

Health Impacts of Transport

a review



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Institute of Public Health in Ireland
March 2005



THE INSTITUTE OF
PUBLIC HEALTH IN IRELAND

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Published by the Institute of Public Health in Ireland

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ISBN 0-9542965-7-5

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Foreword

The Institute of Public Health was established in 1998 to promote cooperation in public health across the island. It aims to improve health in Ireland, by working to combat health inequalities and influence public policies in favour of health.

The Institute recognizes that the main determinants of health are people's social and economic circumstances. To be effective in improving health and tackling health inequalities, public health must engage with decision makers in a range of policy areas.

This resource explores the links between transport and health and aims to inform transport development across the island in coming years. For example, the National Development Plan and National Spatial Strategy will see significant investment in transport infrastructure in the South, while in the North the Regional Transportation Strategy is being implemented and an Accessible Transport Strategy is being developed. Interest in the potential health impacts of such initiatives is already evident. A pilot Health Impact Assessment (HIA) of the proposed Regional Transportation Strategy has been published in the North, and a HIA of transport initiatives in Ballyfermot was completed in 2004.

This document reviews evidence of the health impacts of transport. It originated as part of the transport HIA in Ballyfermot organized by the Eastern Regional Health Authority and proceeds from the Institute's strategic objective to strengthen the capacity of those working for public health. It is aimed at a wide audience, including policy-makers in transport and planning, advocates in the community sector, as well as public health practitioners. It is hoped that the document will help to develop informed debate about the links between transport and public health, including health inequalities, and be a useful resource for those working to influence public policy for health gain at local and national levels across the island.

Executive summary

Transport is one of a range of social, environmental and economic factors outside the healthcare sector which are known to influence health. For example, transport policy can promote access to shops selling fresh, nutritious food, or can be used to facilitate walking and cycling and therefore have a positive effect on health. Alternatively, traffic can be a hazard to all road users leading to accidents, and busy roads can divide communities and form barriers to social contact, damaging people's health.

The purpose of this review is to describe evidence illustrating such health impacts and to demonstrate the unequal distribution of these impacts. Since many of the pathways have been extensively studied, and good quality "off-the-shelf" reviews are available, this document takes the form of a "rapid review" of many existing evidence summaries.

Road traffic injuries

Injuries from road traffic accidents are an important cause of death and disability. The damage to health caused by road traffic injuries shows a clear social class gradient with the poorest suffering most. Road traffic injuries are associated with long term psychiatric consequences in children and adults, with studies suggesting this happens in approximately a third of cases. Accidents also affect the wider community. Poorly perceived road safety may act as a potential barrier to healthy forms of transport (walking and cycling). It may also inhibit the use of outdoor space for play by children, and access to family, friends and services.

Studies on the effectiveness of interventions to reduce road traffic injuries were reviewed for this document. Area-wide traffic calming appears to reduce road traffic injuries. Speed limit reductions prevent road traffic injuries, but evidence for the effectiveness of road surface changes is less certain. Public lighting is effective in reducing accidents. Median barriers appear to increase accidents, but reduce fatalities, probably by preventing passage of vehicles into oncoming traffic. Roundabouts, traffic signals, refuge islands and pedestrian fences also show evidence of effectiveness.

Air pollution

The effect of air quality on human health has been extensively researched and expert opinion is available in this area. Currently, evidence is strongest for air pollution as a cause of short-term health effects in susceptible groups (the elderly and those with underlying health problems such as heart or lung disease). Longer term health impacts are suspected to result from certain components of air pollution; however, it has been difficult to ascribe cause and effect with certainty. Traffic is a leading source of air pollution, and initiatives which reduce traffic volume can have potential benefits to health by improving air quality. Vehicle speed is also a factor warranting consideration. Low average speed journeys, such as those taken on congested routes, are less efficient in their use of fuel and result in greater pollution emissions.

Noise pollution

Community noise is noise emitted from all sources except at industrial workplaces. Major reviews of the health impacts of noise have found that, while studies indicate a possible impact on health from noise, many were of poor quality and produced conflicting results. It was concluded that a causal link between noise and health damage could not be drawn with certainty, except in the case of annoyance. This is likely to be the most widespread and important effect of noise. While sleep disturbance in response to noise has been documented, it is not certain that these changes have health effects. Noise has been shown to have negative effects on children's reading comprehension and attention, although most of the evidence accumulated in this regard is from studies of airport noise. Chronic exposure to noise may increase the risk of heart disease, but expert groups do not agree that this is a certain effect. Noise may also exacerbate mental health problems for those who suffer from these conditions.

Planning the location of sources of noise away from communities, and limiting noise production through banning traffic on certain routes or reducing speeds are potential ways of protecting people from noise. Limiting the transmission and reception of noise through barriers and sound proofing are other options.

Physical activity

The health benefits of regular physical activity can be achieved through "active transport" using cycling or walking. There is extensive research providing support for the significant health promoting effects of exercise. The benefits of regular

physical activity include reductions in the risk of overall mortality, death from cardiovascular disease, colon cancer, and the development of Type II diabetes mellitus. It also encourages optimum skeletal development and prevents falls in the elderly. Regular physical activity improves mood and health-related quality of life. Importantly, low levels of physical activity contribute to the development of obesity. Research suggests that patterns of physical inactivity and obesity established early in life determine adult behaviour. Transport initiatives can be used to encourage active transport and produce health gain for the community. For example, improving road safety and the attractiveness of the physical environment can make walking and cycling more appealing transport options.

Effects on community

Links between people (social networks), and the resources which flow from these links (social capital) are important influences on health and well-being. It has been shown that, even after accounting for the effects of being overweight and personal habits such as drinking, smoking and exercise, the risk of dying is least for those who have the most social connections. All-Ireland research supports the positive effect of social networks and aspects of social capital on the health of people living across the island. For example, poor perceived neighbourhood quality, one of a number of measures of social capital, has shown association with poor health.

Transport policy can disrupt or promote the positive influence which social networks and social capital can have on health. Community severance is separation of different areas within a community by the flow of traffic, and can disrupt social networks. Besides physical separation, traffic can also create perceived barriers to social contact. It has been demonstrated that people living on streets with heavy traffic have fewer friends and acquaintances than counterparts living on streets with lighter traffic flow. It has also been shown that people living in neighbourhoods which are “walkable” score higher on measures of social capital than their counterparts living in car-dependent neighbourhoods.

