population size.³¹ However, it is not known whether those killed on rural roads are rural dwellers or urban dwellers travelling through a rural area. In addition, road casualty rates by distance travelled are lower for rural roads than urban non-motorway roads (see [Table 2](#)).

Transport interventions and health inequalities

The uptake and effects of any intervention may vary across different socio-economic groups. For example, there is research evidence to suggest that those in more affluent groups adopt health promotion messages around healthy lifestyles more readily than their less advantaged counterparts.^{32,33} The implication of this is that health inequalities may increase; those in most need of health improvement are least likely to benefit and the gap between the healthier affluent population and the less healthy, less advantaged population may increase. In terms of the impacts of transport interventions on different socio-economic groups, very little is known. However, it is possible that programmes to promote walking and cycling instead of cars may be more effective in affluent groups. In addition, financial penalties on car use, for example fuel tax, will inevitably have a disproportionate effect on those living on low incomes, thus increasing the negative aspects of living in a car-dependent society for those who are already disadvantaged.³⁴ The possible differential impacts of a transport intervention across different social groups must be considered if impacts on both health and social inequalities are of interest to decision makers who are planning a transport policy or initiative.

Chapter 04: Transport and Links to Health/Determinants of Health

02

This chapter provides a review of available research, largely from cross-sectional studies reporting links between different modes of transport and health, and other statistical data linking transport and health. The outcomes included in this chapter are those that were hypothesised by the working group as possible ways in which transport might impact on health. It includes both impacts on health outcomes and impacts on health determinants, such as air and noise pollution. This chapter presents best available research evidence concerning the links between transport and these possible determinants of health in addition to research evidence of the links between the possible health determinants and health outcomes, for example links between air pollution and health. In most cases we have used research that has reported on observed links between a transport factor and a health or related outcome. In some cases, the extent of population health impact attributable to a transport factor is based on estimates, for example transport-related air pollution and predictions around climate change.

The health outcomes and related health determinants considered in this chapter are:

- general physical health
- physical activity
- injuries and deaths
- air pollution
- noise pollution
- stress/mental health and quality of life
- personal safety and perceptions of safety
- community severance and social inclusion
- climate change.

Transport and general physical health

Road transport and general physical health

Although cross-sectional surveys indicate an association between car ownership and better health, this does not denote a causal relationship. There are several plausible explanations for this association. One is that car ownership is strongly linked to socio-economic status (car ownership being lower among those on low incomes). Another explanation is that owning a car is a status symbol and this raises self-esteem. A third explanation is that cars can improve access to essential services and health promoting amenities. Researchers have explored the association between car ownership and health using Scottish survey data. One analysis found statistically significant associations with several health outcomes (e.g. number of symptoms and general health) after controlling for age, sex, income and self-esteem.¹⁹ Another analysis found that although car access was a predictor of health after controlling for social class, the significant association with most health measures was eliminated after controlling for income.²⁰ More research is needed to establish mechanisms through which cars and car ownership may influence health, and to determine the policy implications of this association.

Air transport and venous thrombosis

There is some research evidence pointing to an increased risk of blood clots (venous thrombosis) following long-haul air travel. The risk of a clot forming in the lower leg increases substantially for air journeys of eight hours or more; 1.6% per journey for low-risk groups and 5% per journey for high-risk groups (those at high risk include people with diabetes, hypertension, heart failure, obesity and limited mobility). These blood clots may subsequently travel to the arteries of the lungs leading to life-threatening pulmonary embolism but the risk of this is extremely low; for flights of eight hours or more the figure is less than three per million passengers (0.00028%).³⁵ Wearing anti-embolytic or compression stockings during a long flight does reduce the development of clots, especially small symptomless clots, as well as reductions in leg swelling. Because life-threatening pulmonary embolism is such a rare event it is not known whether the risk of serious embolism is reduced among those who wear compression stockings.³⁶

Overall assessment: Transport and general health

- Access to a car is linked to improved physical health
- This link is not explained by social class, income or feelings of self-esteem linked to car ownership
- The risk of life threatening emboli following air travel is extremely low but may increase following long-haul flights among high-risk groups

Transport and physical activity

02

Physical activity has been repeatedly linked with a range of improved health outcomes. The American College of Sports Medicine has recommended that the level of physical activity required to improve physical and cardiac fitness is at least twenty minutes of any vigorous activity or up to sixty minutes of moderate activity three times per week.³⁷ But other health benefits may be gained from less vigorous and shorter spells of physical activity if undertaken regularly.

In the UK, the current chief medical officer's recommendation for adults is to accumulate thirty minutes of moderate-intensity activity, such as brisk walking, on most days of the week (at least five days per week). This moderate-intensity activity can be accumulated in several bouts of at least ten minutes and is sufficient to bring health benefits.³⁸ Compared with people who are sedentary and do no exercise, people who are physically active have a reduced risk of death from any cause. More specifically, there is a substantial reduction in the risk of developing major chronic diseases such as coronary heart disease, stroke, type 2 diabetes and cancer, especially colon and breast cancer, for those who are physically active.^{38,39} Regular physical activity may also help with weight control and obesity prevention.³⁸ Muscle and bone strength may also benefit from regular physical activity; this can be of particular benefit for those at risk of falls and fractures, for example the elderly. Although there are reports of a link between improved mental health and physical activity, the research evidence to support these links is less clear than for the beneficial links between physical health and physical activity.^{38,39} Adverse effects of physical activity, for example injury or cardiovascular event, are also a possibility but the risks attached to moderate exercise for those with no pre-existing disease are small.³⁸

Some modes of transport involve more physical activity than others; however, whether or not walking or cycling to work leads to an increased level of physical activity overall is not known, as walking or cycling as a form of transport may be used as a substitute for other forms of exercise. For example, someone may start to replace car use with walking, but may subsequently stop an aerobic exercise class.

Determinants of physically active transport

With increasing levels of obesity there is growing interest within public health circles in the promotion of physical activity as a means of weight control and obesity prevention at a population level.³⁸ Overall levels of physical activity and physically active transport have been linked to characteristics of the local environment, in particular the urban built environment.^{40,41} For example, physically active transport (i.e. walking or cycling) has been directly related to increased residential density, street connectivity, mixed land use and amenities within a walking distance.⁴² Identifying key determinants of physical activity for transport, rather than for leisure or sport alone, may help to shape strategies to help promote physical activity through physically active transport. However, an expert review of this topic suggests that although characteristics of the built environment may help to facilitate physical activity, individual socio-demographic factors may be a more powerful influence on levels of physical activity and use of physically active transport. In addition, studies have investigated a number of different measures of the built environment and it is not clear which characteristics are most strongly linked to physically active transport.⁴¹ This suggests that improving neighbourhood design alone is unlikely to lead to a substantial increase in physical activity or use of physically active transport.

Perceived safety and aesthetics of the neighbourhood have also been linked to using walking as a form of transport.^{43,44} Available research suggests that weather is not an important influence on levels of walking in a neighbourhood; however, much of this research comes from Australia where there is less inclement weather than in Scotland.

Physical activity is influenced by many individual factors. There is some suggestion that physically active leisure is more common among those with higher incomes, but those who work long hours (more than forty-eight hours per week for men and more than thirty hours per week for women) are less likely to participate in physically active leisure.⁴⁵ Access to a car is also a predictor of increased levels of physically active leisure regardless of socio-economic position.⁴⁶

Cars and physical activity

Cars are a sedentary form of transport, minimising physical activity by allowing transportation from door to door. Around 58% of trips by car or van (either as driver or passenger) are under five miles, a distance that would take about thirty minutes by bike, and nearly 25% are under two miles (thirty minutes' brisk walk).⁴⁷ Although both health and transport disciplines link the increase in car use with the decline in physical activity and rise in obesity at a population level, these links have not been fully established at an individual level: it cannot be assumed that someone who drives a lot will be less physically active than someone who does not drive a lot. A project is currently under way in the UK to examine the relationship between car use and child health, including physical activity and obesity. Preliminary results suggest that higher car use in the family is linked to lower overall levels of physical activity.^{48,49}

Public transport and physical activity

Using public transport will often involve walking to and from the bus or train stops and may help otherwise inactive groups become more physically active.⁵⁰ In urban areas of Scotland, most people only need to walk a short distance to their nearest bus stop (less than six minutes),²³ and will also be likely to have a short walk at the other end to reach their destination. It is possible that using public transport, where users walk to the service, may promote physical activity compared to door-to-door car travel. Whether measurable health benefits would be realised from this potential increase in walking is not known.

Walking, cycling and physical activity

Walking and cycling as modes of transport are obvious forms of physical activity. The health benefit from walking or cycling instead of travelling by car will depend on the overall time and levels (light, moderate or vigorous) of walking or cycling done. As mentioned above, the health benefit of physically active transport, such as walking to school or work, will also depend on the impact on overall levels of physical activity. One study found that boys who walked to school were more physically active than those who travelled to school by car; however, there was no difference in overall levels of physical activity between girls who walked or were driven to school.⁵¹

Overall assessment: Transport and physical activity

- Walking and cycling are physically active forms of transport
- The current recommendation for adults to achieve health benefits is to accumulate thirty minutes of moderate-intensity activity, such as brisk walking, at least five days per week
- It is not known whether increased car use is linked to reduced physical activity overall at an individual level
- Physically active transport may lead to increases in overall levels of physical activity

Transport-related injury and death

Road crashes

Physical injuries (fatal and non-fatal) are the main consequence of road crashes. An overview of UK injury rates, and causes of road traffic crashes is presented below.

In 2004, 18,404 people were injured on Scotland's roads, of which over 2,700 were seriously injured and 307 were killed. Of the 3,007 people killed or seriously injured, 382 (13%) were children.⁵² Historically, the 'killed or seriously injured' casualty rates per head of population in Scotland have been higher than in England and Wales, whereas the 'all severities' casualty rate has been lower in Scotland than in England and Wales. In 2003, Scotland's casualty rates, compared with England and Wales, were 9% higher (killed), 1% higher (killed or seriously injured) and 28% lower (all severities). In all three cases, this represented an improvement in the position in Scotland relative to that in England and Wales (compared with the 1994–98 average).⁵³ In the UK, around 65% of road crashes occur in built-up areas, 30% outside built-up areas and around 4–5% on motorways (see [Table 2](#)).

Table 2: Rates of crashes (all vehicles), users and pedestrians killed/seriously injured by road type (2004) (rate per 100 million vehicle–kilometres travelled)

	Accident Rates	Users killed/ seriously injured	Pedestrians killed/ seriously injured
Motorways	9	1.2	0.0
Urban A roads	70	6.3	3.2
Urban B, C and unclassified roads	64	5.3	3.2
Rural A roads	25	5.8	0.4
Rural B, C and unclassified roads	46	8.9	1.0

Source: Department for Transport 2005. Road Casualties Great Britain: 2004 Annual Report. National Statistics publication (table 26)⁵⁴

Rates of road casualties (those killed or injured) have been consistently falling for over fifty years across most industrialised countries. In the UK, although there has been an increase in absolute numbers of crashes, the absolute numbers of those killed on the roads in 2004 was 36% lower than in 1950.⁵⁴ This significant fall in casualty rates is despite the massive increase in road traffic. Between 1980 and 2003, road traffic increased by 79%, whereas the number of road crashes resulting in personal injury fell by 15%.⁵⁵ The reductions in the numbers of crashes and casualties in recent years are even more significant given the rapid increase in traffic volume. For example, in 2003 the number of vehicles licensed in Scotland was more than one-quarter higher than in 1993; traffic on Scottish roads was estimated to have grown by about one-fifth since 1993.⁵³

Causes of road crashes and contributory factors

The risk of crashes varies, depending on the type of road, the traffic mix, the time of day, climatic conditions, and the speed and mass of the vehicles involved. Although there are many contributory factors to crashes, official road crash statistics do not record crash causation. Information based on the opinions of police officers collecting data at the scene suggests that the main contributory factors are speed, careless or reckless behaviour, inattention, lack of judgement of own travel path and failure to judge other person's travel path.⁵⁶

Speed

The most frequently cited contributory factor to fatal crashes in the UK was excessive speed, recorded in 28% of fatal crashes between 1999 and 2002.⁵⁶ This compares with 18% of severe crashes and 11% of slight crashes for which speed is cited as a contributory factor. Speed also affects injury severity; 80% of pedestrian or cyclist fatalities occur at impact speed between 20 and 40 miles per hour (mph), whereas fatal impacts at 0–20 mph account for only 5% of fatalities among vulnerable road users. Around 40% of pedestrians who are struck at speeds below 20 mph sustain serious injury, whereas at impacts of up to 30 mph, 90% sustain serious injury.^{57,58}

Driver sleepiness

Driver sleepiness is another contributory factor to crashes. In the UK between 1995 and 2001, 17% of road traffic crashes (RTCs) resulting in injury or death were sleep related. The proportion of sleep-related RTCs varies between 3% and 30%, depending on the road type, time of day (more likely during early hours of the morning) and use of artificial lighting.⁵⁹ A systematic review found that current epidemiological evidence for a causal role of fatigue in car crashes is weak but suggestive of an effect.⁶⁰

Motorway service areas are provided for drivers to stop and rest. An investigation of road crash data from two motorways in the UK over two to three years reports that there is little difference in the rate of sleep-related crashes on stretches of motorway before and after motorway services areas. It is unclear whether or not provision of motorway service areas or 'Tiredness kills – take a break signs' help prevent sleep-related crashes.⁶¹

Mobile phones

There is considerable concern that using a mobile phone while driving creates a significant crash risk to the user, and to other people on the road, because it distracts the driver, impairs their control of the vehicle and reduces their awareness of what is happening on the road around them.⁶² Using a mobile phone while driving has been reported to increase the risk of a road crash by four times; this increased risk was regardless of whether or not a 'hands-free' set was used.⁶³ In 2002 just under 1% of drivers in Scotland were observed to be using hand-held mobile telephone equipment while driving.⁶⁴ In December 2003 a law came into force to prohibit drivers using a hand-held mobile phone, or similar device, while driving. Although this has reduced the use of mobile phone use while driving, it has not stopped the practice altogether.

Drink-driving

Drink-driving is a significant cause of crashes. Drink-drive casualties are defined as any road users killed or injured in a drink-drive crash. UK estimates for 2003 suggest that 7% of all road casualties and 17% of road deaths occurred when someone was driving while over the legal limit for alcohol.⁶⁵ In Scotland the number of people killed as a result of drink-drive crashes is estimated to have fallen by around 20%, from about 60 in 1992 to around 50 in 2002. The number of serious casualties is also estimated to have dropped by 20% (from roughly 310 in 1992 to 240 in 2002).⁵³

Vulnerable road users: cyclists and pedestrians

In the UK the absolute numbers of cyclists killed or injured (serious and slight) has fallen by 32%, between the years 1994 and 2004, from 24 385 to 16 648. In addition, the estimated distance cycled has remained relatively constant over the same time period (in 1994, 4,000 million kilometres versus 3,900 million kilometres in 2004) so that the rates of cyclists killed or injured have also fallen substantially over the past decade. For example, rates for cyclists killed or seriously injured fell by 35% between 1994 and 2004.⁶⁶ Casualty rates for cyclists in Scotland are substantially lower than in England and Wales ('killed or seriously injured', 37% lower; 'all severities', 48% lower).⁵³ This difference may be due to quieter roads.

Countries that have seen a modal shift in cycling have noted reductions in casualties as more people cycle. The increased safety for cyclists is explained by the effect of a 'critical mass'. For example, a motorist is less likely to collide with a person walking and cycling when there are significant numbers of people walking or cycling.⁶⁷ An illustration of this comes from Copenhagen, where, over the past 10 years, the number of kilometres cycled has increased by twice as much as the number of kilometres driven, and the risk of a cyclist being involved in an RTC reduced by half between 1995 and 2000.⁶⁸ Thus there is some evidence that in places and countries where cycling is common, cycling is safer than in the UK, where cycling, as a means of transport, is relatively uncommon and provision for cyclists is limited.

The areas of highest risks for vulnerable road users such as pedestrians and cyclists are where minor roads intersect with arterial roads.⁶⁹ Roads near houses and schools are high-risk areas for children and may restrict their levels of physical activity, including cycling and walking. Parents report the fear of RTCs as the main reason for escorting children to school.⁷⁰

Severity of injury to pedestrians involved in a vehicle-pedestrian collision may be influenced by the size and shape of vehicle. The risk of fatal pedestrian injury is higher following collision with a light truck (sport utility vehicles (SUVs), pick-up trucks and vans) than with a standard passenger car.^{71,72} The weight and size of the larger vehicle will affect the severity of injury but this is not thought to explain the increased risk of fatality. Light trucks and SUVs have higher bonnets and bumpers than passenger cars and so collisions with these vehicles are more likely to result in injury to the middle and upper body, i.e. to the head, chest and abdomen.⁷³

Transport-related injury and death: other transport modes (trains, aeroplanes, buses, ferries and trams)

The number of fatalities from train, aeroplanes, bus or ferry crashes is small (see [Table 3](#)) and is largely as a result of major crashes. In the UK, fewer than 20 fatalities per year occur as a result of train movement, for example as a person enters or alights from a train.⁷⁴

No UK government statistics were found that reported the number of road crashes involving trams. However, two observational studies (in Sheffield, England, and Gothenburg, Sweden) found that trams can be a cause of crashes.^{75,76} In Sheffield the number of tram injuries presenting in the hospital accident and emergency department represented 0.13% of the patients attending the department. Cyclists appear to be the group at highest risk from tram-related injury, followed by pedestrians and motor vehicle users.⁷⁵ For cyclists, the most commonly described scenario was one where the cycle wheels became stuck in the tram tracks resulting in loss of control of the cycle. In the Swedish study, a majority (60%) of those fatally injured by a tram were under the influence of alcohol and most injury events happened at or near a tram stop.⁷⁵

Accidents by mode of transport

Although the number of people killed or seriously injured provides a simple measure of the danger of travel it makes no allowance for the number of people using a particular mode of transport or the distance travelled. These can be taken into account by calculating casualty rates.⁷⁷ Motorcycles are the most dangerous mode in this respect; walking and cycling are about half as dangerous, with car, taxi and bus travel being many times safer (see Table 3). The relatively high rates of fatality and injury among cyclists and pedestrians need to be viewed in context. These rates are for crashes occurring on roads, where, in the large majority of cases, a motor vehicle will be involved. The inevitable factors of the speed and weight of a motor vehicle mean that unprotected road users, i.e. cyclists and pedestrians, are far more vulnerable to being killed or seriously injured if involved in a road crash.

Table 3: Passengers killed or seriously injured (KSI) rates per billion passenger-kilometres travelled (2003)

Mode of transport	KSI rates
Rail (2002/03)	0.4*,**
Air	0.01**
Water	61**,–
Road: car	27+
Road: van	10+
Road: bus / coach	10
Road: motorcycle	1264+
Road: cycle	534
Road: pedestrian	443

Note: Rates taken from Department for Transport Annual Report 2003, table 51⁷⁸

* Fatalities only

** 1994–2003 average

– Passenger casualties on UK-registered merchant vessels (includes all public ferries and commercial ships)

+ Includes drivers and passengers KSI

Other health impacts of transport crashes

Although physical injuries (fatal and non-fatal) are the main consequence of transport crashes, there may be other impacts. For example, post-traumatic stress disorder has been found to affect one in three children⁷⁹ and one in ten adults⁸⁰ involved in RTCs.

Overall assessment: Transport-related injury and death

- Travel by rail and aeroplane has the lowest rate of fatality or serious injury
- Road users at highest risk of being killed or seriously injured are cyclists and pedestrians
- The most commonly cited cause of a road crash is speed
- Rates of road crashes in Scotland are falling despite increased road traffic
- Rates of crashes involving cyclists are lower in countries where cycling is common
- Very little research has been carried out on tram-related crashes

Transport, air pollution and health

Road transport as a source of air pollution in the UK

Air pollution is a complex mixture of particles and gases; and particulate matter (PM) is itself a complex mixture. The pollutants most associated with traffic are PM, nitrogen dioxide (NO₂), carbon monoxide (CO) and toxicants such as benzene. PM₁₀ is the mass concentration of inhalable particles, i.e. of about 10 microns aerodynamic diameter or less. PM_{2.5} is the corresponding measure for particles of 2.5 microns or less. The usual units are µg.m⁻³ (micrograms per cubic metre).

Primary particles are those emitted to air as particles. With road transport, this is principally from diesel engines, with some contribution from the wear of brakes and tyres. Using data from 2001, the Air Quality Expert Group (AQEG)⁸¹ (2005, table 4.11) reported that in the UK, road transport is responsible for more than 30% of the emissions of primary particles measured as PM_{2.5}, and about 50% of the very small (ultrafine) particles (PM_{0.1} less than 0.1 microns in diameter), which are, increasingly, believed to play an important role in causing adverse health effects.

Secondary particles are formed in the atmosphere through chemical reactions involving gases. Sulphates and nitrates are the two main components, with sulphur dioxide (SO₂) and nitrogen dioxide (NO₂), respectively, as precursor gaseous pollutants. SO₂ emissions from road transport are negligible. However, road traffic is responsible for almost one-half of the nitrogen oxides (NO_x) emitted into the air in the UK (AQEG, 2004, table 2.4; AQEG 2005, figure 4.7).^{81,82} NO_x is also a precursor of ozone (O₃), at a distance from the source of emissions. (Close to source, emissions of NO_x lead to reductions in low-level O₃.)

Annual average PM_{10} is about $25 \mu\text{g}\cdot\text{m}^{-3}$ (micrograms per cubic metre), and annual average $PM_{2.5}$ around $15 \mu\text{g}\cdot\text{m}^{-3}$ in UK cities. In terms of overall contribution to PM in the UK, emissions of primary particles from local transport are the source that dominates measurements of PM at roadside locations (AQEG 2005, p373).⁸¹ Background urban concentrations of PM are affected more by regional (long-distance) sources, including secondary particles from traffic elsewhere. This dual contribution of traffic to ambient PM highlights the importance of both local and international efforts to control air pollution from traffic.

Air pollution and health

Air pollution remains a public health problem associated with several adverse health outcomes. Although it has long been accepted that air pollution episodes lead to increased mortality and morbidity, more recent research has established that 'normal' levels of outdoor air pollution may also have adverse consequences. More than ten years ago there was already evidence that in the days following higher air pollution there were small but clear increases in:

- premature deaths from cardiorespiratory causes
- respiratory hospital admissions
- exacerbations of pre-existing asthma
- respiratory symptoms, and
- reductions in lung function⁸³.

More recent studies have reported links between increased daily outdoor air pollution and both cardiac hospital admissions, and other measures of cardiovascular morbidity.⁸⁴

Note that although higher air pollution may worsen the symptoms of pre-existing asthma, it has not been established that air pollution initiates the disease.⁸⁵ In particular, changes in air pollution appear not to be the cause of the increase in asthma in the UK in recent decades.

The main cause of poor health following exposure to increased air pollution is thought to be particulate matter, although effects of ground-level O_3 are also well established. Some effects occur in the days immediately following air pollution. For example, in Europe a rise of $10 \mu\text{g}\cdot\text{m}^{-3}$ of PM_{10} is estimated to increase the number of daily deaths by 0.6%, with an estimated 0.3% increase in daily death per $10 \mu\text{g}\cdot\text{m}^{-3}$ of O_3 .⁸⁶ These are small increases in daily deaths and those at greatest risk are people whose health is already impaired, in particular those with existing cardiorespiratory disease. However, small increases in risks across a large population may have significant public health impacts. The associations with PM are accepted as almost certainly causal,^{87,88} leading to recommendations for more stringent control of ambient particles in the UK and many other countries.

In addition, and much more importantly for public health, there are adverse consequences of longer term exposure to outdoor air pollution, especially to ambient PM, even at 'normal' levels. This was highlighted about 10 years ago when two large-scale cohort studies in the United States^{89,90} showed that, having adjusted for other factors (individuals' smoking habits, educational status, occupational exposure to air pollution), the risks of mortality are increased in cities with higher long-term air pollution. These results have been corroborated by further re-analysis, longer follow-up of the original studies, and studies elsewhere including in Europe,^{91,92} which have also found relationships between longer term exposure to air pollution and mortality.

It is now widely accepted that the annual average concentration of fine particles ($PM_{2.5}$) is the best available indicator for estimating the effects on mortality of long-term exposure to ambient air pollution. It is estimated that overall there is a 6% change in mortality per $10 \mu g.m^{-3}$ change in annual average $PM_{2.5}$.^{88,93,94} It has recently been estimated that this implies a reduction in life expectancy of about 220 days per person, on average across the population of UK, for every $10 \mu g.m^{-3}$ increase in $PM_{2.5}$, compared with an estimated reduction in life expectancy of less than 90 days attributable to passive smoking.⁹⁵ Bearing in mind that there are uncertainties in any estimates such as these and considering the contribution of transport to annual average concentrations of outdoor $PM_{2.5}$ in the UK, the reduction in life expectancy from transport-related air pollution is estimated to be of the same order as the reduction from passive smoking. It is widely accepted that there is no safe threshold for the effects of PM from human activities, including transport.

Health effects of traffic-related air pollutants

The health effects of traffic-related air pollutants were reviewed recently by the World Health Organization (WHO).⁹⁶ This report has informed much of the following review of traffic-related air pollutants and their health impacts.

Ambient particulate matter

As noted above, small particles, especially from combustion sources, are the components of air pollution most strongly associated with adverse health effects. Although the evidence is by no means conclusive, it is now thought that, per unit mass, primary particles are relatively more toxic than secondary ones; that, within the size range of PM_{10} , very small (fine, or ultrafine) particles are more dangerous than coarser ones; and that surface properties of particles, including transition metals, have a bearing on toxicity.^{81,86,97}

The gases: nitrogen dioxide, carbon monoxide and ozone

There are standards for the control of NO₂ that limit both short-term (one hour) exposures to very high concentrations and long-term exposures. Epidemiological studies show associations between NO₂ and respiratory health but it may be that in these studies NO₂ is primarily a marker for traffic-related air pollution more generally. Control of NO₂ is nevertheless important because it is a precursor of both secondary particles and O₃.

There is strong evidence that daily variations in O₃ concentrations are associated with increases in mortality from cardiorespiratory causes and with respiratory (although not cardiovascular) morbidity (e.g. see WHO 2003,⁹⁷ 2004⁸⁶) Currently, it is thought that there is no threshold at which O₃ levels start to affect health and that there is some risk to some of the population even at low background levels of O₃.⁸⁶ It is unclear whether there are particular additional risks associated with long-term exposure to ambient ozone.

Some studies also show associations between carbon monoxide (CO) and ill health, for example cardiovascular hospital admissions.⁹⁸ It may be that CO is acting as a marker for traffic-related pollution.

Other pollutants: benzene and lead

Other pollutants such as benzene or 1,3-butadiene pose only a small public health risk. In the UK lead has been phased out from petrol.

Studies of traffic-related air pollution and health

It is difficult to assess, through epidemiology, whether PM from traffic is more toxic (per unit mass) than PM from other sources. There is, however, some evidence that it is. The Air Pollution and Health – A European Approach (APHEA) studies in Europe have shown that the mortality risks from short-term exposures to PM are greater when concentrations of NO₂ (a common marker of traffic-related air pollution) are also elevated, suggesting a particular toxicity of traffic-related pollution.⁹⁹ A study in the United States found that the risks of mortality per 10 µg.m⁻³ PM_{2.5} were three times as high when the PM was attributed to traffic when compared to coal combustion as a source; PM from crustal sources (e.g. sea salt, natural wind-blown dust) was not shown to be related to daily mortality.¹⁰⁰

There is evidence of increased risk of mortality in people living near major roads; these risks may be due in part to relatively high concentrations of ultrafine particles in roadside air pollution, although other factors may also play a part. In particular, a study of the mortality (1986–94) of nearly 5,000 people in the Netherlands, aged 55–69 in 1986, found that deaths from cardiorespiratory causes were almost twice as likely (relative risk 1.95; confidence interval (CI) 1.09–3.52) in people who had lived within 50 m of a major road for 10 years or more. Although some relationships with air pollution were found, it is not clear how much of this increased risk can be attributed to the increased exposure to transport-related air pollution associated with living near a major road.⁹¹

As noted earlier, there is little evidence that exposure to air pollution is a cause of the increase in asthma noted in many Western countries, including the UK. Nevertheless, the belief persists that transport, generally, and the associated air pollution in particular, is an important cause of the disease. Several studies have investigated the possible association between traffic and prevalence/incidence of asthma, especially in children. In an overview of the limited number of studies available in 1995, the Committee on the Medical Effects of Air Pollutants (COMEAP)⁸⁵ found 'a consistent, though modest, association between exposure to traffic and asthma prevalence in children' but was unclear if the association was causal, especially with regard to initiation rather than provocation of asthma. The evidence is currently being reviewed again by COMEAP. However, most studies since 1995 have examined asthma prevalence rather than incidence, making it difficult to clarify the role of pollution, and traffic, in the initiation of asthma. There is evidence of association with heavy goods traffic in particular though, if the association is causal, it does not appear to be mediated via air pollution concentrations as measured conventionally.

In-vehicle concentrations and exposure to air pollutants

The relationships between pollutant concentrations in vehicles and concentrations at background measurement sites, i.e. away from roadside or other immediate sources of pollution, were reviewed by the WHO.⁹⁶ Generally, studies in the United States and Europe found that in-vehicle concentrations were on average 4–5 times as high as measurements at background sites for carbon monoxide, 5–8 times as high for benzene, and lower, at about 1.5 times background, for NO₂. In London, in-vehicle PM_{2.5} was more than twice the background level, with a much higher ratio for elemental carbon, presumably from diesel.¹⁰¹ These are average ratios whose magnitudes vary in particular circumstances according to traffic conditions, weather conditions and characteristics of the vehicle. As noted in the WHO report,⁹⁶ the differences between background and in-vehicle concentrations reflect both general differences between background and roadside concentrations, which also affect cyclists and pedestrians, and some in-vehicle accumulation relative to general roadside concentrations.

Mass concentrations of PM (e.g. PM₁₀ or PM_{2.5}) in underground railways are typically much higher than ambient background levels in cities. However, studies of the London Underground showed that when particle number rather than mass was considered, measurements were much lower underground than above ground.¹⁰² The dust underground is principally due to abrasion between wheels and rails, whereas general ambient PM is mostly from combustion, especially traffic. Underground dust is consequently much coarser than ambient particulate pollution, and has a different composition. Seaton *et al*¹⁰² concluded that there were some risks to health from pollution above and below ground but that the differences were not big enough that they should influence individuals' choice of mode of transport.

Exposure to air pollution is influenced not only by background pollution levels but also by time spent in various micro-environments (e.g. at home, at work, travelling) and by breathing patterns which are, in turn, influenced by levels of physical activity. These vary by age, gender, occupation and so on, for example, the volume of air inhaled per minute by cyclists and walkers is higher than by sedentary travellers in cars or in underground trains.

Overall assessment: Transport-related air pollution and health

- Air pollution is a complex mix of particles and gases. Increased outdoor air pollution is associated with increased cardiorespiratory mortality and morbidity. Some effects are more or less immediate and affect vulnerable groups in particular, whereas the effects of long-term exposure are more widespread
- Small particles (PM) are the constituent most closely associated with adverse health outcomes
- Road transport is responsible for 30% of the emissions of PM_{2.5}, and about 50% of the emissions of PM_{0.1}
- It is estimated that overall there is a 6% change in mortality per 10 µg.m⁻³ change in annual average PM_{2.5}
- For many pollutants, concentrations in vehicles are higher than background and general roadside concentrations

Transport-related noise pollution and health

Motorised forms of transport are a common source of noise pollution, with road traffic being the most common. Other sources of transport noise, such as rail and air traffic, may be less common in terms of people affected but may be regarded as a serious cause of noise pollution for those living or working near a rail or air network. Noise levels are measured in decibels and Table 4 shows the levels for different types of transport.

Table 4: Noise levels for different forms of transport

Decibels, A-weighted dB(A)	Form of transport
120	Aircraft at take off
110	
100	Pneumatic drill at 1 m
90	Lorry, motorcycle, underground train
80	Busy crossroads
70	Near a motorway
60	Busy street through open windows
50	Busy street through closed windows
40	
30	Quiet room
20	Broadcasting studio
10	Desert
0	

Source: adapted from R. Tolley and B. Turton (1995) *Transport Systems, Policy and Planning: A Geographical Approach*, Burnt Mill, Harlow Essex: Longman Scientific & Technical, p279.¹⁰³

About 65% of the population of the European Union are exposed regularly to sound levels of 55–65 dB. These levels do not result in hearing loss but are enough to lead to serious annoyance, interference with speech and sleep disturbance.^{104,105} Stress has been suggested as a possible mechanism through which noise may affect mental and physical health.¹⁰⁶

Road transport

The noise of motorised road vehicles is mainly generated from the engine and from frictional contact between the vehicle and the ground and air. In general, road contact noise exceeds engine noise at speeds higher than 60 km/h. The level of noise from traffic is correlated with the weather, road surface type, for example asphalt or cement, traffic flow rate, vehicle speed, tyre width and vehicle type. Heavy vehicles, such as lorries and motorcycles, tend to be about twice as loud as motor cars.¹⁰⁷

No systematic review of the evidence on road noise was identified. However, noise from road intersections above 50–60 dB(A) has been reported to cause sleep disturbance,¹⁰⁵ and road noise may also deter people from walking or cycling on busy roads.¹⁰⁸

Walking and cycling

Walking and cycling are not a source of noise pollution.

Other transport modes: trains, aeroplanes, buses, ferries and trams

Those living near to an airport will be exposed to high levels of noise, especially those living near an airport used by large numbers of jet planes. As indicated above, the negative impacts of noise are most commonly annoyance, sleep disturbance and stress. Hearing loss occurs more rarely following sustained exposure to high levels of noise, most often via occupational exposure.

One systematic review studied the health impacts of aircraft noise for those living near a busy airport.¹⁰⁶ The research evidence reviewed reported a range of physical and mental health impacts often with contradictory findings. In addition, the quality of the research evidence available was poor, and increased levels of poor health among residents living near airports often disappeared when socio-economic status, age and sex were considered. In summary, there is no clear link between living in an area with high levels of aircraft noise and mental or physical health outcomes. High levels of noise cause annoyance and irritation, especially for those who are highly sensitive, but noise annoyance is not always an indicator of high noise levels.¹⁰⁶

Living in an area with high levels of aircraft noise is associated with other impacts, such as sleep loss and reduced quality of sleep, but it is not clear whether this leads to further health outcomes. The impact of aircraft noise on child health and educational performance has been assessed among children living in the three boroughs (123 schools) surrounding Heathrow Airport. Although levels of noise were linked to higher levels of annoyance, perceived stress, poorer reading comprehension and reduced attention, this link disappeared when the socio-economic status of the children and schools were considered.¹⁰⁹

No research was found investigating the possible health impacts of noise from other modes of transport such as trains, ferries and trams. However, possible impacts of transport noise will be similar and will depend on the level of noise rather than on the specific cause or source.

Overall assessment: Transport noise and health

- Links between transport noise and health are inconclusive
- Transport noise is unlikely to result in long-term hearing problems
- Aircraft noise may lead to sleep disturbance and reduced quality of sleep
- There is no clear link between living near to an airport and other health outcomes

Transport, mental health and stress

There are many possible sources of stress for transport users, for example overcrowding on trains and traffic jams for cars. However, there is very little research evidence looking at the mode of transport and its effects on an individual's levels of stress and mental health.

One area that has been of interest is the links between commuting and stress. Commuting by car and train has been linked to elevated stress and blood pressure. It is difficult to compare different commuters and different stress levels due to the multiple influences on stress, in particular with job-related stress linked to commuting. Journey duration, predictability and convenience, for example direct train route, number of road intersections, appear to be associated with lower stress levels.¹¹⁰⁻¹¹³

Physical activity

Increased levels of physical activity may be linked to improved mental health in some groups but the research evidence to date is inconclusive.³⁹

Access to a car

Access to a car has been linked to improved mental health independent of social class. This link has also been shown to be independent of self-esteem and income.^{19, 20}

Road rage

'Road rage' is a phenomenon that has been highlighted by the media in recent years. The label is now commonly associated with any form of aggressive or antisocial behaviour that occurs when at least one party is involved in driving and may involve other road users such as pedestrians and cyclists. A study of recent UK surveys and media reports found that although many people feel that they have been a victim of road rage, there is little reliable information on this and no real measure or estimate of incidence. National newspaper reporting would suggest that road rage incidents are a serious problem, but the incidence and prevalence of road rage is not accurately captured.¹¹⁴

Public transport

Very little research exists looking at the mental health impacts of public transport. One review of passenger crowding on trains in the UK was identified. It is suggested that perceptions of crowding and actual passenger density levels are not always closely linked. Where passengers do feel 'overcrowded' this may lead to stress but the perceptions of overcrowding and related stress may be mediated by feelings of safety and control, and familiarity with the journey.¹¹⁵

02

Overall assessment: Transport and mental health

- Links between physical activity and improved mental health are unclear
- Access to a car is linked to improved mental health
- There is little available research on the subject of road rage or public transport-related stress

Transport, personal safety and perceptions of safety

Cross-sectional data on the level of personal safety (excluding crashes), for example muggings, between the different types of transport modes is not available. However, surveys and qualitative research undertaken in Scotland suggest that perceptions of personal safety may affect an individual's decision to walk, cycle or use public transport, especially after dark.⁴

Walking and cycling

Streets dominated by motorised vehicles with reduced numbers of people on the streets may create a social environment that is conducive to increased crime, which then discourages more people from walking,⁴ in particular women and children.¹¹⁶ It has been argued that the greatest contribution to safe, comfortable walking is to encourage more people to walk.⁴⁷

Public transport users

One survey found that users of public transport experience a range of crime and nuisance.¹¹⁷ For example, in the UK over a twelve-month period:

- 5% of passengers report being threatened with violence
- 4% of passengers report being the victim of theft
- 11% of passengers report being stared at in a hostile or threatening way; and
- 12% of passengers report being deliberately pushed.