Social inclusion

Transport is an important component of social inclusion. Firstly, transport is a public service to which all members of society need fair and equal access. For example, people with disabilities need access to buses, poorer people need to be able to afford to use public transport and geographically remote areas need to have frequent public transport to prevent isolation. Transport is also key to

securing access to other resources which form the basis of social inclusion. These include travel to work or school, visiting family and friends, access to a GP or hospital, shopping, and access to recreational facilities. “Transport poverty” is used to describe the lack of real travel choice for those who experience exclusion from transport, and as a consequence lack choice in their destinations and activities.

Some of the health effects of poor access to transport are caused by preventing access to health protecting and promoting resources, such as recreational facilities for exercise, family and friends for social support, or shops which sell a variety of fresh, nutritious food. Poor transport facilities can also contribute to a perception of poor local services amongst a community. All-Ireland research has shown that, compared with people who felt their locality had good services, people who felt their locality had poor services were less likely to have good general health or good mental health. Affordability, availability and accessibility are key issues in promoting social inclusion through transport.

Conclusion

The scope of the effects that transport may have on health have been highlighted. These health impacts are brought to bear through a number of potential pathways that have been described. Through careful consideration of these impacts, transport policy makers are in a powerful position to promote the positive and mitigate the negative effects which their decisions may have on the public’s health. There is a need to engage with decisions made about the wider social and physical environment if the public’s health is to be protected and promoted and inequalities in health are to be addressed.

1. Introduction

This resource explores the links between transport and health and aims to inform transport development across the island.

This document originated as part of a Health Impact Assessment (HIA) in Ballyfermot, Dublin, organized by the Eastern Regional Health Authority and proceeds from the Institute's strategic objective to strengthen the capacity of those working for public health. HIA is a "combination of procedures, methods and tools by which a policy, programme or project may be judged as to its potential effects on the health of the population, and the distribution of those effects within the population".¹ Health is known to be determined by a range of social, environmental and economic factors outside the healthcare sector² and decisions made in these areas strongly influence health. HIA presents the possible positive and negative effects of decision making on health and aims to influence policy in favour of better health and well-being. Through consideration of the distribution of health impacts within a population, it can also address inequalities in health.

The "Acheson report" in 1997 described the role of transport in health - "The primary function of transport is in enabling access to people, goods and services. In doing so it promotes health indirectly through the achievement and maintenance of social networks. Some forms of transport, such as cycling and walking, promote health directly by increasing physical activity and reduction of obesity. Lack of transport may damage health by denying access to people, goods and services and by directing resources from other necessities. Furthermore, transport may damage health directly, most notably by accidental injury and air pollution".³

The evidence base presented in this document takes the form of a "rapid review".⁴ It relies, in part, on published reviews which describe the results of a wide number of studies in the area. Many of the pathways through which transport affects health (air pollution, noise, physical activity) have been extensively studied, and good quality "off the shelf" reviews are available. For this reason, an attempt has not been made to collect and summarise all original studies on these topics. However, this was supported by a search of published scientific and "grey" literature to address other areas. These were located using appropriate search terms in the following search engines: Medline, HIA Gateway, Health Development Authority (HDA) Evidence Base, the NHS Public Health Electronic Library and the World Health Organisation Health Evidence Network (HEN).

Important sources for this document are previously completed HIAs on transport.⁵⁻⁷ The results of completed assessments have been collected as a resource for those undertaking future work in the same area,⁸ and a list of some of those reviewed as a background to the current project is provided in Table 1.

Table 1: List of some completed Health Impact Assessments of Transport Policy.

Location	Policy
West Midlands	RPG Transport Chapter
Merseyside	Merseyside Integrated Transport Strategy
Northern Ireland	Proposed regional development strategy
Edinburgh	City of Edinburgh Council's Urban Transport Strategy
Cardiff	St. Mellon's Link Road Development
Rotherham, Sheffield	Rotherham Sheffield Motorway Planning Study
Thurrock	Thurrock Local Transport Plan

In addition, Health Impact Assessments of air quality and noise control policies were also reviewed because of their relevance to the scope of potential effects arising from a transport initiative.

2. Potential health impacts of transport

The UK Faculty of Public Health provides a summary list of potential health impacts of transport,⁹ as shown in Table 2. Other available documents support this list.¹⁰⁻¹²

Table 2: Potential health impacts of transport

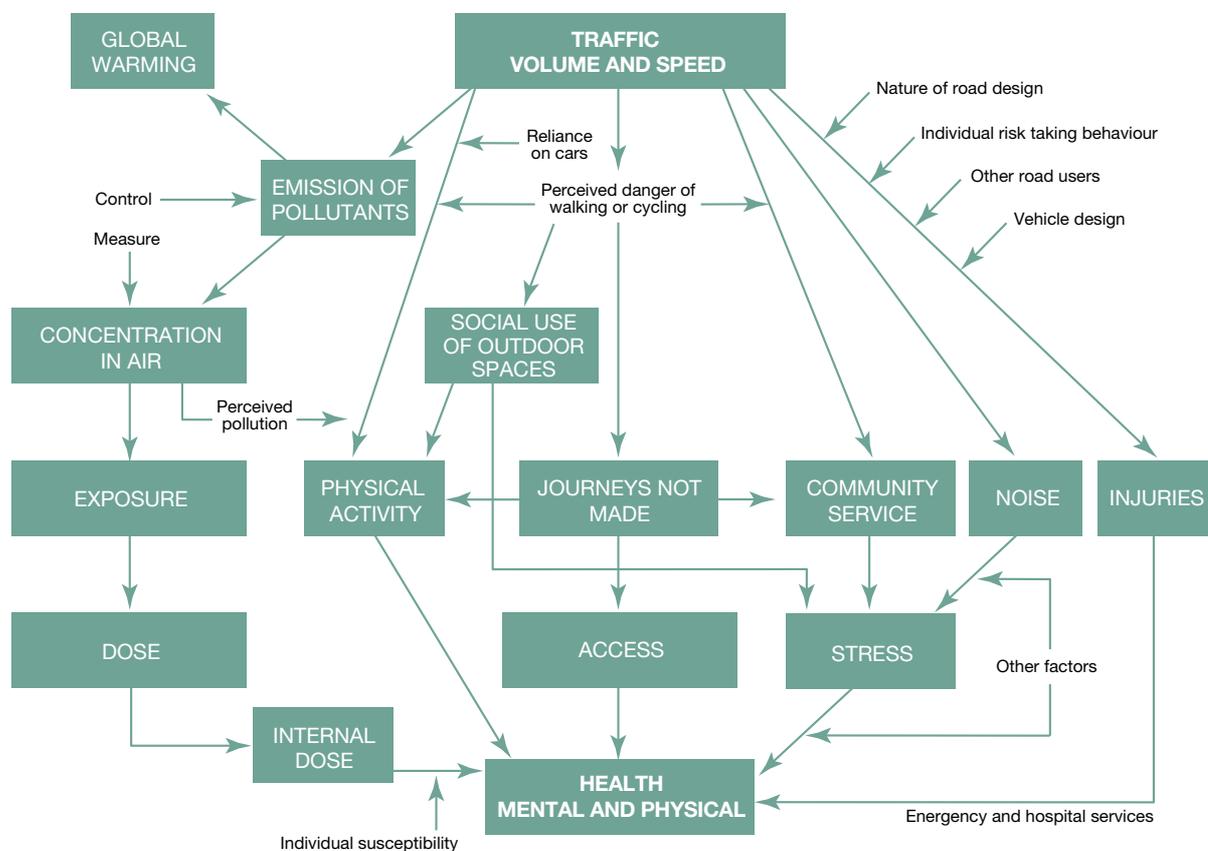
Health Impact	
Health promoting	Health damaging
Enabling access Recreation Exercise Economic development	Employment Shops Recreation Social support Health services Countryside Road traffic injuries Air pollution Noise pollution Stress and anxiety Danger Loss of land and planning blight Severance of communities by road Constraints on mobility access and independence Reduced social use of outdoor space due to traffic and streets
	Particulates Carbon monoxide Nitrogen oxides Hydrocarbons Ozones Carbon dioxide Lead