Fear of crime emerges repeatedly in passenger surveys as being an important factor influencing travel choices.¹¹⁸ On the whole, women's fear is greater than men's, and women are more likely to avoid using public transport as a result.¹¹⁷

Overall assessment: Transport and personal safety

- Personal safety fears and fear of crime may deter people from walking, cycling or using public transport

Transport and community severance

A transport route may run near or through inhabited areas and communities. In some cases these routes may run through a community such that it bisects the community. This is referred to as community severance and is defined here as reduced access to local amenities and disruption of local social networks caused by a physical barrier running through a community. For example, the route of a new road, railway or transport facility may run through an existing community. Community severance may also follow significant increases in traffic flow on a road that was not originally regarded as a barrier.

The severance effect of transportation routes may lead to reduced access to local services and facilities especially for pedestrians and cyclists who feel unsafe crossing a busy road. In addition, busy roads may disrupt social networks within a community; this may be of particular importance to those who rely heavily on local social networks, e.g. the elderly and parents with young children. A study of three San Francisco streets in the 1970s found that the busier the traffic on a street, the fewer friends and acquaintances were made with neighbours living on the same road.¹¹⁹

The health impacts of community severance are not known. Although access to essential services and engaging with social networks may be linked to health, the potential for a road to have a substantial impact on these factors would depend on the specific nature of the severance and the reliance of the affected population on local services and networks bisected by a new road or rail route or increased traffic.

Overall assessment: Transport, community severance and health

- New transport routes running through an existing community may lead to community severance
- Substantial increases in traffic through a community may lead to community severance
- The health impacts of community severance are not known

Transport and climate change^b

Climate change and transport

The Department for Transport estimates that transport accounted for 22% of carbon dioxide (CO₂) emissions in the UK in 1995; road transport accounts for 95% of all transport emissions.¹²⁰ Although measures to reduce carbon emissions have been introduced nationally, transport is the only sector in the UK in which carbon emissions are still increasing.¹²¹ These gases collect in the earth's atmosphere and act to increase the earth's surface temperature, causing complex changes in the climate system.¹²² The United Nations Intergovernmental Panel on Climate Change (IPCC) concluded that there is strong evidence that the Earth's climate system has demonstrably changed since the pre-industrial era. In the past century the global mean surface temperature is thought to have risen by around 0.6°C (± 0.2°C). The IPCC states that it is likely that the 1990s were the warmest decade on record and forecasts continuing increases in CO₂, surface temperatures and sea levels during the twenty-first century.¹²³ Historically there have been major changes in climate and some change seems to be an essential part of the global weather system. Some debate remains about the exact amount of recent climate change attributable to human activity, specifically that attributable to large increases in fossil fuel use compared with the pre-industrial era. However, there is no doubt that human activity has led to increased concentrations of greenhouse gases and aerosols. The scientific consensus expressed by the IPCC is that most of the warming over the past 50 years is attributable to human activity.¹²³

Climate change and health

Climate change is thought to have already caused health impacts. The WHO estimates that in 2000 climate change was responsible for approximately 2.4% of cases of diarrhoea worldwide, and 6% of malaria cases in some middle-income countries. Climate change was estimated to have caused 150,000 deaths and 5.5 million disability adjusted life years (DALYS) in the year 2000.¹²⁴

A model illustrating how climate change may lead to health impacts suggests a number of routes for, and a range of, possible health impacts.¹²⁵ Climate change could have beneficial impacts in causing some reduction in winter mortality in temperate countries. However, most of the health impacts of climate change are likely to be adverse and are predicted to include:^{123,124,126}

- direct impacts of thermal stress in heatwaves
- death and injury associated with natural disasters, such as floods and storms
- infectious diseases caused by changes in the seasonal ranges of disease vectors, such as mosquitoes
- food and water-borne disease: WHO estimates that incidence of diarrhoea is 10% higher in some regions than it would be in the absence of climate change
- altered transmission of other infectious diseases
- cardiorespiratory and allergic diseases associated with changes in air pollution and aeroallergen levels
- malnutrition caused by changes in plant pests and diseases, droughts and famine, and
- the impacts of population displacement due to natural disasters, crop failure, water shortages and conflict over depleted natural resources.

^b Where possible this review draws on research which has reported on observed links between a transport factor and a health or related outcome. For evidence on the size or amount of health impact attributable to climate change the review draws on estimates and predictions of health impacts.

People may employ a range of social, technical, environmental and behavioural adaptations to mitigate the impacts of global warming. In its Third Assessment Report (2001) the IPCC concluded that 'Overall, climate change is projected to increase threats to human health, particularly in lower income populations, predominantly within tropical/subtropical countries'. The poorest populations are often those least able to adapt and are therefore the most vulnerable. For example, city dwellers who are socially isolated and have fewer financial and other resources are most likely to suffer from excess heat. The impact of global climate change is likely to fall heaviest on the poorest people, and particularly on people in tropical regions, low-lying areas and developing countries with fragile ecosystems.^{122,124}

The WHO states that estimates of the health impacts of climate change are essential to guide policies to reduce greenhouse gas emissions. It has produced some guidance on the health impact assessment of climate change.¹²⁴

The health impacts of climate change differ from the other impacts discussed in this document in that their effects are global and will arise over a longer time interval. Transport decisions made in one area can cause impacts across the world, such that the cumulative effects of local decisions need to be considered. Although any individual decision may have a very small impact, an accumulation of many similar small changes may together have serious environmental, social, economic and health impacts at a global level.

Overall assessment: Climate change, transport and health

- There is wide scientific consensus that the global climate is changing and that most of this change is attributable to human activity since the pre-industrial era
- Motorised transport accounts for 22% of CO₂ emissions
- A range of detrimental health impacts are predicted to arise from continued climate change, with lower income populations, predominantly within tropical/subtropical countries the most likely to be seriously affected

Summing up

Transport facilitates access to jobs, education, shops, leisure and other essential services, for example health services. As well as having a key role in the wider economy, access to these daily essentials is of central importance to an individual's socio-economic status and levels of neighbourhood social exclusion. Therefore availability of accessible, affordable transport may also, in itself, be regarded as a determinant of health.

However, the mode of transport used (e.g. car, bike, train or bus) may additionally impact positively or negatively on health outcomes for both individuals and the population as a whole. As indicated in this review of research, the relationship between mode of transport and health outcomes is complex. For example, at an individual level, access to a car may encourage sedentary behaviour, but access to a car may also facilitate physical activity (e.g. by enabling access to gyms and the countryside).

At a population level, car use may cause death and injury to vulnerable users such as pedestrians and cyclists, and increase noise and air pollution. As more people walk and cycle, the risk of road injury for vulnerable road users falls due to a 'critical mass' effect. A summary of the research evidence reporting links between road transport and health is presented in Table 5 below and overleaf.

Table 5: Summary of hypothesised links between road transport and health with strength of supporting research evidence (SoE)* (Table 5 continued overleaf).

Transport factor	General health	SoE	Mental health and stress	SoE	Physical injury/death	SoE	Physical activity	SoE
Mode of transport								
Car	Very little research investigating links between use of different transport modes and general health		Very little research investigating links between use of different transport modes and mental health		27** killed per billion miles travelled		Sedentary form of transport	
Bike					534** killed per billion miles travelled		Physically active form of transport	
Walking					443** killed per billion miles travelled		Physically active form of transport	
Public transport					10** (bus/coach) killed per billion miles travelled		May require short walk to pick-up point (mean time from home to bus stop is six minutes in Scotland)	
Car ownership/access	Improved health independent of social class, income, self-esteem	2-	Improved mental health: independent of income and self-esteem	2-			High levels of car use may be linked to lower levels of physical activity	2-
							Those with access to a car are more likely to participate in physically active leisure, independent of socio-economic status	2-

* See Appendix 3 for framework used to assess strength of evidence

** UK data 2003, may vary by country factors and varying proportions of different transport modes, for example cyclists

Table 5 (continued): Summary of hypothesised links between road transport and health with strength of supporting research evidence (SoE)*

Road transport factors/impacts and hypothesised links to health or related social outcomes		SoE
Transport factor	Links to health and related social outcomes supported by research evidence	
Physical activity	Moderate physical activity, such as brisk walking, accumulating to thirty minutes on five days per week is recommended for adults to benefit health. Regular moderate activity may lead to reduced risk of chronic disease and death from any cause and may help control weight and prevent obesity.	2++
	Physical activity may have a protective effect on mental health.	2++
Community severance	May disrupt local social networks and access to local services but potential for impact will vary substantially by area geography. Health impacts are unknown.	3
Air pollution	Traffic contributes to outdoor air pollution. Both short- and long-term exposure to ambient particulate matter (PM) increases the risks of death and disease from cardiorespiratory causes. Some effects are more or less immediate and affect vulnerable groups in particular, whereas the effects of long-term exposure are more widespread. In Britain, long-term exposure to transport-related air pollution measured as PM _{2.5} is estimated to reduce life expectancy by a few months, an effect similar to the estimated effect of passive smoking.	3
Noise pollution	Not sufficient to lead to hearing loss, but is likely to cause sleep disturbance for those living in the immediate vicinity of a busy street or motorway. Other health effects are unknown.	3
Personal safety	May affect decisions to walk, cycle or use public transport but health effects are not known.	3
Stress	Traffic congestion may cause short term elevations in stress markers but possible long-term effects are not known.	2-

Chapter 05: Health and Health-related Impacts of Transport Interventions

This chapter draws on systematic reviews of research evidence of the health impacts of transport interventions (see Appendix 2 for the search strategy). The term transport intervention is used here to refer to any deliberate activity, initiative or policy. These interventions can range from the legal enforcement of seat belt use to investment in traffic calming, road design, driver education campaigns and initiatives promoting active commuting, for example cycling to work.

As with the previous chapter, the research reviewed focuses on road transport. This reflects the dearth of research into the health impacts of non-road transport. In addition, transport research has been dominated by interests in injury reduction and thus much of this chapter reports the impacts of interventions designed to reduce crashes; there is much less evidence on the impacts of other kinds of intervention. Despite extensive literature searching, no research reviews were identified that evaluated the health or social impact of interventions for air travel, travel by railways (heavy or light) or ferries.

Although a HIA should consider a range of potential impacts, including unintended impacts of a proposed intervention, available research has tended to study a very small range of outcomes and often focused solely on the intended outcome, most often injury reduction.

The interventions considered are the health impacts of:

- new transport infrastructure
- interventions to reduce road traffic and fuel consumption
- interventions to reduce air pollution
- interventions to reduce noise pollution
- interventions to promote modal shift to walking and cycling instead of car use
- interventions to improve psychosocial aspects of public transport
- interventions to reduce injury and death from crashes.

The health impacts of new transport infrastructure

The building of new transport infrastructure, for example a new road, airport or train station, may have significant impacts on the affected area.

New infrastructure: roads

One systematic review has been undertaken in this area. The review summarised studies that had evaluated the health impacts following construction of new roads and/or upgrading of existing roads. Details of the studies reviewed are reported below.¹²⁷ A summary of the impacts reported in the systematic review is provided in [Table 6](#).

Most of the studies in the review examined either impacts on road injuries or disturbance among local residents. No studies were identified that examined the impact of new roads on access to healthcare, health inequalities or physical activity. There was sparse evidence on outcomes involving specific physical symptoms, for example respiratory symptoms or mental illnesses.

Injuries

The review found four studies that considered the effects of building new major urban roads (these are defined as roads used to take traffic through urban areas) on the wider local network assessing changes in the overall rate of crashes and related injury. In each study the overall incidence of road crashes involving injury fell (mean 8.1%, range 1–19%). Some data suggest that the reduction in road crashes was largest in the secondary roads feeding the main roads, but impacts on secondary roads were rarely assessed.¹²⁷

The opening of out-of-town bypasses (roads which are designed to take road traffic away from populated urban areas) were shown to lead to reduced levels of injury crashes (changes in injury crashes compares total number of injury crashes on main through roads 'before' the bypass was opened with injury crashes on both old through roads and the new bypass between one and three years 'after' the bypass was opened). There is some suggestion that, following the opening of a bypass, injury crashes in smaller surrounding roads and intersections may increase.¹²⁷ This could be due to drivers using short cuts or 'rat-running'.

Two out of the three studies of major connecting roads (roads which join two urban areas often to relieve older connecting roads) found significant reductions in rates of injury crashes (range 20–32%) following the building of a new connecting road.¹²⁷

Other health impacts

Changes in traffic levels and traffic fumes may lead to an impact on respiratory health. However, there is no conclusive research evidence that respiratory symptoms are affected by increases or decreases in traffic linked to the building of new roads and bypasses.

Disturbance: noise, vibrations, fumes and dirt

A total of 21 studies evaluated the impact of new roads on disturbances such as noise, vibration, fumes and dirt.¹²⁷ New major urban roads led to increased disturbance from traffic noise in communities living near to the new road or bypass. Residents may make attempts to adapt to the disturbance effects of a new road. However, in some areas the effects of disturbance were still detected three years after the opening of a new road.

Levels of disturbance fell in areas where traffic was diverted from an existing through road onto a new bypass road. Disturbance from noise, vibrations, fumes and dirt fell on both main and secondary roads in the bypassed area.

Disturbance: community severance

There is very little research evidence on the impact of a new road on community severance (defined as reduced access to local amenities and disruption of social networks caused by a road running through the community). One study reported a fall in people crossing the new road that bisected the neighbourhood. This effect was still evident thirty years later, with people choosing to use amenities on their side of the road.¹²⁸ In areas where a new bypass diverts traffic away from a town or village, levels of traffic on the through road fall and thus the severance effect of the through road also falls.¹²⁷ The possible health impacts of community severance are unknown.

Displacement of impacts

The construction of a new road may lead to some impacts being displaced from one area to another. For example, the opening of a bypass will lead to the displacement of traffic from local roads to the new bypass. Thus the possible impacts of increased traffic in one area, for example around the new bypass, may be outweighed by opposite impacts of less traffic in another area, for example the bypassed town. There may also be displacement of traffic to other roads, for example where drivers 'rat-run' through a small road to avoid an area of main road. Although studies have assessed changes in overall injury rates in the bypassed road and the new road, the differential impact of new roads on nearby secondary roads has rarely been assessed.

New infrastructure: other transport modes

No systematic reviews were identified which evaluated the health impact of building other new transport infrastructure (e.g. light and heavy railways, airports or ferry terminals).

Overall assessment: Health impacts of new transport infrastructure

- Out-of-town bypasses decrease injuries on main roads through or around towns, although more robust evidence is needed to assess the impacts on secondary roads
- New major urban roads have little effect on incidence of injury
- New major roads between towns decrease injuries. There is no available research evidence about the impacts of new roads on respiratory health, mental health, physical activity and access to health services
- Out-of-town bypasses reduce disturbance and community severance in towns but may increase them elsewhere
- Major urban roads increase disturbance and severance
- No research was identified which evaluated the health impact of building other new transport infrastructure (e.g. light and heavy railways, airports or ferry terminals)

Table 6: Summary of the health and related impacts of new roads with indication of SoE*

Links between transport and health outcomes and strength of supporting evidence (SoE) where applicable										
	Injuries	SoE	Respiratory health	SoE	Disturbance in affected area: noise, vibrations, fumes and dirt	SoE	Community severance	SoE	Evidence of impact displacement	SoE
New major urban roads or road widening	Little or no decrease in overall injury crashes across wider road network	2++			Increased disturbance due to noise	2-	Neighbourhood traversal may fall immediately after new road building but residents adapt neighbourhood boundaries over time (one study, thirty years' effect still observed)	3	Displaced noise disturbance from relieved roads now with less traffic – relieved roads now quieter	3
	Reduction in fatal crashes following addition of central overtaking lane to two-lane road	2-								
Bypasses	Overall decrease in both old and new roads	2++	Little or no improvement after one year. Possible small improvement for minor respiratory symptoms	2-	Increased noise and related sleep disturbance for those living near bypass; little evidence of adaptation; greatest benefit for small towns	2++	Decreased in area being bypassed	2++	Possibility of displacement of injuries to secondary roads.	4
	Possibility of increased crashes where old and new road intersect	3							Disturbance factors displaced to area around bypass	2-
Major connecting roads	Overall decrease in injury crashes	2++								
	Little evidence of change in crash severity	2++								

*See Appendix 3 for framework used to assess strength of evidence

The health impact of interventions to reduce road traffic

Measures to reduce congestion have been implemented in the UK, and other countries, for decades.¹⁰ These measures are often fiscal, such as road and fuel tax, and may be used as strategies to raise revenue, as well as incentives to drive less or buy fuel-efficient cars. Interventions that aim primarily to reduce transport-related air pollution are reviewed in the following section, whereas measures that primarily aim to reduce traffic congestion are reviewed below.

Predicted health impacts of these measures are likely to be linked to reduced car use and fuel consumption. However, very little research evaluating specific measures has been carried out. The overview of reported impacts following congestion charging schemes draws on data from the monitoring programme for the London Congestion Charging (LCC) scheme implemented in February 2003. This scheme imposes an £8 charge to all motorised vehicles (not motorcycles) entering the city centre charging zone (7am - 6.30pm, Monday to Friday). In addition, empirical data are available from a series of short-term (seventeen days) transport limitation measures implemented in Atlanta, United States, during the 1996 Summer Olympic Games in order to avoid traffic congestion and air quality violations for O₃ during the Games.^{129,130} Traffic, air pollution and exacerbations of asthma over the seventeen-day summer Games period were compared with a baseline period comprising the four weeks before, and after, the seventeen-day period. The pollutants measured were O₃, PM₁₀, SO₂, NO₂ and carbon monoxide (CO), another traffic-related pollutant.¹³⁰

Health and health-related impacts of congestion charging

Predictions that congestion charging measures will lead to health impacts assume substantial and sustained reductions in fuel consumption as well as increased overall physical activity linked to reduced car use.

Physical activity

Impacts on levels of physical activity, including active commuting, following the introduction of congestion charging schemes have not yet been assessed. It is therefore unclear whether or not such schemes to reduce car use can also result in increases in overall levels of physical activity or physically active transport.

Road traffic crashes and injury

There is no evidence of an increase in casualty severity at RTCs despite an increase in traffic speeds following the introduction of the LCC scheme. In addition, it is estimated that the LCC scheme has prevented between 40 and 70 crashes per year in the zone area; this estimate takes account of the background downwards trend in road crashes.¹²⁹

Air pollution

It is estimated that the LCC scheme has led to a 12% reduction in the emissions of NO_x and PM₁₀ within the zone, with little overall change in surrounding areas (this is against a background of steadily declining NO_x in the locality attributed largely to improvements in the fuel efficiency of cars).¹²⁹ However, the monitoring programme of the LCC scheme reports that it has not been possible to detect a 'congestion charging effect' in measures of air quality. This reluctance to draw firm conclusions is largely explained by the unusual weather conditions in 2003 and problems with attributing short-term improvements in air quality to an intervention that is only in place for 34% of the week (7am - 6.30pm, Monday to Friday).¹²⁹

Air pollution (continued)

The traffic reduction measures for the Atlanta Games produced a significant reduction in levels of CO and PM₁₀ within the affected area. There was also a significant reduction in O₃ concentrations within the affected zone, which was greater than the reductions reported in neighbouring districts, even after taking weather conditions into account.¹³⁰

Respiratory health

Following the measures to reduce traffic and improve air quality during the Atlanta Olympic Games there was a small reduction in the number of asthma events requiring hospital attention among children during the seventeen-day Games period compared with a four-week period before and after the Games.¹³⁰ There was no change in the number of children requiring acute care due to other causes. No data on respiratory impacts have been reported from the LCC scheme.

Noise pollution

There has been no reported change in levels of traffic-related noise in the LCC zone.

Other impacts of congestion charging: traffic and congestion

Two years after the introduction of the LCC scheme, congestion remains down by 30%, and there is an 18% reduction in traffic entering the zone area compared with before the scheme (during the charging period: 7am - 6.30pm, Monday to Friday). Traffic speeds increased in the LCC area due to reduced congestion. Those living within the charging zone receive a 90% discount and report little change in their car use.¹²⁹

Significant improvements in the public bus network accompanied the LCC scheme, which was followed by an increased use of bus services.¹²⁹

Other impacts of congestion charging: economic

Data from a range of sources suggest that the LCC scheme has had little or no effect on economic outcomes such as business performance, employment, property prices and retail sales.

Overall assessment: Interventions to reduce congestion and fuel consumption

- Stringent measures such as congestion charging zones lead to reduced traffic and congestion within the zones and may improve air quality
- There is very limited research evidence on health impacts of congestion charging

The health impact of interventions to reduce traffic-related air pollution

There are now several studies showing the benefits of measures that control air pollution from traffic. The interventions reviewed below have controlling air pollution as their primary aim. In some of the interventions reviewed below there is observed evidence of benefits to health. In others, benefits to health may be inferred from the identified reductions in air pollution.

Impacts of European directives to control pollution from traffic

Various European Commission directives from 1990 onwards aimed to reduce air pollution from traffic. These measures included the introduction of unleaded petrol, successive controls on the sulphur content of diesel and petrol, and further policies known variously as Euro I to IV.

Impacts on outdoor air pollution (estimated)

The impacts on air pollution and subsequent health impacts attributable to these policies, in particular reductions in ambient PM, have been estimated by Watkiss *et al.* (2005).¹³² The authors estimate that the policies described above have led to major reductions in emissions and to associated dramatic improvements in air quality. For example, the study estimated that without these transport policies in place in the UK by 2010, 17 million people would have been exposed to annual mean concentrations in excess of the current long-term average limit for NO₂. With these transport policies in place, 0.36 million people are projected to be exposed to these levels by 2010.

Other potential impacts of the directives were not assessed.

Health impacts (estimated)

The health benefits associated with these improvements in air quality were not studied directly but were estimates, based on data from previous studies, using methods similar to those used in the HIA and cost-benefit analysis of the European Commission's Clean Air for Europe Programme.¹³¹ The estimates suggest an annual reduction of the order of 1,000 people whose lives are shortened by the more or less immediate effects of air pollution in the UK. These are believed generally to be people with pre-existing significantly impaired health, in particular cardiorespiratory problems. Within the general population, it is estimated that between 8,000 and 80,000 life-years have been saved annually from reductions in long-term exposure to air pollution following the introduction of these pollution control measures; this represents a major public health gain. Estimated benefits to health and mortality were attributed principally to reductions in primary combustion particles from traffic and partly to reductions in nitrate particles derived from NO₂.¹³²

Impacts of local measures to control air pollution peaks

Several policy measures have been studied for their effects on the reduction of local air pollution peaks, or 'hotspots', in various European countries.¹³³ These measures include:

- controlled access by low-emission zones: all heavy goods vehicles (HGVs) travelling within urban conurbation must conform to certain emission standards such as Euro I (Sweden)
- control of motorway traffic volume and speed using cameras at peak times (Rotterdam, the Netherlands), and
- incentives to switch to less polluting modes of travel, including major investment in public transport and cycle paths (Strasbourg, France).

Outdoor air pollution (estimates)

A review of the evaluations of these local measures reported their impact on air pollution.¹³³ The initiative in Rotterdam to control motorway traffic volumes and speeds at peak times appeared to have the greatest impact on air quality within 200 m (NO_2 , 7%; PM_{10} , 4%) and 3.5 km (reductions of: NO_x , 15–25%; PM_{10} , 25–35%; CO, 21%) of the affected road. In addition, reductions in noise pollution and crashes were reported. Measures to control emissions from HGVs were reported to be effective in reducing emissions from HGVs but had only a small overall impact on levels of background NO_x (-1.3%) and PM_{10} (-3%).¹³³ Following a range of initiatives in Strasbourg, use of public transport increased but the impacts on air quality were unclear.¹³³

Although some local measures may be cost-effective in reducing air pollution and promoting compliance with European air quality standards, these need to be supplemented by European-wide actions to ensure that standards are met (AQEG 2005, chapter 4, annex 9).⁸¹ Other considerations of these measures include the cost of implementation and how these costs are distributed. For example, the compulsory introduction of cleaner engines for HGVs has considerable cost implications for haulage and logistics companies.

Impacts of banning high-sulphur fuels (Hong Kong)

In 1990, the use of high-sulphur fuels was banned in Hong Kong.¹³⁴

Outdoor air pollution

There was an immediate, marked and sustained decrease in ambient SO_2 , to about one-half of the previous levels. Sulphate particles also decreased, although not so strongly, and increased again over time as part of a wider increase in sulphate pollution in southern China. Levels of O_3 increased throughout the period but there was little change in either NO_2 or in PM_{10} .

Cause-specific mortality

Prior to this intervention, monthly deaths had been rising by 3.5% per year due to demographic changes. After the intervention was in place, there was a clear and sustained reduction in this increase, for all causes and all ages, over the following five years. The change in mortality was greatest for respiratory and cardiovascular causes, with a much smaller reduction for lung cancer and other non-cancer causes. Cancers other than lung cancer followed the trends observed before the intervention was put in place and continued to rise. The change was most marked in the areas where there was a large reduction in SO_2 ; indeed, the areas in which SO_2 was reduced the least showed a higher increase in mortality after the intervention was in place than before it.

Traffic changes in Atlanta, United States, during the 1996 Olympic Games

Short-term traffic restriction measures were introduced to avoid traffic congestion and air quality violations for O_3 during the 1996 Summer Olympic Games in Atlanta, and major changes in transportation were introduced over a seventeen-day period in summer 1996.¹³⁰ The available data on impacts on air pollution and child asthma events are described in the previous section.

Overall assessment: Health impacts of interventions to reduce traffic-related air pollution

- Estimates of the benefits to health of reducing traffic-related air pollution are substantial
- Observational studies of traffic interventions confirm that real benefits can occur

02

The health impact of interventions to reduce transport noise pollution

Few research studies have been undertaken to evaluate the impact of interventions on noise pollution.

Road noise

Interventions to reduce road noise include the elimination of noisy vehicles and the development of better, quieter road surfaces, for example the use of porous asphalt.¹³⁵ These measures may be effective at reducing noise but there is insufficient evidence to know whether these measures have any health impact.

Research into transport noise is primarily concerned with technical measures to limit noise (e.g. quieter tyres, quieter road surfaces, quieter engines). Increasing numbers of heavy vehicles might cancel out positive gains from these interventions, but this has not been explored.¹⁰⁸ Noise reduction measures on individual vehicles may be outweighed by increasing levels of road traffic, especially when the numbers of heavy vehicles increase.

Some speed reduction measures may also lead to noise reduction. (See Section 7: Speed Reduction Measures.)

Aircraft noise

No research evidence was identified that evaluated interventions to reduce air traffic noise. New airports or airport expansion will inevitably lead to increased air (and road) traffic and increased noise in local area, but no studies looking at the subsequent impacts of this on local residents have been identified.

Overall assessment: Interventions to reduce noise pollution from transport

- There is currently little evidence about the health impact of transport interventions designed to reduce transport-related noise

The health impact of interventions to promote a modal shift to walking and cycling instead of car use

02

Promoting a population shift from one mode of transport to another, i.e. promoting walking and cycling as alternatives to car use, is referred to as a modal shift. Two systematic reviews assessing the effectiveness of transport interventions to promote physically active transport, i.e. walking and cycling, were identified.^{136,137} Although the studies reported on shifts from car use to walking and cycling, impacts on health outcomes were rarely reported; [Table 7](#) summarises the impacts reported.

Impact on levels of walking and cycling

Engineering measures which may promote walking and cycling

Engineering measures tend not be designed specifically to promote active transport; rather these measures are designed to improve safety for vulnerable road users. It is possible that providing a safer environment for cyclists and pedestrians may facilitate an increase in active transport. Engineering measures that may help to promote walking and cycling instead of travelling by car include improving, extending or building new cycle networks and routes, 20 mph speed restriction zones and car restriction zones. There is little research evidence to support the effectiveness of these measures in terms of changing people's mode of transport. Some evaluations have reported a small increase in walking and cycling, whereas others have reported no effect or a fall in walking and cycling. Where walking and cycling have fallen, it is likely that this is a reflection of the declining levels of active transport generally, rather than a direct result of the intervention.

Targeted behaviour change programmes to promote walking and cycling

Targeted programmes aim to change people's travel behaviour by offering an intervention to a motivated subgroup of the population or by offering information and advice tailored to people's particular requirements, or both. Evaluations suggest that targeted programmes can change the behaviour of motivated subgroups and may improve levels of general health and physical fitness. Although these impacts may result in health improvement at a population level, this is only a reflection of the improvements among the motivated subgroups. Affecting behaviour change among those who are not motivated remains difficult.

One example of a targeted behaviour intervention is individualised marketing of alternative modes of transport to households showing an interest in using them (TravelSmart, Australia). This intervention used a tailored combination of public transport information, a cycle route map and a walking information booklet with a motivational challenge chart. At a population level this intervention resulted in around 5% of all household trips shifting from cars to walking and cycling.¹³⁶ This same programme was piloted in two areas of England; positive shifts to walking and cycling were reported but levels of significance were unclear. A further programme in Glasgow (Walk in to Work Out) aimed to increase walking and cycling to work among volunteers already contemplating an increase in their levels of physical activity. The selected group was sent a self-help pack to promote active commuting, containing advice on choosing routes, personal safety, safe cycle storage, an activity diary and maps of local cycle routes. Levels of walking increased but cycling did not.¹³⁸

Agents of change and publicity campaigns to promote walking and cycling

These interventions are applied to the general population and do not specifically target individuals already motivated. Examples of these types of interventions are the use of school travel coordinators, provision of free bus passes, and mass media campaigns to promote walking and cycling. There is little evidence that these measures and/or campaigns lead to increased levels of walking or cycling. For example, one trial in primary schools in London found that pupils in ten schools that received one year's input from a school travel coordinator were no less likely to travel to school by car than those in schools that had no input from the travel coordinator (odds ratio 0.98, 95%; CI 0.61 to 1.59).¹³⁹ Another campaign using mass media and community activities to raise awareness of alternative modes of transport for households on trunk route corridors had little effect at the time and showed a further decline in cycling trips two years later ($p < 0.05$).¹⁴⁰

Financial incentives to promote walking and cycling

Financial incentives that have been evaluated include subsidies for staff who commute by modes other than driving and a toll ring around city centres. The review reported one study in California that offered cash to staff who did not drive to work (cash offered was at least equivalent to the value of rented car parking space offered to staff with cars). Employees reported a small positive shift (1% from car to other modes, $p < 0.01$) of commuting journeys compared with no significant change in a workplace in which no subsidies were offered.^{141,142} Following implementation of a toll road to access the city centre of Trondheim, walking and cycling journeys fell.^{143,144} This fall in physically active journeys is likely to reflect the falling levels of walking and cycling more generally and cannot be assumed to be an effect of the intervention.

Provision of alternative services to promote walking and cycling: improved public transport availability and car pools

Car share clubs and telecommuting have not been shown to lead to a shift in mode of transport from car use to walking or cycling, and may result in increased car use.¹³⁶ An evaluation of a new train station showed a shift of 5% from car to train use.¹⁴⁵ The specifics of these interventions and the context in which they are delivered will vary enormously and so therefore will the potential for behaviour change. Some explanations for there being little impact on car use linked to these types of interventions are: following the provision of a car pool, non-car owners made more car journeys; provision of telecommuting facilities close to employees' homes led to increased car journeys home owing to employees travelling home for lunch.¹⁴⁶ There is currently no evidence about the actual health impacts of such interventions, for example increased levels of fitness and increased levels of physical activity.

Other health impacts of promoting modal shift

The above section has presented an overview of whether or not these interventions or initiatives are effective at getting people to walk or cycle instead of use their car. Where there is a shift from car use to a physically active form of transport, there is the possibility that health may also be improved. The available research evidence is summarised below.

General well-being and mental health

One study, the Walk in to Work Out trial in Glasgow, showed significant improvements in mental health and general health (SF-36) after six months among a group of motivated individuals who started to walk or cycle to work.¹³⁸

Physical fitness

A randomised controlled trial found that those who shift from driving to work to always walking or cycling to work do benefit from improved levels of walking speed and other measures of physical fitness.^{147,148}

Road traffic crashes and injury

The effects on RTCs and other aspects of community health following interventions to promote walking and cycling are unknown.

Noise and air pollution

The review did not evaluate the effects on noise and air pollution but, given the small changes in car use, these are likely to be minimal.

Overall assessment: Health impacts of promoting physically active transport

- Targeted behaviour change programmes may lead to increased walking and cycling among motivated subgroups and may lead to short-term improvements in certain measures of physical and mental health
- Other attempts to promote physically active transport have not led to substantial increases in walking and cycling
- Individuals who change from driving to walking or cycling to work may benefit from improved physical fitness and mental health
- The health impact of promoting public transport as an alternative to car use is not known

Table 7: Summary of health and environmental impacts of initiatives promoting physically active forms of transport with indication of SoE*

Links between transport and health outcomes and strength of supporting evidence (SoE) where applicable									
	Example of intervention	Walking and cycling	SoE	Physical fitness and weight	SoE	General well-being	SoE	Road traffic crashes and injury	SoE
Engineering measures	Road based measures to promote safe walking and cycling, e.g. cycle lanes, speed restrictions	No evidence of an effect	2++						
Targeted behaviour change	Individualised marketing of alternative modes of transport to households showing an interest in using them	May shift to 5% of car trips among motivated subgroups	2++	Small improvement in fitness No change in average weight	2+ 2-	Possibility of small improvements	2+	No changes reported	2-
Agents of change and publicity campaigns	Campaign using mass media, community activities and/or travel coordinator to promote alternative modes of transport	No evidence of an effect							
Financial incentives	Charging road users, e.g. road tolls, charging for car park space at work	Unclear effect. May depend on specifics of intervention	2+						
Provision of alternative services	Neighbourhood-based car sharing cooperative	Unclear effect. Possibility of small increase in car use; will depend on specifics of intervention	2-						

*See Appendix 3 for framework used to assess SoE

The health impact of interventions to improve psychosocial aspects of travelling on public transport

Few studies have evaluated interventions to reduce the negative aspects of travelling on public transport. A systematic review of the crime prevention effects of closed-circuit television (CCTV) identified four studies in public transportation systems.¹⁴⁹ However, they presented conflicting evidence on their effectiveness: two found a desirable effect, one found no effect, and one found an undesirable effect on crime. The pooled effect size for all four studies was a non-significant 6% decrease in crime.

One study was identified which assessed changes in stress levels following the upgrading of a commuter rail line to provide a direct journey to the centre of New York, where, previously, a change of trains was necessary. Following the upgrading, levels of self-reported stress among commuters fell.^{111,112}

Overall assessment: Interventions to improve psychosocial aspects of travelling on public transport

- There is currently little evidence of the impact of interventions that are designed to improve the psychosocial aspects of travelling on public transport
- Installation of CCTV cameras may reduce crime on public transport

The health impact of interventions to reduce injury/death from crashes

Most transport research has focused on crash prevention. For this reason much of this chapter reports on effective ways to reduce injury and death from transport. As with much of the research in this chapter, very few studies included potential unintended impacts of interventions. [Table 8](#), at the end of this chapter, provides a summary of the health and related impacts of interventions designed to reduce transport-related injury.

Reducing injury/death from crashes: road transport

Most of the interventions to reduce injury or death from crashes focus on improving road safety. Strategies to improve road safety may draw on a range of approaches. For example, a strategy to reduce speeds may include legislation around speed limits, speed cameras, traffic calming schemes and education campaigns about the dangers of speed. The interventions reviewed here have been grouped into the four different approaches used to reduce transport-related injury:

- environmental and engineering strategies
- safety equipment for individuals
- legal strategies
- educational and behavioural change interventions.

Environmental and engineering strategies

Many of the interventions in this section are designed to reduce the risk and severity of pedestrian-vehicle crashes (as opposed to vehicle-vehicle crashes). The risk of crashes and injuries for pedestrians is higher than for car drivers. When the built environment assigns low priority to pedestrians, it can be difficult for them to move around safely. Environmental interventions to improve safety for pedestrians are sub-grouped into three broad categories:

- separation of pedestrians from vehicles
- increasing the visibility of pedestrians
- managing vehicle speeds.

Separation of pedestrians from vehicles

These interventions generally either separate pedestrians from vehicles by time (e.g. exclusive traffic signalling phasing for pedestrians) or by space (e.g. overpasses).¹⁵⁰ Exclusive pedestrian signal phase (e.g. pelican crossings that stop all traffic for part of the time) can reduce pedestrian-vehicle crashes by 50%. Pedestrian overpasses and underpasses also reduce pedestrian-vehicle crashes. However, overpasses and underpasses are expensive and may only be justified at very wide crossings, or where the traffic speed is high. Other effective interventions include pavements, multilane roads with raised medians or refuge islands, and advance stopping lines at intersections (lines which indicate that vehicles should stop a few feet from the area where pedestrians will be crossing the road).¹⁵⁰ Although these interventions have the potential to improve pedestrian safety, the safety effects will be limited if people are reluctant to use the facilities owing to security concerns or inconvenient access points, for example dark secluded pedestrian underpasses are unlikely to be used.