Source: Transport and health study group and Faculty of Public Health Medicine⁹

2.1. Pathways from transport to health

Transport policy affects health both directly (e.g. through air pollution or traffic accidents) and indirectly (e.g. through exercise or its impacts on neighbourhoods and community life). Breaking down the stages in the pathway between transport and health (a “policy-risk assessment model”) can help in understanding the health impact of transport initiatives.¹² Figure 1 provides a diagrammatic representation of the pathways from transport policy to health outcomes.

Figure 1: Pathways from transport policy to health outcomes



Source: Joffe M and Mindell J.¹³

2.2. Unequal distribution of health impacts and inequalities in health

The term health inequalities describes differences in the health of different individuals or groups and usually refers to inequities in health status between different social groups. Work by the Institute of Public Health in Ireland has demonstrated that perceptions of poor health and death from disease tend to fall more heavily on certain groups on the island of Ireland, with our poorest people suffering most.^{14 15}

In its overview of the relationship between transport, the environment and health, the World Health Organization identifies a number of vulnerable groups:¹⁶

- Communities living in **urban areas**, especially those in inner-city districts
- The poor are at risk of traffic related injuries, health damage from air pollution, exposure to elevated levels of community noise and of living in areas in closer proximity to traffic than other socioeconomic groups
- **Women** are less likely to be car dependent, less likely to be injured by traffic, but also more likely to have their needs unmet by public transport
- **Children** are vulnerable to injury by traffic. They may be more vulnerable to the performance damaging effects of sound, and their social interaction and physical activity habits may become more isolated and sedentary because traffic places real and perceived limitations to their physical independence
- **Older people** are vulnerable to the effects of air and noise pollution due to their underlying health state, and may be more inclined to become socially isolated due to poor access to transport and fears over personal safety, and are at high risk of traffic related injury relative to other age groups
- **Pedestrians** and **cyclists** engaging in health promoting physical activity are vulnerable to road traffic injury, and perceived danger in this regard may be a factor in reducing the number of journeys which people would potentially undertake by this route.

3. Road traffic injuries

3.1. The impact of road traffic injuries on health

The impact of road traffic injuries on health is the most obvious and direct link between transport and health.

In the South of Ireland, accident information is collected by the National Roads Authority (NRA) and categorised into three groups: fatal accidents, injury accidents and material damage accidents (wherein vehicles, buildings or other property are damaged). This is based on information collected by the Garda Síochána on reported incidents. Data for 2002 show that 376 people were killed in 346 fatal accidents, 9,206 people were injured in 6,279 injury accidents and 17,915 incidents of material damage accidents were reported.¹⁷ Overall, in that year, motor vehicle traffic accidents caused 8.8 deaths per 100,000 persons in Ireland.¹⁸ In the North, the Police Service of Northern Ireland collect road traffic related statistics. In 2002, 150 people were killed, 1,526 were seriously injured, and a total of 11,914 casualties were recorded from 6,784 injury collisions.¹⁹ In that year motor vehicle accidents caused 11.0 and 3.0 deaths per 100,000 males and females respectively in Northern Ireland.²⁰

Over recent years, the trend in fatal and serious injury accidents has fallen.^{17 19} Ongoing efforts are required to sustain this favourable trend.

The risk of death from a road traffic accident does not fall equally across the population. An analysis of mortality on the island of Ireland for the period 1989-1998 showed a clear social class gradient for death from transport accidents with the poorest suffering most (annual directly standardized mortality rate for transport accidents of 40.7/100,000 in socio-economic group D versus 9.0/100,000 in socioeconomic group A).¹⁴ The mortality from transport accidents is greater in males than females. Analysis of age distribution shows a peak in mortality occurring in late adolescence and early adulthood, when transport accidents are the leading cause of death.

Besides the evident death and physical suffering caused by road traffic injuries, their wider effects should also be considered. In a follow-up study of 1,148 people aged 19-69 years who attended an accident and emergency department in the UK following a road traffic accident, 32% were found to have important psychiatric

consequences (one of either post-traumatic stress disorder, phobic travel anxiety, general anxiety or depression) at one year after the incident.²¹ Post-traumatic stress disorder has also been observed in young children following road traffic accidents.²² When compared with children who attended an accident and emergency department with sports injuries, children who attended following a road traffic accident were more frequently found to have post-traumatic stress disorder at one year follow-up (34.5% versus 3.0% for sports injury sufferers). Male children, those who had previously experienced trauma and those who subjectively appraised the event as a threat to their life were particularly at risk of developing the disorder.