Increasing pedestrian visibility: street lighting and parking regulations

More than half of all fatal crashes occur at night and street lighting may reduce night time fatalities by as much as 65% and night-time road injuries by 30%.¹⁵¹ However, the effect of public lighting varies with crash type and severity and other variables may also further complicate this effect.

Parked vehicles obscure the vision of pedestrians and drivers, and some studies have evaluated the effectiveness of parking restrictions.¹⁵⁰ For example, diagonal parking directs pedestrians into the roadway at such an angle that they are better able to see approaching traffic. Such strategies have been shown to reduce the number of pedestrians entering the roadway in front of a parked vehicle (compared with parallel parking). However, whether this is accompanied by a reduction in crashes is not clear.¹⁵⁰

Improving street lighting has been reported to lead to other benefits including increased pedestrian use after dark.¹⁵² A systematic review has reported significant reductions in crime following improvements to street lighting. However, it is thought that this may be attributed to improved attitudes and social control over a neighbourhood as there were similar reductions in both daytime and night-time crime rates.¹⁵³

Managing vehicle speeds

Speed limits

In 30 km/h zones, crashes are reduced by 3.5% for every km/h that speed is reduced. Speed limit zones in quieter peripheral roads are effective in reducing both personal injuries to pedestrians (-21%, range -9 to -31%) and material damage (-18%, range -9 to -26%). Speed limit zones (e.g. Twenty's Plenty) in built-up areas can reduce personal injuries from crashes by 18% (range -8 to -26%) but have no impact on levels of material damage.¹⁵¹ A change to differential speed limits (speed limits reduced in more built-up areas and increased on peripheral roads going through less built-up or residential areas) is associated with an increase in crashes in the peripheral areas (+17%, range 0–37%).

Roundabouts and road humps

Modern roundabouts are a more effective speed control than conventional intersections and can reduce pedestrian-vehicle crashes by up to 75%.¹⁵⁰ Single-lane roundabouts are particularly effective, and small roundabouts are safer than large roundabouts. Changing an intersection to a roundabout will lead to a larger decrease in injuries or fatal crashes where there is a four-leg intersection (i.e. four road entrances on to the intersection) rather than a three-leg intersection. In cases when the converted intersection had been controlled previously by a 'Give Way' sign, then larger decreases in injuries and fatalities are observed compared with intersections previously controlled by traffic lights.¹⁵⁴ Road humps may reduce crashes locally but increase them in surrounding areas.¹⁵¹ For example, drivers may find alternative routes through nearby roads that do not have road humps and thus do not enforce reduced speed. This may, therefore, lead to displacement of traffic and crashes from the affected road; however, there has been no research investigating this.

Raised crossroads and rumble strips

Raised crossroads are associated with non-significant increases in personal and material crashes. Rumble strips approaching crossroads (grooves or rows of raised pavement markers placed perpendicular to the direction of travel to alert inattentive drivers) are associated with significant decreases in personal injury (-33%, range 25–40%) and material damage (-25%, range -5 to -45%) from crashes.¹⁵¹

Traffic calming schemes

Traffic calming schemes are designed to slow down through traffic on residential roads and may comprise a range of changes to road layout, for example road humps, pedestrian crossings. Area-wide traffic calming (schemes) can reduce the number of crashes by 15% in the whole area affected by the measures (main roads and local roads combined).¹⁵¹ In addition to a reduction in crashes, these types of interventions may have other health effects. For example, a recent study in Glasgow reported that there were increases in observed pedestrian activity and physical health in the area after the introduction of a traffic calming scheme.¹⁵¹

Although traffic calming schemes may reduce vehicle speeds, crashes and injuries, there may be other associated impacts from changes in the levels of exhaust emissions on ambient air pollution and noise pollution, and accessibility issues for emergency service vehicles.

Guardrails and crash cushions

Guardrails and crash cushions are used on busy roads, often motorways and dual carriageways to reduce vehicle-vehicle crashes.

Installation of crash barriers in the central median of motorways and dual carriageways has led to an increased number of vehicle-vehicle crashes by about 30% ($p < 0.05$). However, despite increased numbers of crashes, crash severity is reduced. Although there is little change in the number of crashes causing injury (-2%, -7 to +4%,) there is a reduced risk (-20%) of those involved in a crash being fatally injured.

Guardrails reduce the number of vehicle-vehicle crashes by -27% (range -18 to -35%); crash severity is also reduced. Furthermore, crash cushions may also reduce crashes rates.¹⁵¹

Speed reduction measures and traffic noise

After the installation of road humps and speed cushions, the maximum noise levels from light vehicles (cars) are reduced and so too is the overall level of traffic noise when light vehicles form most of the traffic stream. However, the effect of road humps and speed cushions on noise from large vehicles is more complex. Although there are some decreases in maximum vehicle noise levels from large commercial vehicles, due to reductions in their speeds, this can be offset by increases in noise from the bodywork of such vehicles as they pass over the humps and cushions. The net effect of these vertical deflection measures on overall traffic noise depends on the proportion of large commercial vehicles in the traffic stream and the type of road hump installed.¹⁵⁵

Overall assessment: Reducing injury and death from road transport through environmental and engineering interventions

- Environmental and engineering interventions that can effectively reduce transport crashes include single-lane roundabouts, guardrails, pavements, pelican crossings, lighting and area-wide traffic calming. There is little research evidence that these interventions lead to reductions in fatal or serious injury
- There is very little research evidence around the possible unintended health impacts of engineering and environmental interventions designed primarily to improve road safety

Safety equipment for individual use

Helmets for preventing injury in motorcycle riders and cyclists

A review of trials concluded that motorcycle helmets reduce the risk of head injury in motorcycle riders involved in crashes by around 72%. However, it is likely that the protective effect of the helmet may depend on other factors, such as speed.¹⁵⁶

Two reviews of the effectiveness of bicycle helmets at preventing head and facial injuries found that helmets can provide a 63–88% reduction in the risk of head, brain and severe brain injury for all ages of cyclists involved in crashes, regardless of whether the crash involved a motor vehicle. Injuries to the mid and upper face can also be markedly reduced for cyclist casualties wearing helmets, although helmets have not been shown to prevent lower facial injuries.^{157,158}

Seatbelts

The use of seatbelts is regarded as the single most effective means of reducing fatal and non-fatal injuries in motor vehicle collisions. Lap-shoulder seatbelts are 45% effective in reducing fatalities in passenger cars and 60% effective in light trucks.^{159,160} Lap-shoulder seatbelts are estimated to reduce the risk of serious injury to the head, chest and extremities by 50–83%.¹⁶⁰ Lap seatbelts alone, used most often in central rear seats, are estimated to be 17–58% effective in preventing death compared with the use of no restraints.¹⁶¹ These figures assume that seatbelts will be used at all times when travelling. The effectiveness of seatbelts to impact on road injuries and fatalities at a population level will depend on the effectiveness of educational and legislative measures used to promote seatbelt use (these are reviewed in the relevant sections below).

Visibility aids for pedestrians and cyclists

One common cause of collisions between pedestrians, cyclists and cars is lack of visibility. Aids such as reflective garments and flashing lights aim to enhance visibility and alert drivers in time to avoid a collision. One review found that visibility aids improved drivers' responses in detecting and recognising pedestrians and cyclists; however, no trials were found which studied whether this improves safety and reduces crashes.¹⁶²

Daytime running lights and studded tyres

Daytime running lights (DRLs) (using headlights during the day) may be associated with a reduction in all types of crashes. The effectiveness of DRLs at reducing crashes is greater in countries where there is reduced daylight in winter. The possible negative impacts of DRLs (e.g. glare) have not been evaluated.

Studded tyres are specially designed snow tyres that are used to increase road traction. The tyres are fitted with studs inserted into the tread area of the tyre. The effectiveness of studded tyres at reducing crashes is unclear.¹⁵¹

Overall assessment: Reducing injury/death from road transport through safety equipment for individuals

- Safety equipment that reduces transport-related injury includes helmets for cyclists and motorcyclists, seatbelts and daytime running lights
- The effectiveness of visibility aids for pedestrians in reducing crashes has not yet been established
- The potential for these interventions to be effective will depend on levels of individual use

Legal strategies

Blood alcohol concentration laws

Legislation setting a legal limit of 80 mg (milligrammes) of alcohol/100 ml (millilitres) blood has led to reductions in alcohol-related motor vehicle fatalities of around 7% (US data).¹⁵⁵ Legislation targeted at younger drivers (less than 20 years) which sets a lower blood alcohol limit of 20 mg/100 ml has led to reductions in alcohol-related crashes as well as to reductions in the total numbers of fatal crashes (includes both alcohol and non-alcohol-related events).^{155,163}

The Road Safety Act, introducing the use of breathalysers and the enforcement of a legal blood alcohol limit among drivers, was introduced in the UK in 1967. Since then the legal limit in the UK has been 80 mg of alcohol in 100 ml of blood (0.08 g/dl or 0.08%). In Scotland, crashes and associated injuries and fatalities involving motor vehicle drivers or riders with illegal alcohol levels have been falling since 1989.¹⁶⁴

Other legal strategies to reduce alcohol-related crashes

Another legislative measure that is effective at reducing drink driving or alcohol-related driving injuries is setting a minimum legal drinking age.¹⁵⁵ Both random breath testing checkpoints, where a random selection of all drivers are stopped and breathalysed, and selective breath testing, where only drivers suspected to be driving under the influence of alcohol are tested, have led to significant reductions in alcohol-related crashes and associated injuries.^{151,155}

Probation, rehabilitation and treatment of convicted drink drivers

Probation and rehabilitation of convicted drink drivers to reduce drink driving and related crashes has led to reductions in the risk of a motor vehicle crash by up to 25% (relative risk (RR) 0.76–0.90) and reduced the risk of related injuries by around 10% (RR 0.47 and 0.58). However, probation and rehabilitation together may increase the risk of injury (RR 1.06, non-significant). Programmes to treat drink drivers showed that there was a small decrease in alcohol-related crashes (mean 7% reduction) but that non-alcohol-related crashes were worse as a result of the intervention (mean 11% increase).

Severe licence sanctions (e.g. twelve-month driving ban) have reduced crash rates by 1–7% but lighter sanctions have led to an opposite effect, a 7% increase in crash rates. The use of mandatory jail sentences has also been followed by an increase in alcohol-related vehicle crashes.¹⁵¹

Alcohol ignition interlock

To operate a vehicle equipped with an ignition interlock device, the driver must first provide a breath specimen. The interlock reduces re-offending as long as it is still fitted to the vehicle, but there is no long-term benefit after it has been removed. The low percentage of offenders who choose to have an interlock fitted also makes it difficult to reach firm conclusions about their effectiveness.¹⁶⁵

Motorcycle and bicycle helmet legislation

Results from trials have found that motorcycle helmet legislation was followed by a 30% reduction in fatalities. In one country when this law was abolished, fatalities increased by 25–40%.¹⁵¹

No systematic reviews of bicycle helmet legislation have been undertaken but the evidence suggests that bicycle helmet legislation increases helmet use. However, whether the introduction of helmet legislation leads to a reduction in the numbers of children cycling is a contentious issue.¹⁶⁶ In Australia, mandatory bicycle helmet laws led to increased helmet use, but levels of cycling fell substantially in the two years following the legislation,¹⁶⁷ whereas in Canada, helmet use and levels of cycling increased in the three years following helmet legislation.¹⁶⁸ Falls in head injuries have been reported following the introduction of cycle helmet legislation. However, there is debate about whether this can be attributed to increased helmet use, or to reductions in cycling and decreasing trends in head injuries observed for some years before the introduction of this legislation.^{169,170} (Other interventions to increase the use of bicycle helmets are described under 'Educational and behavioural change interventions'.)

Seatbelt legislation

The introduction of seatbelt legislation is effective at increasing seatbelt use, especially where seatbelt use is initially low.^{171,172} Seatbelt legislation is also effective at reducing injury and death by around 8% following a vehicle collision;¹⁷¹ following seatbelt legislation, the risk of death in a vehicle crash may be reduced by 50%.¹⁷² Seatbelt legislation in the UK uses 'primary enforcement', where a motorist can be stopped solely for not wearing a seatbelt. Primary enforcement is more effective in promoting seatbelt use and reducing motor vehicle injury/fatality than secondary enforcement, where the seatbelt law is only enforced if the driver has been stopped for another offence.¹⁷³ In addition, initiatives to promote enforcement of the legislation, for example a week when police officers focus on detecting those not wearing a seatbelt, can also increase seatbelt use.¹⁷³ Legislation requiring proper child restraint use in the front seats may have led to more children sitting in rear seats.¹⁷⁴

The wearing of front seat restraints has been compulsory in the UK since 1983, and the wearing of rear restraints (where fitted) since 1989 for children and since 1991 for adults (over 14 years old). Current seat belt wearing rates in Scotland are 95% for drivers, 91% for front seat passengers and 78% for rear seat passengers. There is a correlation between the behaviour of car drivers and passengers, with a greater likelihood of passenger compliance when the driver also uses a seat belt.⁶⁴

Following the introduction of seatbelt legislation in the UK, high levels of compliance were reported (95%) and there were reductions in car drivers and front seat passengers who were killed or seriously injured (-26.5%); however, there were small but significant increases in crash fatalities among rear seat passengers.¹⁷⁵ The numbers of road crash casualties with abrasions, contusions, facial, eye, brain and lung injuries also fell, but there were increases in the numbers of fractured sternum (breastbone) and neck injuries associated with seatbelt injury during a collision.¹⁷⁶ Despite the increasing amount of traffic on the roads, the absolute numbers of those killed or seriously injured on roads in the UK were already falling before the introduction of compulsory seatbelt wearing, and there is some dispute over how much impact the seatbelt legislation has had.^{177,178} (Other interventions to increase the use of seatbelts are described under 'Educational and behavioural change interventions'.)

Red light cameras

Red-light cameras are now widely used to identify drivers that jump ('run') red lights. These cameras effectively reduce the number of times that drivers jump red lights and can reduce injury crashes at the affected junction by nearly 30%. However, it is not clear whether the total number or rate of crashes at the affected junction falls.¹⁷⁹

Speed cameras

Speed cameras lead to reductions in driver speed on a specific stretch of road and can result in reductions in crashes (-5% to -69%), crash-related injuries (-12% to -65%), and crash-related deaths (-17% to -71%) in the immediate vicinity of camera sites.¹⁸⁰

Driving bans and licence revocation

Suspension or revocation of a driver's licence following a traffic offence have led to small reductions in crash rates during and after the period of licence suspension, and may also lead to a reduced level of violations among problem drivers.¹⁸¹

Graduated licensing laws

Graduated driver licensing (GDL) laws are used in some countries to help reduce crash rates among new drivers. New drivers are gradually introduced to higher risk driving situations after passing their driving test. GDL does appear to lead to reductions in fatal and non-fatal crashes among all teenage drivers.¹⁸²

Banning use of handheld mobile phones

In October 2003 a law prohibiting the use of hand-held mobile phones was introduced in the UK. A survey of drivers in Birmingham found that in the ten weeks following the legislation use of hand-held phones by drivers fell by around 50% (from 1.85% to 0.97% of drivers).¹⁸³ However, two years after the legislation levels of use on the same roads as previously surveyed had risen to 1.63%.¹⁸⁴

The effect of the legislation on road accidents and related injury is not known.

Overall assessment: Reducing injury and death from road transport through legislative interventions

- Legal strategies that reduce road transport crashes and/or related injury include: red light cameras, speed cameras, use of random breath testing, and legislation to enforce blood alcohol limits of 0.08%, use of motorcycle helmets and seatbelts, and graduated licensing laws
- Probation and rehabilitation of drink-driving offenders has led to reductions in crashes and related injury. Severe licence sanctions are required if a reduction in crashes are to be achieved

Educational and behavioural change interventions

Reducing alcohol impaired driving

Following mass media campaigns, alcohol-related crashes have been reported to fall by around 13%. Although these campaigns are expensive, economic analyses of campaign effects indicated that the societal benefits were greater than the costs of the campaign.¹⁸⁵

Promotion of cycle helmet wearing by children

Campaigns to promote cycle helmet wearing do lead to increased helmet use among children exposed to the campaign compared with other children.¹⁸⁶ School based and public/parent education to use bicycle helmets may also lead to small reductions in hospital inpatient rates for cyclist injuries.¹⁵¹

Promoting seat belt use

Interventions to increase seatbelt use include educational programmes, incentives and community-based programmes. Currently, there is insufficient research evidence to establish the effectiveness of education-only programmes aimed at parents, young children, healthcare professionals or law enforcement personnel.¹⁸⁷ Interventions that use tangible incentives (such as money, prizes and vouchers) lead to substantial short-term increases in safety belt use (mean 12.0%) but the effect may fall over time.¹⁸⁸ Campaigns have been most effective in primary schools, where incentives were given immediately rather than delayed, and where the initial baseline use of seatbelts was low.

Community-based programmes (which use a combination of social and physical environmental interventions in the context of community-directed activity) may be effective in promoting in-car restraint use for occupants and may also lead to a fall in injuries among motor vehicle occupants. However, limitations in the evaluation methodologies of the studies requires the results to be interpreted with caution.¹⁸⁹

Driver education and school education programmes

Driver error is a factor often contributing to traffic crashes, and driver education is often used in the belief that this makes drivers safer. Post-licence driver education for licensed drivers may be either remedial programmes for those with poor driving records or advanced courses for drivers generally.¹⁹⁰ They may be offered by correspondence, in groups or with individualised training. In one systematic review, crash reductions of 6–32% were found in 10 out of the 59 included programmes but 3 out of the 59 resulted in crash increases of between 20% and 46%. There was no apparent difference in the effectiveness of individual versus group interventions, direct versus indirect approaches or targeting certain types of violation.¹⁸¹ A Cochrane review reported similar results, concluding that there was no evidence that post-licence driver education is effective in preventing road traffic injuries or crashes.¹⁹⁰ Distributing educational or informational material has not been associated with any reductions in problem drivers.¹⁸¹

In the UK, drivers aged 17–21 years make up 7% of licence holders but 13% of drivers involved in RTCs resulting in injury. As in many countries, the UK government has proposed tackling this problem with driver education programmes in schools and colleges. Teenagers have a higher risk of road death and serious injury than any other group. School-based driver education has been promoted as a strategy to reduce the number of road crashes involving teenagers. The results of a systematic review show that driver education in schools leads to early licensing. However, there is no evidence that driver education reduces road crash involvement, and the reviewers suggest that it may lead to a modest but potentially important increase in the proportion of teenagers involved in traffic crashes.¹⁹¹

Road safety campaigns

Safety education can improve children's road safety knowledge and their observed road crossing behaviour¹⁹² and may reduce casualties from children emerging from behind a vehicle by 20%.¹⁵¹ However, education needs to be repeated at regular intervals as the effect may fall over time. Whether these changes to knowledge or behaviour can be linked to a reduction in pedestrian-vehicle crashes and subsequent injury is unknown.¹⁹² General injury prevention approaches may lead to small reductions in hospital admissions.¹⁵¹

Overall assessment: Reducing injury/death from road transport through educational and behavioural change interventions

- It is unclear whether or not educational interventions among drivers or pedestrians can lead to reductions in crashes and transport-related injury
- Some education initiatives have led to improved road safety skills, knowledge and behaviour among pedestrians
- School-based driver education has led to earlier licensing among teenagers

Reducing injury/death from crashes: other modes of transport

No reviews were found that evaluated interventions to reduce crashes and injuries in other modes of transport. However, one cross-sectional study reported that studies of trams conducted in Amsterdam have shown that identifying crash 'black spots' and separating trams from other vehicles and bicycles in these areas, can lead to a significant reduction in crashes.⁷⁵ Other unevaluated interventions to reduce tram crashes include safety railings at tram stops, side barriers on the tramcars to prevent people from falling under the tram and lower speeds near tram stops.⁷⁶

Overall assessment: Reducing injury/death from crashes: other modes

- There is very little research establishing effective ways to reduce injury and death from other modes of transport such as air, train, tram and ferry
- Identifying crash 'black spots' and separating trams from other vehicles and bicycles in these areas, may lead to a reduction in tram-related crashes

Table 8: Overview of health impacts of interventions that aim to reduce transport-related injury[†] (continued overleaf).

Intervention	Impact on crashes in affected area	Effect on fatal and serious injury from crashes	Effect on less serious injury from crashes	Other health-related effects	Other unintended effects/comments
Environmental and engineering: separating pedestrians from vehicles and increasing pedestrian visibility					
Exclusive pedestrian signalling (traffic light pedestrian crossings) ¹⁵⁰	Decreased (2-)				Effectiveness will depend on use. Which will depend on perceived safety and convenience for pedestrian users.
Pedestrian overpasses and underpasses ¹⁵⁰	Decreased (2-)				
Median/refuge islands in multi-lane roads ¹⁵⁰	Decreased (2-)				
Pavements ¹⁵⁰	Decreased (2-)				
Advance stopping lines (indicating vehicles to stop a few feet from crossing) ¹⁵⁰	Decreased (2-)				
Street lighting ¹⁵²	Decreased (2-)	Decreased (2-)			
Diagonal on-street car parking ¹⁵⁰					Reduces number of pedestrians entering road in front of a parked vehicle (2-)

[†] See Appendix 3 for framework used to assess strength of evidence.

* Alcohol-related crashes. ** Non-alcohol-related crashes.

Note: blank cells indicate that there is no available research evidence reporting on this specific impact. Where the cells for serious and less serious injury are merged this indicates that available data has not distinguished between serious and non-serious injury.

Table 8 (continued): Overview of health impacts of interventions that aim to reduce transport-related injury[†].

Intervention	Impact on crashes in affected area	Effect on fatal and serious injury from crashes	Effect on less serious injury from crashes	Other health-related effects	Other unintended effects/comments
Environmental and engineering: managing vehicle speeds					
Speed limit zones, e.g. Twenty's Plenty ¹⁵¹			Decreased (2-)		Speed limit zones in quiet peripheral roads also lead to reduced amount of material damage
Changes to speed limits: slower in built-up areas and faster on peripheral roads ¹⁵¹	May increase crashes on peripheral roads where speed limit is increased (2-)				
Roundabouts ¹⁵⁰	Decreased (2-)				Largest decreases in crashes observed when the intersection was previously controlled by a Give Way sign rather than by traffic lights
Road humps ¹⁵¹	Unclear (2-)				May displace crashes to alternative local roads
Raised crossroads ¹⁵¹	Small increase (2-)				
Rumble strips ¹⁵¹			Decreased (2-)		
Area-wide traffic calming ¹⁵¹	Decreased (2+)			Possible increase in walking in local area (2-)	Impact on noise levels will vary depending on type of traffic
Environmental and engineering: separating vehicles from other vehicles, pedestrians and local area (i.e. motorways running through an area)					
Guard rails ¹⁵¹	Decreased (2-)	Decreased (2-)	Decreased (2-)		
Crash cushions ¹⁵¹	Decreased (2-)	Possible decrease (2-)	Possible decrease (2-)		
Central reservation crash barriers ¹⁵¹	Increased (2-)	Decreased (2-)	No change (2-)		

Table 8 (continued): Overview of health impacts of interventions that aim to reduce transport-related injury[†].

Intervention	Impact on crashes in affected area	Effect on fatal and serious injury from crashes	Effect on less serious injury from crashes	Other health-related effects	Other unintended effects/comments
Safety equipment for individuals					
Motorcycle helmets ¹⁵⁶		Decreased head injury, Unclear effect on neck and facial injury (2+)	Unclear effect		Impact dependent on speed and driving habits of helmet wearers
Bicycle helmets (pedal cycle) ^{157,158}		Decreased (2+)	Decreased (2+)		May not prevent lower facial injuries
Daytime running lights ¹⁵¹	Decreased (2-)				Not commonly used in the UK
Studded tyres ¹⁵¹	Unclear (2-)				
Seatbelts ¹⁵⁹⁻¹⁶¹			Decreased (2++)		Potential for benefit depends on use of seatbelt
Legal strategies					
Blood alcohol concentration (0.08 g/dl or 0.08%) ^{151,155}	Decreased* (2+)		Decreased* (2+)		UK legal limit is 0.08%
Lower blood alcohol concentration for teenage drivers (0.02 g/dl or 0.02%) ^{155,163}	Decreased* (2+)	Decreased*, **, (2+)			
Minimum legal drinking age ¹⁵⁵		Decreased* (2+)			Reduces drink driving among younger drivers
Random breath testing ^{151,155}	Decreased* (2+)	Decreased* (2+)			
Red light cameras ¹⁷⁹	Unclear (2++)	Decreased (2++)	Decreased (2++)		Reduces red light running
Speed cameras ¹⁸⁰	Decreased (2++)	Decreased (2++)	Decreased (2++)		Reduces speed at affected area (2++)

[†] See Appendix 3 for framework used to assess strength of evidence.

* Alcohol-related crashes. ** Non-alcohol-related crashes.

Note: blank cells indicate that there is no available research evidence reporting on this specific impact.

Where the cells for serious and less serious injury are merged this indicates that available data has not distinguished between serious and non-serious injury.

Table 8 (continued): Overview of health impacts of interventions that aim to reduce transport-related injury[†].

Intervention	Impact on crashes in affected area	Effect on fatal and serious injury from crashes	Effect on less serious injury from crashes	Other health-related effects	Other unintended effects/comments
Legal strategies (continued)					
Motorcycle helmet legislation ¹⁵¹		Decreased (2+)			
Bicycle helmet legislation					Increases helmet use but unclear impact on cycle use
Graduated licensing laws ¹⁸²	Decreased (2+)	Decreased (2+)	Decreased (2+)		Not used in the UK
Seatbelt legislation (primary) ¹⁷²		Decreased (2-)			Increases seat belt use
Licence ban/suspension for problem drivers ¹⁸¹	Small decrease (2+)				May also reduce rates of violation among problem drivers
Educational interventions					
Post-licence driver educational courses ¹⁹⁰	Mixed effects (2++)				
Distribution of educational material to problem drivers ¹⁸¹	No change (2++)	No change (2++)	No change		
School-based driver education ¹⁵¹	Possible small increase (1+)	No change (1+)	No change (1+)		Leads to earlier licensing among teenagers
Road safety campaigns ¹⁵¹				Improves road safety behaviour among pedestrians (2++)	
Child safety campaigns (road behaviour) ^{151,192}				Fewer children walk on to road from behind a parked car (2++)	Improves children road safety knowledge and behaviour

Table 8 (continued): Overview of health impacts of interventions that aim to reduce transport-related injury†.

Intervention	Impact on crashes in affected area	Effect on fatal and serious injury from crashes	Effect on less serious injury from crashes	Other health-related effects	Other unintended effects/comments
Educational interventions (continued)					
Promoting use of cycle helmets ^{151,186}				Decrease in hospital admissions for cycle injuries (2++) Increased helmet use	
Promoting seat belt use ¹⁸⁷⁻¹⁸⁹		Unclear (2++)	Unclear (2++)	Increased use of seat belts and in-car restraints for children	Community-based campaigns with financial incentives may be most effective – especially when seat belt use is already low
Reducing drink driving (mass media campaigns) ¹⁸⁵	Decreased* (2++)				
Remediation of drinking and driving offenders					
Alcohol ignition interlock ¹⁶⁵					Reduces re-offending while lock fitted to car (2++) Not used in the UK
Probation and rehabilitation ¹⁵¹	Decreased (1+)	Decreased (1+)			Probation and rehabilitation together may increase risk of injury (1+)
Treatment of convicted drivers ¹⁵¹	Decreased* Increased** (1+)				
Licence ban/sanction ¹⁵¹	Increased (light sanctions) (2-) Decreased (severe sanctions) (2-)				

† See Appendix 3 for framework used to assess strength of evidence.

* Alcohol-related crashes. ** Non-alcohol-related crashes.

Note: blank cells indicate that there is no available research evidence reporting on this specific impact. Where the cells for serious and less serious injury are merged this indicates that available data has not distinguished between serious and non-serious injury.

Section 3: Applying the Evidence

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Chapter 06: Applying the Evidence to the Local Context

To assess the impact of a transport proposal, the evidence presented in Chapters 4 and 5 needs to be applied to the specific proposal and local context.

Applying research evidence: certainty and uncertainty

The previous chapters presented a review of the best available research evidence of the health and health-related impacts of transport. There are still many gaps in the research evidence: in many cases, particularly for non-road transport, there is almost no research evidence of their health impacts.

Absence of, or insufficient, research evidence should not be confused with evidence of no effect or no link between transport and a hypothesised health impact. Where there is no research evidence of actual impacts, the links between a cause and effect or impact remain hypothetical but the actual impacts remain unknown. For this reason, where there is insufficient research evidence, it cannot be assumed that a hypothesised or predicted impact will occur.

There are many examples for which preliminary research or 'common sense' suggests that a certain intervention will lead to a specific beneficial impact. However, when the intervention is evaluated no such benefits occur and, in some cases, the impact is in the opposite direction to the expected impact, i.e. the intervention causes unexpected adverse health impacts. For this reason, where there is insufficient research evidence to support predictions about the health impacts of an intervention it should be made clear that any predictions set out in an HIA are hypothetical.

In some cases there may be research evidence suggesting a link between one thing and another, for example regular brisk walking and improved health, but the actual impacts of the planned intervention on levels of walking have not been investigated. In such cases the hypothesised impacts remain hypothetical but have a stronger grounding in terms of research evidence.

Where predicted impacts are hypothetical, it is recommended that the HIA is accompanied by prospective monitoring to confirm whether the predicted impacts did or did not emerge (see Chapter 7).

Incorporating local evidence

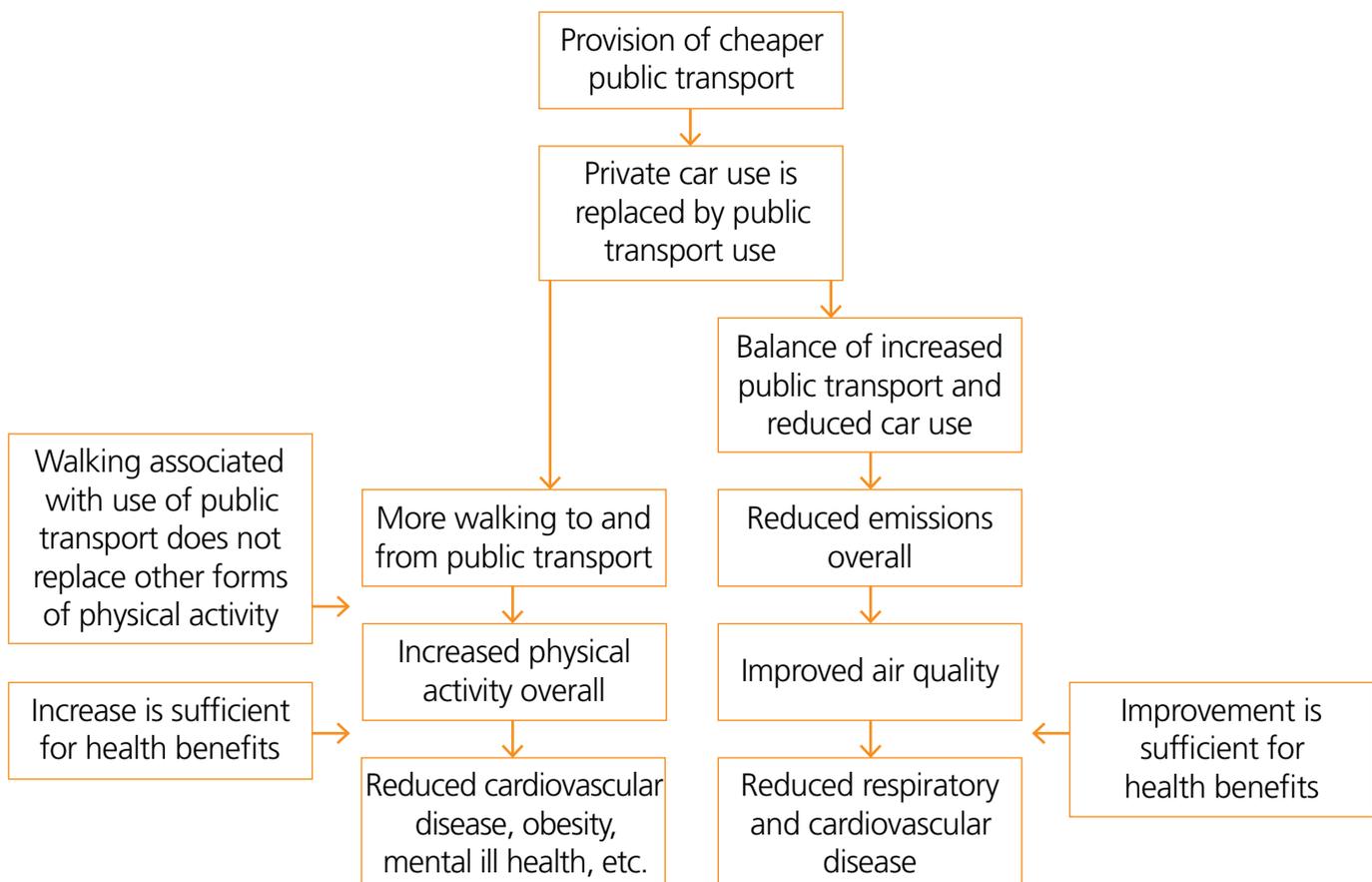
The research review presented in the previous chapters draws on the best available research evidence. Where appropriate, efforts have been made to draw attention to important differences between the setting of a research study and the Scottish context, for example promoting physically active transport in Australia may be easier than in Scotland. When applying research evidence to a different context it is important to consider how relevant it is to the context of that specific HIA, as impacts in a specific research setting may differ from those that arise in another setting. The research evidence should be integrated with other kinds of evidence for the local context for the intervention being assessed. This includes the local profile and qualitative evidence from key informants who have knowledge of the local context, as this context may influence whether findings from research are likely to be applicable (see Chapter 7).

Mapping unintended health impacts

The lack of research evidence around the unintended health impacts of transport interventions is likely to be very frustrating, and indeed may be surprising. In addition to listing hypothesised health impacts it may be helpful to map the hypothesised steps to these health impacts. For example:

- Hypothesis: Providing cheaper public transport will improve health

This hypothesis is based on a number of assumptions that link the intervention to improved health; some of these are shown in the diagram below.



By being explicit about how health impacts may arise it may be easier to identify which elements of the HIA can be supported by research evidence and where there is a need to look for additional support for the hypothesis.

Questions to ask in a health impact assessment of a transport proposal

The questions below have been prepared in light of the research review and are designed to help direct those trying to prepare an HIA of a transport intervention.

Define nature and extent of intervention or policy being assessed

- What are the specific transport-related changes proposed?
- What is/are the overall aim(s) and objectives of the transport changes proposed?
- How will the changes be implemented?
- What phases of implementation are there, for example consultation, implementation/ construction and maintenance?

Research evidence about health impacts of the intervention (refer to Chapter 5)

- What is the research evidence that this intervention is effective in achieving its stated aims, for example reducing speed?
- What is the research evidence that this intervention will have the intended health impacts (positive or negative)? Include any stated health objectives of the intervention.
- What is the research evidence that this intervention has unintended health-related impacts (positive or negative)?

Define features of the local area

- What is/are the geographical area(s) covered by the intervention?
- What are the key features of the area:
 - Is it urban or rural?
 - What transport infrastructure currently exists?
 - What facilities and amenities are there that people need to access?

Define populations

- What populations will be affected by the changes?
 - Note any vulnerable population groups.
 - For each impact identified, who will be affected positively.
 - For each impact identified, who will be affected negatively.
- Will the impacts be distributed equally in different socio-economic groups? If not this may have implications for health and social inequalities.

Economic implications

- What are the predicted effects of the proposal on the local economy?
- How will travel costs be affected for individuals?

Changes in travel and traffic patterns

- How will traffic levels or speed change? If appropriate, consider different parts of the affected area separately.
- Will there be any part of the affected area where traffic levels, speed, or infrastructure, will change to the extent that severance effects may occur?
 - How will these changes affect access to essential services and amenities for those living in or travelling through the affected area?
- What will be the effect on individuals' travel patterns? Consider levels of driving, walking and cycling, and public transport use. Consider travel patterns of those both living in and travelling through the affected area(s).
 - How will the expected changes affect safety for vehicle drivers or other transport users?
 - How will the expected changes affect safety for other vulnerable road users, for example pedestrians?
 - How will the expected changes affect air quality in the affected area?
 - How will the expected changes affect noise levels in the affected area?
- Will there be a shift to more or less physically active forms of transport? (Walking, cycling or public transport use)
 - Will this shift affect individuals' levels of physical activity overall?
 - Will this change in physical activity be sufficient to affect health?
 - Will changed levels of physical activity be seen in the general population of the affected area or in a minority of motivated individuals?
- How will safety, and perceptions of safety, among vulnerable road users and public transport users be affected?

Traffic and impact displacement

- Will there be displacement of traffic and related impacts to or from surrounding areas? For example, traffic calming may lead to less traffic in one area but displace traffic to a peripheral area. If displacement is expected, a HIA should consider impacts on both areas.

Chapter 07: Doing a Health Impact Assessment of a Transport Proposal

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Health impact assessment is a way of applying the evidence in this document, and other relevant evidence, to a transport proposal in order to inform decision making. This should be done at a stage of planning when the proposal is clear enough to be assessed but there is still the opportunity to make changes that would improve the health impacts that will arise from that proposal. The evidence must be applied to the specific proposal and local context. This is what distinguishes a HIA from a general review of the health effects of transport with more general recommendations.