Road traffic accidents can also have an indirect effect on the entire community when these events occur, through changing people's perceptions of safety. Poor perceived road safety can deter parents from allowing their children independent mobility and this may limit their capacity for social interaction and exercise.^{10 11} Reduced physical activity will affect their current health and may also affect their health-related behavior in later life.²³ Poor perceived road safety may reduce the number of people who could protect and promote their health through walking and cycling.^{10 11} Concerns over road safety may be a barrier to people's mobility and therefore reduce their access to family, friends, shops and other services. A perception of poor road safety may contribute to the negative views about a locality in general. The associations between some of these effects and poor health will be discussed in section 8.

3.2. Initiatives which reduce road traffic injuries

Given the scale of death and ill-health caused by road traffic injuries, an effective response is demanded. Interventions include measures such as health promotion campaigns to encourage safer transport (e.g. publicizing the use of childhood rear seats, driver education, incentives to use seat belts) and legislative interventions (such as drink-driving legislation, car safety belt laws). This literature review will focus on the effectiveness of the following engineering and environmental interventions:

- Traffic calming schemes
- Speed limit reductions
- Road surface changes
- Public lighting
- Guardrails and crash cushions
- Roundabouts
- Traffic signals, refuge islands, & pedestrian fences.

Box 1: Deciding if a crash prevention measure works

Discovering what works in the prevention of road traffic crashes is acknowledged as being difficult.²⁴ Most trials of transport initiatives which evaluate effectiveness of accident prevention take the form of “before versus after” comparisons, with or without reference to a similar area where no such intervention has taken place. Under these circumstances it is possible that factors other than the intervention may have caused the observed change in the occurrence of accidents. For example, at the same time as traffic calming was introduced in a locality, a road safety campaign may have been in place. More rigorous studies require comparison to be made with similar areas which did not receive the intervention. Also, reports of evaluations of studies which have been completed are difficult to locate because databases which hold transport research documents are not designed to allow easy access to tests of preventive interventions as described above.

Traffic calming

Accidents have a tendency to occur frequently at particular points in the road network, for example at a sharp turn or hill. However, in urban areas, road traffic accidents do not tend to localize to so-called “black-spots”. Thus, in localities where crashes tend to be scattered across the road network, “area-wide traffic calming schemes” are instituted. Traffic calming may be defined as “the combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behavior, and improve conditions for non-motorized street users”.²⁵ These measures include:

- Vertical or horizontal shifts in traffic (e.g. road humps, speed cushions, raised cross roads, raised sections of road, chicanes, mini-roundabouts, road narrowing, channelized slip lanes etc)
- Optical measures (chevron road signs, road surface treatment, reduced horizontal visibility), audible measures, alterations to road lighting
- Redistribution of traffic or alteration in road hierarchy, (e.g. permanent or temporary blocking of roads, diagonal blocks, gateways, creation of one-way streets, re-introduction of two-way streets, 4-way stops)
- Changes to road environment (increased vegetation along road, introduction of roadside furniture).

A systematic review and meta-analysis of the effects of area-wide urban traffic calming schemes was undertaken by Elvik.²⁸

Box 2: What is a systematic review?

In deciding whether or not a particular intervention is effective, it is common to collect and summarize the results of all available studies, and to draw an overall conclusion.²⁶ This is called a “systematic review”, which is an attempt to provide an informed and fair “verdict” on the effectiveness of an intervention. Sometimes, data from the studies included in the systematic review is combined to give an “average” result on the effectiveness of an intervention. This process is called meta-analysis. The time-consuming production of systematic reviews and meta-analyses save a great deal of work for researchers and decision makers. However, there are also potential pit-falls and the quality of a systematic review should be ascertained. Unless all available studies are obtained, the overall summary is incomplete and can lead to incorrect conclusions being drawn. Sometimes the available studies are few in number or of poor quality, and so summaries are not built on good foundations.²⁷

This review was based on 76 results from 33 studies. An overall beneficial effect was observed; on average there was a 15% reduction (95% Confidence Interval 10%-19%) in accidents causing injuries across the whole area subject to traffic calming. There was a greater effect on local roads where accidents causing injury were reduced by 34% (95% Confidence Interval 23%-43%), compared with only an 8% (95% Confidence Interval 2%-13%) on main roads. This may be explained by an increase in the volume of traffic on main roads in response to the traffic calming. Across studies included by Elvik, those which had the greatest reduction in traffic flow in response to the traffic calming also had the greatest reduction in traffic accidents. The results of the studies included were similar across countries and across time-periods, suggesting that the results of the systematic review and meta-analysis may be applied widely.

Box 3: What are Confidence Intervals?

When an effect, such as the reduction in fatal accidents, is measured in a study, the estimate is based on information about those people with whom it was performed. However, in applying the results more generally, we want to know what effect we could expect if we were to implement a similar intervention elsewhere. To answer this question, a “confidence interval” is calculated.²⁹ So the expression (95% Confidence Interval 10%-19%) means that we can be 95% certain that if we were to implement this traffic calming measure (a measure that reduced accidents by 15% locally) it would reduce accidents by 10% to 19% elsewhere.

Bunn et al have also published a systematic review and meta-analysis of traffic calming.³⁰ While many of the studies from Elvik's systematic review²⁸ were also included, they omitted simple before and after studies which were deemed to be of poor quality. In all, 16 results from 12 studies were included. Overall, the results were consistent with a reduction in road traffic injuries (there was approximately an 11% reduction in road traffic injuries in response to the traffic calming measures). However, the confidence interval is such that we cannot be certain that such interventions are of significant benefit. The authors say that while traffic calming shows a potential to prevent road traffic injuries, more rigorous studies are required to demonstrate this effect beyond doubt.

Speed limit reductions

The effect of speed limit reductions was examined through systematic review and meta-analysis by Vaa.³¹ Overall, based on results of varying quality, speed limit reduction from 60kph to 40kph and 50kph to 30kph was shown to reduce personal injury accidents by 67% (95% Confidence Interval 54%-76%). Those studies examining the effect of 30kph speed zones, which were of better quality, showed an 8% reduction in all levels of injury (95% Confidence Interval 2%-14%) and an 18% reduction in personal injury (95% Confidence Interval 8%-26%).

Road surface changes

In the same study,³¹ the evidence for effectiveness of speed humps was examined. All studies combined showed a 53% reduction in personal injury accidents (95% Confidence Interval 46%-59%). However, when the meta-analysis concentrated on better quality studies, the benefits could not be stated with certainty. Similarly, elevated crossings and rumble zones did not demonstrate a certain effect of reducing personal injuries. This points to a need for more rigorous research.

Public lighting

The results of a systematic review on the effects of public lighting on accidents are presented in an overview of evidence from a number of systematic reviews by Morrison et al.³² Overall, there was a 15%-35% reduction in night time accidents as a result of public lighting interventions. Fatal accidents were reduced by 65% (95% Confidence Interval 52%-75%). The greatest effects were seen in areas which suffered the majority of accidents at night, and rural areas benefited more than urban areas. However, the results of studies tended to vary between countries, and so some caution may be required in applying the overall conclusions widely.

Guardrails and crash cushions

Elvik has also undertaken a systematic review and meta-analysis of the effects of guardrails and crash cushions on accidents.³³ Median barriers showed an overall effect of increasing accidents by 28% (95% Confidence Interval 25%-32%). Their effect on injury accidents was uncertain. However, fatal accidents were reduced by 32% (95% Confidence Interval 14%-46%). Thus, while the added obstacle of a median barrier makes accidents more likely, the prevention of vehicle passage into oncoming traffic in the event of an accident is life-saving. Guardrails have an overall beneficial effect, with accidents reduced by 27% (95% Confidence Interval 18%-35%), fatal accidents by 44% (95% Confidence Interval 40%-48%) and injury accidents by 52% (95% Confidence Interval 51%-53%). Lastly, crash cushions also appear effective, with accidents reduced by 84% (95% Confidence Interval 74%-90%), fatal accidents by 69% (95% Confidence Interval 46%-83%) and injury accidents by 68% (95% Confidence Interval 60%-74%). In applying these summary results, however, it should be borne in mind that the author states that the quality of many of the studies on which the meta-analysis was performed was not ideal.

Roundabouts, traffic signals, refuge islands and pedestrian fences

A review of studies examining the effectiveness of traffic engineering measures to reduce pedestrian-motor vehicle crashes included results for roundabouts, traffic signals and refuge islands.³⁴ It should be noted that this review did not undertake an exhaustive search of published material and therefore may not allow comprehensive conclusions to be drawn. Roundabouts are estimated to reduce pedestrian crashes by 75%, with better results for those which only allow single line traffic. Installation of traffic signals has been shown to reduce accidents by half. Median traffic refuges reduce pedestrian-vehicle crashes by half, while pedestrian barriers and fences which prevent crossing outside areas controlled by traffic lights reduce crashes by 20%-48%.

A summary of the effectiveness of initiatives to reduce road traffic injuries discussed above is presented in Table 3.

Table 3: Summary of the effects of initiatives to reduce road traffic injuries

Initiative	Outcome	Effect	Range*
Area wide traffic calming			
Whole area	Injury accidents reduction	15%	10-19%
Local roads	Injury accidents reduction	35%	23-43%
Main roads	Injury accidents reduction	8%	2-13%
Whole area	Injury accident rate ratio [†]	0.89	0.8-1.0%
Speed limit reduction			
60-40kph and 50-30kph	Injury accidents reduction	67%	54-76%
30kph zones	Injury accidents reduction	8%	2-14%
Road surface changes			
Speed humps – all studies	Injury accidents reduction	53%	46-59%
– good quality studies only	Injury accidents reduction	Uncertain	
Elevated crossing	Injury accidents reduction	Uncertain	
Rumble zones	Injury accidents reduction	Uncertain	
Public lighting	Fatal accident reduction	65%	52-75%
Median barriers	All accident increase	28%	25-32%
	Injury accident reduction	Uncertain	
	Fatal accident reduction	32%	14-46%
Guardrails	All accident reduction	27%	18-35%
	Injury accident reduction	52%	51-53%
	Fatal accident reduction	44%	40-48%
Crash cushions	All accident reduction	84%	74-90%
	Injury accident reduction	68%	60-74%
	Fatal accident reduction	69%	46-83%
Other initiatives			
Roundabouts	Pedestrian crash reduction	75%	
Traffic signals installation	All accident reduction	“Half”	
Median traffic refuges	Pedestrian crash reduction	“Half”	

*if this initiative were to be put into practice outside the area where it was studied, one could be 95% certain that the effect would lie within this range.

[†]the ratio of the rate of accident in the area with the initiative to the area without the initiative; if this is less than one it implies a benefit from the initiative.

3.3. Evaluation of traffic calming on the island of Ireland

The National Roads Authority has published an evaluation of traffic calming schemes constructed on national roads in the South of Ireland from 1993 to 1996.³⁵ This is a simple before and after study, and does not account for factors other than the traffic calming schemes which may have affected the occurrence of accidents. They estimate an annual average reduction of 1.5 fatal accidents, 1.3 serious injury accidents and 2.8 minor injury accidents in areas subject to traffic calming on both approaches. A more modest effect was observed in areas which had traffic calming measures installed on only one approach. The Roads Service has published a report on road safety engineering measures implemented from 1995/96 to 1998/99.³⁶ This included accident remedial and traffic calming measures. There has been a reduction in accidents reported subsequent to these initiatives.

4. Air pollution

Air pollution has damaging effects on the environment and the public's health. It is a mixture of different but inter-related chemicals, some, though not all, of which have been implicated in causing damage to health. These include:

- Particulates (sometimes referred to as PM10)
- Carbon monoxide
- Sulphur dioxide
- Nitrogen oxides
- Hydrocarbons
- Ozones
- Carbon dioxide
- Lead
- Benzene.

4.1. Air quality and health – experience on the island of Ireland

Outdoor air pollution is a controllable threat to health. An assessment of the effects of the ban on the marketing, sale and distribution of bituminous (“smokey”) coal on deaths in Dublin is a good example of how policy can control and even reverse the negative effects which air pollution has on health.³⁷ Subsequent to the introduction of this ban, there was a 70% reduction in the amount of “black smoke” in the city, and a 5.7% reduction in all deaths unrelated to trauma was observed. Deaths from respiratory and cardiovascular disease fell by 15.5% and 10.3% respectively.

Legislation is in place across the island to assure air quality. In the cases of both the North and South, the legislative framework for air quality limit values proceed from European Directives which have been summarized in Table 5.^{38 39}

Table 5: EU Directive limit values for the components of air pollution.