The steps to carry out in a HIA are now well established and can be described as follows:

Step 1	Screening	Decide whether you need to do a HIA.
Step 2	Set up a team to do a HIA	Ensure appropriate expertise is included.
Step 3	'Scoping'	Set the geographical, population and time boundaries over which to predict impacts. Identify affected population groups.
Step 4	Local profile	Collate relevant data on the local populations and features of the local area(s).
Step 5	Involve stakeholders	Consult with local people and other stakeholders to identify their views on possible impacts.
Step 6	Identify and assess impacts	Identify likely health impacts from the proposal. Carry out further review or research if this will help make recommendations.
Step 7	Make recommendations	Use findings to recommend changes to the proposal or other changes that would improve health impacts.
Step 8	Monitor impacts	Monitor actual impacts that arise after implementation of the proposal.

Source: Adapted from Health Impact Assessment: A guide for local authorities (CoSLA/PHIS 2001).

Although presented here as linear steps, HIA is usually iterative. Sometimes findings in later steps mean you have to revisit earlier ones.

Step 1: Screening

Those developing a proposal hold primary responsibility for deciding whether a HIA should be done. Sometimes the initial interest comes from elsewhere but it is important that findings and recommendations are fed into the decision-making process. So it is useful to involve policy makers in screening. Often screening may identify potential impacts that were not previously considered, and this may in itself inform changes without the need for a more detailed assessment.

Screening should include consideration of:

- Who may be affected by this proposal. Even if a proposal has a stated target group, it may affect people who are not part of this intended target, so it is important to consider different groups of people and how they may be affected.
- What determinants of health may be affected. You can do this using information in Chapters 3–5 on the health effects of transport, and a checklist to help you to think broadly about all the possible ways that the proposal might affect people. The screening tool below can be used to help you do this.
- What further evidence is needed to inform recommendations. You will need to use your judgement to decide if further assessment would be useful in informing or changing the proposal or other actions.

Questions to use in screening

- What population subgroups will be affected by the proposal?
- Who might be disadvantaged by the proposal?
- What is the geographical and population scale of the proposal?
- Will any of the results of the proposal be irreversible?
- Is there conflict or disagreement about the proposal? If so, would a HIA help to resolve it?
- Are there time, money and expertise to do a HIA?
- Is it possible to change the proposal in light of the HIA findings?

Source: Adapted from Scottish Needs Assessment Programme Health Impact Assessment: Piloting the process (2000) and Netherlands School Of Public Health Checklist for Health Impact Screening (1998).

A screening tool may be used for this step. The tool below could be used for this purpose. It is generally used in a group exercise with a group of people with different perspectives in order to generate discussion on potential impacts.

The possible outcomes of screening are:

- There are no likely significant health impacts → No further action required
- There are likely health impacts but recommendations to gain maximum benefit from the proposal are already obvious and no further assessment is required → Decide who should make and implement the recommendations
- There are possible significant health impacts and uncertainty about which impacts are most significant and how, or if, the proposal should be adjusted → Go to Step 2 (see table opposite)

Screening checklist for potential impacts

Which groups of the population do you think will be affected by this proposal?	Other groups:
<ul style="list-style-type: none"> • Minority ethnic people (incl. gypsy/travellers, refugees and asylum seekers) • Women and men • People in religious/faith groups • Disabled people • Older people, children and young people • Lesbian, gay, bisexual and transgender people • People of low income • People with mental health problems • Homeless people • People involved in criminal justice system • Staff 	
<p>(The word proposal is used below as shorthand for any policy, procedure, strategy or proposal that might be assessed.)</p>	<p>What positive and negative impacts do you think there may be? Which groups will be affected by these impacts?</p>
<p>What impact will the proposal have on lifestyles?</p> <ul style="list-style-type: none"> • Diet and nutrition • Exercise and physical activity • Substance use: tobacco, alcohol or drugs • Risk-taking behaviour • Education and learning, or skills 	
<p>What impact will the proposal have on lifestyles?</p> <ul style="list-style-type: none"> • Social status • Employment (paid or unpaid) • Social/family support • Stress • Income 	
<p>What impact will the proposal have on equality?</p> <ul style="list-style-type: none"> • Discrimination • Equality of opportunity • Relations between groups 	
<p>What impact will the proposal have on the physical environment?</p> <ul style="list-style-type: none"> • Living conditions • Working conditions • Pollution or climate change • Accidental injuries or public safety • Transmission of infectious disease 	
<p>How will the proposal impact on access to and quality of services?</p> <ul style="list-style-type: none"> • Healthcare • Transport • Social services • Housing services • Education • Leisure 	

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Step 2: The health impact assessment team

The team's role will include:

- scoping the work (see below)
- brainstorming to identify likely impacts
- reviewing evidence and its local relevance
- consulting stakeholders
- doing any further assessment that might be required, for example to calculate how many people will be affected by different impacts
- debating and agreeing the recommendations.

The team should report to a group with authority to agree terms of reference for an assessment and to implement the recommendations. This is often the group that has developed the proposal.

The team should include people with knowledge of:

- the specific proposal
- transport policy and practice
- the local area and population, and
- health.

Step 3: Scoping

Decisions about scope should be debated and agreed by the HIA team. The terms of reference should define the different population groups to be considered, the geographical scope and the timescale over which to try to predict impacts. Sometimes later in an assessment it becomes clear that impacts will be spread more widely than originally thought, and the scope has to be reconsidered.

Step 4: Local profile

The purpose of this profile is to inform the identification of impacts, the relevant population groups who may bear these impacts, and to provide the background information needed to help you apply the evidence on the health impacts of transport to your own specific context. This involves collating available data on:

- demographic make-up of the local population: include, especially, any particularly vulnerable groups, as identified in your scope
- health status of the local population: again, consider vulnerable groups
- features of the local area.

Step 5: Involve stakeholders

Stakeholders to be consulted include potentially affected people and people with relevant knowledge of the local area or of transport. They may give insights into, for example: different ways the proposal could affect health; whether mitigating measures are likely to work in the local context; and what values are placed on different impacts. Focus groups, questionnaires, open meetings, etc. can all be used as methods of consultation. The screening checklist can be used to structure discussions. Try to include the different population groups included in your scope.

Step 6: Identify and assess possible health impacts

The aim is to identify all the potential health impacts, to define them and decide which might require further assessment. Screening should already have identified some likely impacts, but for a more detailed assessment a systematic trawl should be done. As HIA means looking for unintended impacts, you should be systematic and transparent about how they are identified. It is important to think broadly, as impacts often arise in an indirect way, and can occur at different stages of a causal pathway.

Impacts may be identified by:

- screening findings, particularly if you have used the tool with the checklist of health determinants
- reviewing the evidence on health effects of transport
- findings from consulting with stakeholders
- the HIA team brainstorming other possible effects of the proposal.

One way to present the findings is to prepare a matrix showing impacts and population groups. This should help make it explicit who will bear what impacts, and indicate the overall balance of positive and negative impacts on each population group.

Sometimes simply identifying impacts is enough to inform recommendations.

Often you may have a long list of impacts and want to focus on the impacts that are most significant – a matrix should help with this. ‘Significant’ impacts may be:

- potentially severe or irreversible negative impacts
- impacts affecting a large number of people
- impacts affecting people who already suffer poor health or are socially excluded
- positive impacts with potential for greater health gain.

Sometimes more information is needed to inform recommendations, for example to help decide which impacts are ‘significant’ as defined above, to weigh up benefits and harms or to suggest ways to mitigate adverse impacts. Before carrying out a further assessment of the identified impacts, decide the aims of that assessment: what questions do you need to answer in order to inform recommendations?

For example, you may need to know:

- how many people will be affected by each impact
- the pathways by which impacts occur
- what value people place on each impact
- what priority to give to each impact, compared with other impacts or other factors.

It is often helpful to map the causal pathway by which impacts are expected to arise. This can be by using a diagram, such as the diagram in Chapter 6 (see page 71) that shows some possible impacts of providing cheaper public transport. Alternatively, you can outline in words the links between an intervention and impacts. Mapping the causal pathway helps you to think critically about the likelihood of impacts and evidence base for each step in the pathway. It can be a useful way to demonstrate to others the links between the proposal and health. It may also help inform recommendations, by identifying points in the pathway where changes could be made to improve the health impacts.

HIA does not require new methodologies. The methods and evidence used will depend on exactly what information you need to inform decision making, the kind of impacts identified, and the scope of the proposal. Both quantitative and qualitative methods may be appropriate. Sometimes you may need to commission the work externally. Remember to involve affected communities, especially when trying to value or prioritise impacts.

Step 7: Make recommendations

Recommendations should aim to mitigate any adverse impacts arising from the proposal, and maximise the benefits. Recommendations may be broader than the proposal being assessed. For example, assessment of a transport proposal may inform recommended changes to land use planning. The HIA team is responsible for developing and agreeing the recommendations based on the available information. This should be reported to a group with the appropriate authority to implement them.

Step 8: Monitor impacts

Monitoring should be meaningful. This means defining the population(s) to monitor, deciding in advance the aims of monitoring, and defining the outcomes that should be monitored. Monitoring should feed into the future implementation and review of the proposal and, ideally, be part of standard monitoring processes. The aims of monitoring may be to:

- monitor implementation of the recommendations of the HIA team
- identify impacts that were not foreseen in the HIA
- inform the evidence base for future assessments, particularly when there has been uncertainty over the likely impacts.

Chapter 08: Summaries of Completed Transport Health Impact Assessments

This chapter gives brief summaries of completed HIAs of transport initiatives and proposals. All of these HIAs are listed on the UK HIA Gateway website and were available in May 2006. They are included here to show the types of evidence that has been used and the impacts that have been identified in transport-related HIAs. They range from very rapid desktop assessments to detailed appraisals. They have not been critically appraised or evaluated. Very brief summaries are given below of the proposals assessed, the methods used, the impacts identified and the recommendations made. In most cases, the reports are available online and the links to these are given. The HIA Gateway website is www.hiagateway.org.uk/page.aspx?o=hiagateway.

Health impact assessments of transport strategies

Health impact assessment of the West Yorkshire Local Transport Plan (2000)

Proposal	Evidence and methods	Impacts identified	Recommendations
Assessment of impacts related to transport in West Yorkshire	Quantified impacts from statistical sources	<ul style="list-style-type: none"> • Road crashes • Air pollution • Physical activity 	<ul style="list-style-type: none"> • Promote physical activity • Work with transport professionals • Green transport plans in NHS

www.hiagateway.org.uk/media/hiadocs/129_Judith_Hooper_Local_Travel_Plan_hia_cs.pdf

www.wyltp.com/NR/rdonlyres/352829FE-EECB-444E-98C5-70E84BE57E1D/0/app_18_health.pdf

Health impact assessment of the City of Edinburgh Council's Urban Transport Strategy (2000)

Proposal	Evidence and methods	Impacts identified	Recommendations
City transport strategy with three scenarios based on different levels of funding	<ul style="list-style-type: none"> • Literature • Key informants • Impacts presented as matrix to show inequalities 	<ul style="list-style-type: none"> • Accidents • Pollution • Physical activity • Access • Community networks 	<ul style="list-style-type: none"> • Supported high cost scenario and made recommendations to address impact of transport on health inequalities

www.hiagateway.org.uk/media/hiadocs/hia_city_of_edinburgh_urban_transport_strategy.pdf

London Mayoral Strategy on Transport (2000)

Proposal	Evidence and methods	Impacts identified	Recommendations
Mayoral strategy. Themes included: promotion of modes of transport other than cars; linking transport, economic development and spatial development; congestion charging; and segregating modes of transport	Rapid assessment <ul style="list-style-type: none"> Literature Stakeholder meetings 	<ul style="list-style-type: none"> Positive on physical activity Less stress Reduction in social exclusion Reduce noise and air pollution Reduced crashes and injuries Improved access 	<ul style="list-style-type: none"> Many recommendations made to promote cycling and walking and include health measures in monitoring

www.hiagateway.org.uk/media/hiadocs/hia_transport_london_mayoral_strategy.pdf

Thurrock Local Transport Plan Rapid Health Impact Assessment (2001)

Proposal	Evidence and methods	Impacts identified	Recommendations
Local transport plan	Rapid assessment using Swedish county council policy appraisal checklist. Full methods not stated in report.	Predicted positive impacts for all of the determinants in the checklist: <ul style="list-style-type: none"> Democracy/opportunity to exert influence/equality Financial security Employment/meaningful pursuits/education Social network Access to health care and social services Belief in the future/life goals and meaning Physical environment Lifestyle factors 	<ul style="list-style-type: none"> Supported the plan

www.hiagateway.org.uk/media/hiadocs/104_Thurrock_Local_Transport_Plan_Rapid_HIA.pdf

The 2003 West Midlands Local Transport Plan (2003)

Proposal	Evidence and methods	Impacts identified	Recommendations
Local transport plan, particularly sections on: social inclusion; walking strategy; cycling strategy; road safety strategy; bus travel; light rail strategy; passenger rail strategy; red routes; safe routes to school; congestion charging	<ul style="list-style-type: none"> Literature Consultation with selected informants 	<ul style="list-style-type: none"> Physical activity Air pollution Noise pollution Accidents and injuries Access Planning blight Social inclusion/exclusion 	<p>Recommended priority be given to:</p> <ul style="list-style-type: none"> Walking and cycling Accidents and safety Targets and monitoring Air pollution Social inclusion

www.hiagateway.org.uk/media/hiadocs/WM2003LTP_HIA.pdf

Health impact assessment of Regional Planning Guidance Transport Chapter (2003)

Proposal	Evidence and methods	Impacts identified	Recommendations
Regional transport plan that aimed to improve access and journey reliability, decrease highway congestion, reduce car travel and increase walking and cycling.	<ul style="list-style-type: none"> Literature Interviews with key informants <p>Focus on inequalities and distribution of benefits and disbenefits</p>	<ul style="list-style-type: none"> Noise Injuries Physical activity Community severance Social exclusion 	<p>Supported the proposals, commented on need to ensure less well-off people were not disadvantaged.</p>

www.hiagateway.org.uk/media/hiadocs/RPG_HIA.pdf

Health impact assessments of road transport interventions

Best Value Review - Working with Partners to make Westminster a Healthier City: Road Safety Unit (Safer Routes to School) (2001)

Proposal	Evidence and methods	Impacts identified	Recommendations
Safe routes to school scheme	Rapid assessment workshop with stakeholders	Issues discussed included: <ul style="list-style-type: none"> • Respiratory and cardiovascular effects • Sense of community • Geographical awareness • Parental control • Educational attainment • Pollution • Crime • Accidents • Emotional health 	<ul style="list-style-type: none"> • Officer to promote walking and cycling • Improved routes for walking and cyclists • Support from schools • Establishment of road safety forum • Changes to council's transport policy to prioritise walking and cycling

www.hiagateway.org.uk/media/hiadocs/HIA_Road_Safety.pdf

The health impact assessment of the 'Clean Accessible Transport for Community Health' Project (2001)

Proposal	Evidence and methods	Impacts identified	Recommendations
Research and development project, aims to contribute to reducing road traffic generated air pollution in the city centre of Liverpool. Studied impact on population of five most affected wards.	<ul style="list-style-type: none"> • Profiling • Policy analysis • Interviews and focus groups 	<ul style="list-style-type: none"> • Improved mobility • Physical activity • Personal safety • Social support • Local economy • Access • Air quality Inequalities as some populations may benefit less.	Several recommendations including: <ul style="list-style-type: none"> • Target populations for support • Promote use of safety equipment • Review fares policy

www.ihia.org.uk/document/impacthiareports/CATCH%20HIA%20Final.pdf

A Health (Inequality) Impact Assessment of the St Mellons Link Road Development (2002)

Proposal	Evidence and methods	Impacts identified	Recommendations
<p>Link road</p> <p>Studied impacts on residents within 2 km of road</p>	<ul style="list-style-type: none"> Literature review Quantitative estimates of impacts 	<ul style="list-style-type: none"> Emissions: respiratory and cardiovascular effects Accidents and injuries Stress Restrictions to children walking and playing in the area Uncertain impact on walking and cycling Uncertain impact on social capital Possible employment Noise disturbance Loss of countryside and negative aesthetic impact 	<ul style="list-style-type: none"> Designate residential roads for access only Local labour agreements Noise reduction Tree planting

www.hiagateway.org.uk/media/hiadocs/32_st_mellons_wales.pdf

The Foresight Vehicle Initiative Health Impact Assessment (2002)

Proposal	Evidence and methods	Impacts identified	Recommendations
<p>A strategy to develop and demonstrate new road vehicle technologies and working practices, mainly through funding research</p>	<ul style="list-style-type: none"> Profiling Policy analysis Qualitative methods with stakeholders and informants Quantification of health effects of changes in health determinants due to the initiative Economic analysis Compared impacts on different populations 	<ul style="list-style-type: none"> Reduction in crashes Little impact on physical activity Increased mobility Increased productivity Small improvements in air quality Small noise reduction Limited impact on inequalities 	<ul style="list-style-type: none"> Recommended priority areas for future research funding

www.hiagateway.org.uk/media/hiadocs/Foresight_exexsumm.pdf

Health impact assessment of the proposed western extension to the central London congestion charging zone (2005)

Proposal	Evidence and methods	Impacts identified	Recommendations
Extension of congestion charging scheme	<ul style="list-style-type: none"> • Analysis of proposal • Community profile • Literature • Stakeholder workshop 	<ul style="list-style-type: none"> • Reduced congestion in a deprived area • Improved physical activity • Fewer injuries • Small effects on noise and air pollution • Variable effects on access 	<ul style="list-style-type: none"> • Monitoring of health impacts • Traffic management to promote active travel modes • Bus service improvements • Monitor and address impacts on vulnerable groups • Promote physically active travel with schools, employers, etc.

www.hiagateway.org.uk/media/hiadocs/Proposed%20Western%20Extension.pdf

Health impact assessments of airport developments

A prospective health impact assessment of the proposed development of a second runway at Manchester International Airport (1994)

Proposal	Evidence and methods	Impacts identified	Recommendations
Second runway	<ul style="list-style-type: none"> • Literature • Quantitative estimation 	<ul style="list-style-type: none"> • Positive impacts of employment • Air pollution 	<ul style="list-style-type: none"> • Green travel plan

(Report not available online.)