Component	Limit value for the protection of human health		
	Hourly	Daily	Annual
Sulphur dioxide	350 micrograms/m ³ not to be exceeded more than 24 times in a calendar year	125 micrograms /m ³ not to be exceeded more than 3 times in a calendar year	
Nitrogen dioxide	200 micrograms/m ³ not to be exceeded more than 18 times in a calendar year		40 micrograms/m ³
Carbon monoxide		10 mg/m ³ (maximum daily 8 hour mean)	
Benzene			5 micrograms/m ³
Lead			0.5 micrograms/m ³
Particulates (PM10)*		50 micrograms/m ³ not to be exceeded more than 35 times a calendar year	40 micrograms/m ³
Ozone [†]		120 micrograms/m ³ not to be exceeded more than 25 days per calendar year averaged over 3 years	

*lower limits will be in operation from 2010

†target value for ozone from 2010

4.2. The impacts of air pollution on health

A large number of studies have examined the link between air pollution and health. Agreement has grown from examination of this work between scientific experts that some components of air pollution can be shown with certainty to cause disease and death. Rather than attempt to summarize this major body of literature, the results of two major expert reviews in the area are presented: the UK Committee on the Medical Effects of Air Pollution (COMEAP) study^{40,41} and the European Community “Externalities of Energy” (ExternE) study.⁴² While both studies are broadly in agreement, the ExternE study examines more chemicals and potential health effects than the COMEAP study. These reviews form the basis of a report on transport health impacts prepared for the UK National Health Service.⁴³ In addition, a report prepared by an independent scientific advisory group convened by WHO to support the EC DG Environment Clean Air for Europe (CAFÉ) was reviewed.⁴⁴ Health effects were demonstrated for the following components of air pollution:

- Particulates (PM10)
- Ozone
- Sulphur dioxide
- Carbon monoxide (weaker evidence)
- Nitrogen dioxide (weaker evidence).

In the case of carbon monoxide and nitrogen dioxide, the evidence supporting their causal role in health damage is weaker as they may act as markers for the other, proven health damaging constituents rather than having a direct toxic effect themselves.

Box 4 – Linking air pollution and health effects

Establishing a link between air pollution and health requires careful attention to a number of stages. Most studies examine variations in the levels of air pollutants and of health outcome over time in a particular area to see if a pattern exists (e.g. are rises in the level of air pollution followed by rises in the level of hospitalization for respiratory disease?). If a link between the pollutant makes biological sense (e.g. based on evidence from laboratory experiments), and if these links are strong and are also established in repeated studies, opinion is formed in support of the air pollutant being a cause of health damage. Most of the work presented in this review takes this form. Other studies follow healthy people over time to see if those who are exposed to air pollution go on to develop particular health outcomes (such as diseases of the lungs and heart), and whether development of these outcomes is greatest in those who are exposed to the most pollution. There are a number of potential difficulties with both of these approaches. Since many individual air pollutants are emitted from the same source at the same time it can

be hard to decide exactly which are responsible for health effects. Some uncertainty also exists about the actual amount of pollutant which gets into people's bodies from the air, and so the amount of air pollution measured at a particular location may not be representative of the risk for all people living in different proximities to that point across a locality. Other factors which relate to air pollution and to health outcomes also need to be considered, e.g. air temperature. However, even taking into account these potential problems, the weight of evidence and expert opinion in this area supports air pollution as a source of real concern for the public's health.

Short-term effects

Most studies in this area examine the short-term effects of air pollution. They show rises in overall death rates and in hospital admissions for respiratory and cardiovascular disease shortly after rises in the levels of air pollutants. Those most likely to suffer consequences of the negative short-term effects of air pollution are people who are old and have underlying health problems such as chronic bronchitis and congestive heart failure.

Long-term effects

Long-term health effects from pollution in healthy people, such as the development of chronic bronchitis or certain cancers, and overall reduction in life expectancy have also been studied. While studies have suggested that chronic health effects are present, some debate exists in this area. COMEAP, while suspecting that there is probably a long-term impact, did not find sufficient UK data to estimate the risk in this regard and to provide a definitive statement. This leads the committee to focus only on short-term effects which were felt could be attributed to air pollution with greater confidence: these are listed in Table 6. ExternE, however, appraised a wider body of studies, and Table 7 lists the possible short and long term health effects. The World Health Organisation identifies that socially disadvantaged people may be more at risk of the long-term effects of air pollution and that lung development in children may also be negatively affected. In particular, though, it is worth noting that air pollution has not been shown to cause childhood asthma.

Although air pollution contains chemicals which are believed to cause cancer (e.g. benzene and 1,3 butadiene), the levels in the air are low, and there is no certain evidence that health damaging effects occur in these amounts. With regards to lead, while blood levels have been shown to have a negative effect on the IQ development of children, it is uncertain whether lead in the air contributes to this problem. Moreover, with the widespread introduction of lead free petrol, lead from air pollution caused by traffic is becoming less common.

Table 6: Health impacts ascribed to air pollutants by COMEAP

Health impact	Air pollutant
Deaths from all causes brought forward	PM10 Sulphur dioxide Ozone
Respiratory Hospital Admissions	PM10 Nitrogen dioxide Sulphur dioxide Ozone

Source: adapted from Watkiss et al⁴³

Table 7: Health impacts ascribed to air pollutants by ExterneE

Population Group	Health impact	Air Pollutant	
Asthmatics	Adults	Bronchodilator use	PM10, PM2.5
		Cough	PM10, PM2.5
		Wheeze	PM10, PM2.5
	Children	Bronchodilator use	PM10, PM2.5
		Cough	PM10, PM2.5
		Wheeze	PM10, PM2.5
Over 65 years	All	Asthma attacks*	Ozone
		Congestive heart failure*	PM10, PM2.5
Children		Carbon monoxide	
Children		Chronic cough*	PM10, PM2.5
Adults		Restricted activity days	PM10, PM2.5
		Minor restricted activity days*	Ozone
All population		Chronic bronchitis*	PM10, PM2.5
		Chronic mortality*	PM10, PM2.5
		Respiratory hospital admissions*	PM10, PM2.5
		Ozone	
		Sulphur dioxide	
		Cerebrovascular hospital admissions*	PM10, PM2.5
		Symptom days	Ozone
		Cancer risk estimates*	Benzene 1,3 butadiene
	Acute mortality	PM10, PM2.5 Ozone Sulphur dioxide	

*estimated effect of pollutant on risk of health impact is very small

Source: adapted from Watkiss et al⁴³

4.3. Traffic's contribution to air pollution

Although other sources such as industry and energy production are important, transport is a leading source for many of the chemicals which contribute to air pollution. This is principally due to emissions from the combustion of fuel. However, particulates are also created through propulsion of dust into the air by tyres. Ozone is not directly created by vehicle emissions, but rather is a result of the reaction of emissions with the atmosphere. Table 8 illustrates the relative contribution of transport to this problem in Great Britain.

Table 8: Percentage of total national emissions attributable to transport, Great Britain, 1999.

Chemical	%
Carbon monoxide	74
Lead	61
Nitrogen dioxide	48
Particulates (PM10)	23
Sulphur dioxide	2

Source: *Department of the Environment, Transport and the Regions, 1999.*⁴⁵

4.4. Effects of transport initiatives on air quality

Fewer vehicles on the road will mean less pollution production. Traffic control measures that reduce the overall amount of traffic by switching from the use of private cars towards more environmentally friendly methods, such as walking or cycling, will contribute to reduced air pollution and improved health. Similarly, switching the mode of transport of goods would be important as larger vehicles produce more pollution.⁴⁶

Reduced traffic on the road will have another potential benefit. Low average speed journeys usually involve frequent stops, starts, and changes in vehicle acceleration with less efficient fuel use and greater pollution emissions.⁴⁶ Smoother journeys will make vehicle operation more efficient and reduce pollutions emissions. An exception in this regard is the production of nitrogen oxides which is greatest when the engine operates under high temperatures usually encountered at higher speeds.

5. Noise pollution

5.1. Community noise

Community noise is defined as “noise emitted from all sources except noise at the industrial workplace”.⁴⁷ The terms “environmental noise” and “residential noise” are also used to describe this phenomenon. Although, physically, there is no distinction between sound and noise, unwanted sound is usually referred to as noise. Transport is recognized as a leading source of community noise, and for most of the population who do not live in close proximity to railway lines or airports, road traffic is the major cause.

5.2. The impact of community noise on health

The potential health effects of community noise are receiving increasing attention. The World Health Organisation convened an Expert Task Force to examine the matter, and guidelines in this regard have been issued.⁴⁷ However, there is still some debate as to whether or not noise truly causes certain health effects described in published literature. It is difficult to perform high quality studies examining the effects of noise on health. Those that are published vary in quality. Many studies have focused on levels of noise usually only encountered in an industrial setting and it may not be appropriate to apply their results to a community context where levels of noise are generally lower. Aircraft noise has also been a common focus, and may not always be applicable to road traffic.

A study commissioned by the National Health Service in the UK examined four major reviews of the health impacts of transport noise - Department of the Environment, Transport and the Regions (DETR) 1997,⁴⁸ DETR 1999,⁴⁹ WHO 1999,⁴⁷ and Institute of Occupational Medicine 1999.⁵⁰ While studies indicate a possible impact on health from noise, many were deemed to be of poor quality and produced conflicting results. Therefore firm conclusions as to a causal link with noise could not be drawn in most cases, apart from annoyance effects. The results of the study are summarized here.

Hearing damage

Two reviews examined the relationship between noise and hearing damage.^{47 49} While conclusive evidence indicating a causal link was found, the levels of noise required are unlikely to be typical of community noise. Possible concern is, however, expressed for the hearing of more vulnerable groups such as children.

Speech interference

Interference of speech due to community noise is a potential source of stress which negatively impacts on health. However, the exact level of noise required to cause this effect is not well understood and may be affected by factors such as age. Older people may be particularly affected by this problem as hearing impairment is more common with increasing age. Young children also require particular consideration in this regard since interference with speech by community noise may impair language acquisition and development.

Annoyance

Since annoyance is a subjective response modified by a number of factors such as context and individual personality traits, it is hard to define a particular noise level above which annoyance occurs. However, this is likely to be the most widespread and important effect of noise and its occurrence represents a negative impact on health in its widest sense.

Sleep disturbance

Most sleep disturbance due to noise is from noise occurring indoors. While there is evidence to demonstrate an effect of noise on sleep pattern (e.g. time taken to fall asleep, depth of sleep), people tend to grow accustomed to noise over time and the effect diminishes. It is not certain that these changes in sleep patterns affect health.

Performance

Reviews agree that community noise can have a negative effect on performance. Children appear particularly vulnerable in this regard with negative effects observed on reading comprehension and attention. This could have implications for their development, academic achievement and subsequent life chances. Most of the evidence gathered in this regard is from studies examining noise from airports. The effect of noise on adult performance is less certain.

Effects on heart and other body functions

Disagreement exists over the effect of noise on the occurrence of ischemic heart disease. Poor quality studies with conflicting results led two reviews to conclude that there is no convincing evidence of a definite link.⁴⁸ However, the other reviews conclude that there is a weak, but definite, association between long term exposure to community noise and subsequent development of disease of the heart and circulatory system.^{47 49} This is the most commonly encountered disease in developed countries.

Mental health effects

The reviews could find no certain evidence for noise as a cause of mental health problems. People with particular personality traits may be more predisposed to interpreting community noise as annoyance and develop mental illness earlier or to a more severe extent as a reaction to it than they may otherwise have done.

However, the noise itself cannot be blamed as a cause for their ill-health. It is suggested that at higher levels of noise people behave more aggressively towards each other.⁴⁷

5.3. Vulnerable groups

A World Health Organisation report recommends that special consideration should be given to subgroups that may be more vulnerable to the negative effects of noise than the general population.⁴⁷ Included are those with particular health problems (e.g. those with mental health disorders), foetuses, babies and young children, the elderly, those with sensory impairment and those required to perform complex tasks.

5.4. Protecting the public from the effects of traffic noise

The World Health Organisation has, as part of its guidelines on community noise, issued advice on measures that can be implemented on noise management.

Measures can be put in place at a number of levels as follows:

- Land use planning and policy: noise burden on communities can be avoided or reduced if developments with a significant potential for noise production (e.g. motorways) are planned with sufficient distance away from residential areas
- Limit noise at source: potential noise sources can be banned from residential areas, or else access limits can be put in place, especially at night-time (e.g. residential areas can be protected for the access of residents only and commercial access can be limited). Noise production from vehicles can be controlled through engineering initiatives, and legislation can be used to enforce this approach (e.g. compulsory car testing). Quiet road surfaces (e.g. porous asphalt, “drain asphalt”) can also be used to control sound production. Speed limits are another option. Cars travelling at 30kph produce maximum sound pressure levels that are 7 dB lower, and equivalent sound pressure levels that are 5 dB lower, than cars driving at 50kph
- Limit sound transmission: noise barriers can protect residents from traffic source, However these measures should be viewed as an order below elimination or reduction at source. Walls, trees and other environmental initiatives are options in this regard
- Limiting receipt of noise: protection of residents within their homes, schools and places of work from community noise can be achieved through sound proofing. This should be seen as the lowest order intervention when the options provided above cannot be implemented.