Finningley Airport Health Impact Assessment (2000)

Proposal	Evidence and methods	Impacts identified	Recommendations
Development of a commercial airport from a former RAF airbase	<ul style="list-style-type: none"> • Policy appraisal • Community profile • Interviews with stakeholders and key informants • Literature • Ranking and prioritising health impacts 	<ul style="list-style-type: none"> • Employment • Noise • Air pollution 	<ul style="list-style-type: none"> • Independent group to monitor impacts • Target employment to local people • Noise abatement • Green transport plan • New motorway link • Review public sector infrastructure

www.hiagateway.org.uk/media/hiadocs/79_finningley_airport_hiareport.pdf

Health impact assessments of other transport plans

Alconbury Health Impact Assessment Report (2000)

Proposal	Evidence and methods	Impacts identified	Recommendations
<p>Redevelopment of air force base to large road and rail freight distribution centre.</p> <p>Studied impacts on people living around the development.</p>	<ul style="list-style-type: none"> • Literature • Public involvement 	<ul style="list-style-type: none"> • Employment opportunities • Positive economic impact • Shift to rail freight leading to less pollution and fewer crashes • Noise pollution • Accidents to workers and road traffic accidents • Air pollution 	<ul style="list-style-type: none"> • Promote jobs in areas of high unemployment • Noise mitigation • Health and safety standards • Green travel plan

www.hiagateway.org.uk/media/hiadocs/72_148_alconbury_airfield_hia_complete_report.pdf

Health Impact Assessment – Proposed Extension to the Port of Southampton at Dibden Bay (2001)

Proposal	Evidence and methods	Impacts identified	Recommendations
Construction of a new deep-water terminal opposite existing docks	<ul style="list-style-type: none"> • Documentary analysis • Community profile • Stakeholder views through participatory public consultation • Literature 	<ul style="list-style-type: none"> • Noise and vibration • Light pollution • Air quality • Road safety and congestion • Employment/economy • Soil contamination/ground quality • Construction and operational safety • Safety on the water 	<ul style="list-style-type: none"> • Noise and light mitigation • Measures to limit air pollution • Road improvements • Training and measures to enhance economic benefits • Monitoring of pollutants

www.phel.gov.uk/hiadocs/dibden_port_extension_hia_summary.pdf

Merseytram Line 1: A Health Impact Assessment of the Proposed Scheme (2004)

Proposal	Evidence and methods	Impacts identified	Recommendations
A tram line scheme Considered construction and operation phases	<ul style="list-style-type: none"> • Profiling • Literature and documentary analysis • Interviews and focus groups 	<ul style="list-style-type: none"> • Employment • Disrupted social networks • Injuries • Air quality • Noise • Modal shift • Increased physical activity • Improved access 	<p>Generally supported the proposal. Recommendations include:</p> <ul style="list-style-type: none"> • Reduce work related risks • Forum to involve local community • Enhance measures to change transport behaviour • Enhance synergy with related plans

[www.ihia.org.uk/document/impacthiareports/Merseytram Line 1 HIA - Final.pdf](http://www.ihia.org.uk/document/impacthiareports/Merseytram%20Line%201%20HIA%20-%20Final.pdf)

Chapter 09: Sources of Data on Transport

03

Scottish Household Survey

The Scottish Household Survey (SHoS) is a continuous cross-sectional survey of adults aged 16 years and over, which includes questions on a wide range of topics, including travel and transport. It provides data down to local authority level. Results are available from the Scottish Household Survey website at: www.scotland.gov.uk/Topics/Statistics/16002/4031.

National Travel Survey

The National Travel Survey is a continuous survey that covers a sample of households across Great Britain, and is conducted on behalf of the Department for Transport (DfT). It collects information about all kinds of personal travel for which the main reason for the trip is for the traveller to reach the destination. (It excludes travel to convey passengers or goods.) Some Scottish data are available within a Scottish Executive statistical bulletin at: www.scotland.gov.uk/Publications/2005/04/1894658/46593.

Routine data on road traffic accidents

Routine statistics are collected from the 'STATS 19' returns submitted by police for all crashes known to them. They include all crashes involving a vehicle which occur on roads (including footways), resulting in death or personal injury and which become known to the police. They do not include crashes in which no one was injured.

Road Accidents Scotland is a Scottish Executive publication that provides statistics about road crashes from STATS 19 returns. Data are given on vehicles involved, drivers and riders, drink-drive crashes, drivers breath tested and casualties. It is available at: www.scotland.gov.uk/Publications/2006/01/23140138/0.

Scottish Executive transport and travel statistics

The Scottish Executive provides data on transport and travel, and produces statistical bulletins on transport-related topics. These are available at: www.scotland.gov.uk/Topics/Statistics/15781/3494.

Scottish Transport Statistics is a Scottish Executive publication of routine and survey data. It includes data on, for example: road vehicles, traffic, crashes, toll bridges, bus and rail passengers, road and rail freight, air and water transport, finance, personal travel and international comparisons. It is available at: www.scotland.gov.uk/Publications/2005/08/25100154/01557.

Scot-TAG

Scot-TAG is the Scottish Executive's web-based central information source on transport analysis guidance. It provides information and guidance for use when developing and assessing transport schemes and strategies. It is available at: www.scot-tag.org.uk/.

UK Department for Transport Statistics

The Department for Transport (DfT) collects, analyses and publishes a wide range of statistics covering all forms of transport. Reports are available at: www.dft.gov.uk/stellent/groups/dft_transstats/documents/sectionhomepage/dft_transstats_page.hcsp.

Transport Statistics for Great Britain is a major annual report, which brings together the full range of transport statistics and is the main general statistical reference source. It is available at: www.dft.gov.uk/stellent/groups/dft_control/documents/contentservertemplate/dft_index.hcst?n=14605&l=3.

Transport Trends is a companion publication that presents an overview and analysis of trends in transport and travel in the UK over the past 25 years, and highlights some of the key issues. It is available at: www.dft.gov.uk/stellent/groups/dft_transstats/documents/page/dft_transstats_026281.hcsp.

TRICS database

This is a database containing site and development information for development sites in the UK. In each of these developments traffic entering and exiting is recorded, and from this information trip rate calculations are carried out, which can be used to estimate traffic flows for a variety of development types. It is available at: www.trics.org.

Appendix 1: Glossary of Terms

Community severance	Reduced access to local amenities and disruption of local social networks caused by a physical barrier running through a community.
Confidence interval	Quantifies the uncertainty in measurement. It is usually reported as 95% CI, which is the range of values within which we can be 95% sure that the true value for the whole population lies.
dB	Unit of sound level.
dB(A)	Levels on a decibel scale of noise measured using a frequency depending weighting that approximates to the characteristics of human hearing. Referred to as A weighted.
DALY	Disability Adjusted Life Year, a quantitative indicator of burden of disease that reflects the total amount of healthy life lost, from premature mortality or from some degree of disability during a period of time.
Green transport plan	'A way by which organisations and business manage the transport needs of their staff and visitors. The aim of any plan should be to reduce the environmental impact of travel associated with work, whether by plane or car' ¹⁷ .
HIA	Health Impact Assessment. 'A combination of procedures, methods and tools by which a policy, program or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population' ¹⁹³ .
KSI	Killed or Seriously Injured rate: often measured per kilometre travelled.
LTS	Local Transport Strategy, a requirement of Scottish Councils.
Modal shift	Promotion of a population shift in mode of travelling, usually from using cars towards walking and cycling.
Moderate physical activity	A level of effort in which a person should experience some increase in breathing or heart rate but is able to continue a conversation. Examples include walking briskly, mowing the lawn, dancing, swimming or bicycling on level terrain.

OR	Odds Ratio. Ratio of probability of an event in one group to probability of the event in a compared group.
Out-of-town bypass	Roads that are designed to take road traffic away from populated urban areas.
P value	A measure of probability that a difference between groups happened by chance. For example, a p value of .01 ($p=.01$) means that there is a 1 in 100 chance the result occurred by chance. Results with p values equal to or less than .05 are usually considered to be statistically significant.
PM	Particulate Matter. Small particles are the constituent of air pollution most closely associated with adverse health outcomes. PM_{10} is the mass concentration of inhalable particles, of about 10 microns aerodynamic diameter or smaller. $PM_{2.5}$ is the corresponding measure of particles of 2.5 microns or less.
RTP	Regional Transport Partnerships, statutory bodies charged with identifying regional transport objectives and projects and initiatives to deliver these objectives.
SF36	Commonly used questionnaire with 36 questions about health status.
STATS 19	Returns submitted by police for all crashes known to them in which a vehicle is involved, which occur on roads and footways and result in death or personal injury.
SUV	Sport utility vehicle
Traffic calming	Schemes that are designed to slow down through traffic on residential roads.
Transport Scotland	An independent agency with responsibility for national capital investment projects and concessionary travel schemes.
Vigorous physical activity	A level of effort in which a person will experience large increase in breathing or heart rate such that conversation is difficult or broken. Examples include jogging, mowing the lawn with a non-motorised push-mower, participating in high-impact aerobic dancing, swimming continuous laps or bicycling uphill, carrying more than 25lbs up a flight of stairs, or standing or walking with more than 50lbs, for example.

Appendix 2: Literature Review Questions and Search Strategy

Questions Addressed in the Literature Review

- What is the evidence that transport policies and initiatives can affect physical activity levels overall (taking account of, for example, substitution effects)?
- What is the evidence that transport policies and initiatives can affect road safety for car drivers, passengers and pedestrians?
- What is the evidence of health effects from air and noise pollution from different modes of transport? What population subgroups are affected?
- What is the evidence of links between stress and mode of travel?
- What is the evidence of impacts of transport policies and initiatives on community severance, and resulting impacts on health? This would include, for example, new roads, crossings and how busy roads are.
- What is the evidence of links between social inclusion and transport policies and initiatives?
- What is the evidence of health impacts of initiatives intended to effect modal shift?
- What is the evidence of the direct and indirect health impacts of measures to promote availability and use of public transport?
- What are the most effective interventions for the following:
 - reducing drink driving
 - reducing speed
 - increasing seat belt use
 - increasing helmet use.

Search Strategy

Research evidence on transport interventions and health

We used a systematic review of systematic reviews (1960s–2001) on transport and health¹⁵¹ as a baseline resource and updated searches for systematic reviews published since 2001 (2001-2005). We searched nine bibliographic databases (Cochrane Library, DARE, SIGLE, PsycINFO, Medline, EmBase, SPORTDiscus, CINAHL and TRANSPORT) and the internet (Google) for systematic reviews of transport and health. Where no systematic reviews of an intervention were located, comprehensive reviews and primary studies were searched for and drawn on.

Search terms:

1. accident prevention
2. automobile driving/ or automobiles/ or crashes, traffic/ or seat belts/
3. bicycles or cars or trains or buses or walking
4. noise, transportation/ or transportation
5. or (1–5).

Limits:

Search restricted to systematic reviews published after 2001^c
Plus TRANSPORT database searched for any systematic reviews

Research evidence on links between transport and health

In addition, we searched for cross-sectional studies and reviews of epidemiological data on the links between transport and health. As well as the above searches, we searched Web of Knowledge for data on links between health and road, rail, bus, air or water transport.

Transport-related air pollution and health

The evidence base drawn on for issues relating to transport-related air pollution draws on various expert reviews such as WHO convened groups and UK Government Expert Advisory Group reports, for example Committee on the Medical Effects of Air Pollutants (COMEAP).

^c Date of last search in Morrision review.¹⁵¹

Appendix 3: Classification Used for Strength of Evidence

The following classification details have been adapted from the work of Weichtman *et al.*¹⁹⁴

1++	High-quality meta-analysis, systematic review(s) of RCTs (including cluster RCTs) or RCTs with a very low risk.
1+	Well-conducted meta-analysis, systematic review of RCTs, or RCTs with a low risk of bias.
1-	Meta-analysis, systematic reviews of RCTs, or RCTs with a high risk of bias.
2++	High-quality systematic reviews of, or individual high-quality, non-randomised intervention studies (controlled non-randomised trial, controlled before-and-after, interrupted time series) comparative cohort and correlation studies with a low risk of confounding, bias or chance.
2+	Well-conducted, non-randomised intervention studies (controlled non-randomised trial, controlled before-and-after, interrupted time series), comparative cohort and correlation studies with a low risk of confounding, bias or chance.
2-	Systematic review (Oxman and Guyatt score < 5: moderate to poor quality) ¹⁹⁵ of non-randomised intervention studies with high risk of confounding, bias or chance. Nonrandomised intervention studies (controlled non-randomised trial, controlled beforeand- after, interrupted time series), comparative cohort and correlation studies with a high risk of confounding, bias or chance.
3	Non-analytical studies (e.g. case reports, case series), single cross-sectional study or single, small non-randomised intervention study (controlled non-randomised trial, controlled before-and-after, interrupted time series), comparative cohort and correlation studies with a high risk of confounding, bias or chance.
4	Expert opinion, formal consensus.

Appendix 4: Summary Findings of Evidence Review

Topic	Overall assessment of health impacts
Transport and general health	<ul style="list-style-type: none"> • Access to a car is linked to improved physical health. This link is not explained by social class, income or feelings of self-esteem linked to car ownership • The risk of life threatening emboli following air travel is extremely low but may increase following long haul flights among high risk groups
Transport and physical activity	<ul style="list-style-type: none"> • Walking and cycling are physically active forms of transport • The current recommendation for adults to achieve health benefits is to accumulate 30 minutes of moderate-intensity activity, such as brisk walking, at least 5 days per week • It is not known whether increased car use is linked to reduced physical activity overall at an individual level • Physically active transport may lead to increases in overall levels of physical activity
Transport related injury and death	<ul style="list-style-type: none"> • Travel by rail and plane has the lowest rate of fatality or serious injury • Road users at highest risk of being killed or seriously injured are cyclists and pedestrians • The most commonly cited cause of a road crash is speed • Rates of road crashes in Scotland are falling despite increased road traffic • Rates of crashes involving cyclists are lower in countries where cycling is common • Very little research has been carried out on tram related crashes
Transport related air pollution and health	<ul style="list-style-type: none"> • Air pollution is a complex mix of particles and gases. Increased outdoor air pollution is associated with increased cardio-respiratory mortality and morbidity. Some effects are more-or-less immediate and affect vulnerable groups in particular whereas the effects of long-term exposure are more widespread • Small particles (PM) are the constituent most closely associated with adverse health outcomes • Road transport is responsible for 30% of the emissions of PM_{2.5}, and about 50% of the emissions of PM_{0.1} • It is estimated that overall there is a 6% change in mortality per 10 µg.m⁻³ change in annual average PM_{2.5} • For many pollutants, concentrations in vehicles are higher than background and general roadside concentrations
Transport noise and health	<ul style="list-style-type: none"> • Links between transport noise and health are inconclusive • Transport noise is unlikely to result in long term hearing problems • Aircraft noise may lead to sleep disturbance and reduced quality of sleep • There is no clear link between living near to an airport and other health outcomes
Transport and mental health	<ul style="list-style-type: none"> • Links between physical activity and improved mental health are unclear • Access to a car is linked to improved mental health • There is little available research on the subject of road rage or public transport related stress
Transport and personal safety	<ul style="list-style-type: none"> • Personal safety fears and fear of crime may deter people from walking, cycling or using public transport

Topic	Overall assessment of health impacts
Transport, community severance and health	<ul style="list-style-type: none"> • New transport routes running through an existing community may lead to community severance • Substantial increases in traffic through a community may lead to community severance • The health impacts of community severance are not known
Climate change, transport and health	<ul style="list-style-type: none"> • There is wide scientific consensus that the global climate is changing and that most of this change is attributable to human activity since the pre-industrial era • Motorised transport accounts for 22% of CO₂ emissions • A range of detrimental health impacts are predicted to arise from continued climate change, with lower income populations, predominantly within tropical/subtropical countries, likely to be the most seriously affected
New transport infrastructure	<ul style="list-style-type: none"> • Out-of-town bypasses decrease injuries on main roads through or around towns, although more robust evidence is needed to assess the impacts on secondary roads • New major urban roads have little effect on incidence of injury • New major roads between towns decrease injuries. There is no available research evidence about the impacts of new roads on respiratory health, mental health, physical activity and access to health services • Out-of-town bypasses reduce disturbance and community severance in towns but may increase them elsewhere • Major urban roads increase disturbance and severance • No research which evaluated the health impact of building other new transport infrastructure (e.g. light and heavy railways, airports or ferry terminals) was identified
Reducing congestion and fuel consumption	<ul style="list-style-type: none"> • Stringent measures such as congestion charging zones lead to reduced traffic and congestion within the zones and may improve air quality • There is very limited research evidence on health impacts of congestion charging
Reducing traffic related air pollution	<ul style="list-style-type: none"> • Estimates of the benefits to health of reducing traffic-related air pollution are substantial • Observational studies of traffic interventions confirm that real benefits can occur
Reducing noise pollution from transport	<ul style="list-style-type: none"> • There is currently little evidence about the health impact of transport interventions designed to reduce transport related noise
Promoting physically active transport	<ul style="list-style-type: none"> • Targeted behaviour change programmes may lead to increased walking and cycling among motivated subgroups and may lead to short term improvements in certain measures of physical and mental health • Other attempts to promote physically active transport have not led to substantial increases in walking and cycling • Individuals who change from driving to walking or cycling to work may benefit from improved physical fitness and mental health • The health impact of promoting public transport as an alternative to car use is not known
Improving psychosocial aspects of travelling on public transport	<ul style="list-style-type: none"> • There is currently little evidence of the impact of interventions that are designed to improve the psychosocial aspects of travelling on public transport • Installation of CCTV cameras may reduce crime on public transport

Topic	Overall assessment of health impacts
Reducing injury and death from road transport through environmental and engineering interventions	<ul style="list-style-type: none"> • Environmental and engineering interventions which can effectively reduce transport crashes include single lane roundabouts, guardrails, pavements, pelican crossings, lighting and area-wide traffic calming. There is little research evidence that these interventions lead to reductions in fatal or serious injury • There is very little research evidence around the possible unintended health impacts of engineering and environmental interventions designed primarily to improve road safety
Reducing injury/death from road transport through safety equipment for individuals	<ul style="list-style-type: none"> • Safety equipment which reduces transport related injury includes helmets for cyclists and motorcyclists, seatbelts and daytime running lights • Safety equipment which reduces transport related injury includes helmets for cyclists and motorcyclists, seatbelts and daytime running lights • The effectiveness of visibility aids for pedestrians in reducing crashes has not yet been established • The potential for these interventions to be effective will depend on levels of individual use
Reducing injury and death from road transport through legislative interventions	<ul style="list-style-type: none"> • Legal strategies which reduce road transport crashes and/or related injury include: red light cameras, speed cameras, use of random breath testing, and legislation to enforce blood-alcohol limits of 0.08%, use of motorcycle helmets and seatbelts, and graduated licensing laws • Probation and rehabilitation of drink-driving offenders has led to reductions in crashes and related injury. Severe licence sanctions are required if a reduction in crashes are to be achieved
Reducing injury/death from road transport through educational and behavioural change interventions	<ul style="list-style-type: none"> • It is unclear whether or not educational interventions among drivers or pedestrians can lead to reductions in crashes and transport related injury • Some education initiatives have led to improved road safety skills, knowledge and behaviour among pedestrians • School based driver education has led to earlier licensing among teenagers
Reducing injury/death from crashes: other modes	<ul style="list-style-type: none"> • There is very little research establishing effective ways to reduce injury and death from other modes of transport such as air, train, tram, ferry • Identifying crash “black spots” and separating trams from other vehicles and bicycles in these areas, may lead to a reduction in tram-related crashes

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