There is no agreement as to how effective noise control interventions are in practice, how well they limit or prevent the health impacts.¹⁰

The European Union has recently introduced a directive for the assessment and management of environmental noise which will be implemented across the island of Ireland.⁵¹ Actions under the directive include:

- **Monitoring the environmental problem;** by requiring Member States to draw up "strategic noise maps" for major roads, railways, airports and agglomerations. These maps will be used to assess the number of people annoyed and sleep-disturbed respectively throughout Europe
- **Informing and consulting the public** about noise exposure, its effects, and the measures considered to address noise
- **Addressing local noise issues** by requiring authorities to draw up action plans to reduce noise where necessary and maintain environmental noise quality where it is good
- **Developing a long-term EU strategy,** which includes objectives to reduce the number of people affected by noise in the longer term.⁵¹

6. Physical activity

The health benefits of physical activity have been well researched and are widely accepted. Physical activity is a general term used to describe any body movement in which muscles use energy. Physical activity can be achieved through “active transport”, a term which describes travel to a destination by walking or cycling. Through their effects on the use of active transport in a community, transport initiatives can have important effects on physical activity, and thus on health.

6.1. The impacts of physical activity on health

A report by the U.S. Surgeon General, prepared by the Centre for Disease Control, summarizes the extensive research on the health benefits of physical activity, with the following conclusions: ⁵⁵

- Higher levels of physical activity reduce **overall mortality**, not only for the very fit, but also for those who are moderately active
- Regular physical activity reduces the risk of death from **cardiovascular disease**, in particular coronary heart disease. The size of effect is similar to the benefit in this regard from not smoking cigarettes
- **High blood pressure** can be reduced and prevented by regular physical activity
- The risk of **colon cancer** is reduced by regular physical activity. Studies have examined relationships with reduced rates of development of other cancers, but conclusive benefits are not certain
- Regular physical activity lowers the risk of developing **Type II (Non-insulin dependent) diabetes mellitus**. For those who have the condition, it can improve blood sugar control
- Optimum **skeletal development** in children is encouraged by physical activity with achievement and maintenance of peak bone mass which may be of benefit in later life.
- Certain forms of exercise may be helpful in preventing **falls** in the elderly
- Low levels of physical activity contribute to development of **obesity**
- Physical activity improves **mood** through reduction in the symptoms of depression and anxiety, although it is uncertain whether it prevents depression
- Exercise improves **health-related quality of life** by improving psychological and physical well-being.

The cardiovascular benefits of exercise are key across the island because deaths from disease of the circulatory system are the leading cause of death.¹⁴ The prevention of obesity is also an important outcome. Besides the direct effect it has itself on health, it is also a risk for the development of heart disease, certain cancers, osteoarthritis and overall mortality.⁵⁵

There is growing concern across the island over increasing levels of obesity. Analysis of data in the South have shown an overall rise in the proportion of the population who are overweight from 31.8% in 1998 to 34.3% in 2002, and a rise in the proportion who are obese from 10.3% to 13.7% in the same period.⁵⁶ Higher levels of obesity exist for those who are least educated and in the poorest social classes. In the North, the 1997 Health and Social Wellbeing survey found that 37% of those surveyed were overweight and 19% were obese.⁵³ A social class gradient was also observed here. Childhood obesity is a particular concern, both for its immediate effect on well-being and because of the likelihood of adult obesity. Approximately a third of obese preschool children and a half of school age children will become obese adults.⁵⁷ Parental obesity adds to the risk for obese children and is also a risk for adult obesity in non-obese children.⁵⁸

Physical activity, especially through active transport, is not without risk. In general, exercise has been shown to increase risk of sudden death from heart problems and provoke asthma, although, overall, the effect is small and benefits outweigh this risk.⁵⁵ In particular, active transport may increase people's risk of traffic related accidents and health damage from air pollution, but again opinion would suggest an overall health gain from this option.^{10 11}

6.2. Physical activity on the island of Ireland

Physical activity in the South of Ireland is measured by the National Health and Lifestyle Surveys (SLAN (Survey of Lifestyle, Attitudes and Nutrition) and HBSC (Health Behavior of School-Aged Children).⁵² The 2002 survey shows that 51% of people engage in some form of regular physical exercise. Those with lowest educational attainment (a marker for low social class and poverty) are least physically active. Physical activity in children decreases in mid to late teens. Girls are less physically active than boys. In the North the Health and Social Wellbeing Survey⁵³ in 2001 showed 25% as sedentary, 47% at an intermediate level of physical activity, and 28% above the recommended level of physical activity. There was a social class gradient in the prevalence of sedentary activity, with levels highest in unskilled socioeconomic groups.

6.3. Increasing physical activity through transport initiatives

Promotion of physical activity through active transport has a number of advantages. The levels of exertion achieved through brisk walking or cycling are sufficient to bring about health benefits.⁵⁵ Unlike many sports, it doesn't require special skills and so is attainable for people of all abilities. It is cheap to undertake, and is accessible to the whole population. Importantly, incorporation of physical activity through active transport makes it part of a person's overall routine in life, and this is felt to be key to sustaining the change in behaviour required initially to become more active.^{10 11 55}

Transport initiatives can encourage active transport in a number of ways:

- **Reducing perceived danger:** by making roads safer, concern over physical safety while walking and cycling is removed as a barrier preventing the use of active transport; increased use of public spaces will improve perceived safety and reduce fears of crime
- **Making active transport the norm:** as more people are encouraged to undertake active transport, it will appear to be a normal behaviour, which is attractive to all. This is achieved through switching the mode of transport people use away from vehicles and toward walking and cycling through, for example, making the use of a car more difficult by limiting parking
- **Increasing enjoyment:** by making the physical environment appear more attractive, active transport can become a source of enjoyment for those who engage in it; Creation of an environment which supports physical activity through active transport is in keeping with the approaches called for in the Ottawa Charter for Health Promotion.⁶¹ Providing cues, such as cycle lanes and walkways is also likely to be effective
- **Making access to physical activity easier:** unlike the use of a private car, public transport often requires the passenger to undertake active transport at either end of the journey; it can also improve access to the countryside and other recreational facilities where physical activity is undertaken.

Promotion of active transport is an important way of increasing physical activity because it can reach the entire community. In particular, though, it is worthwhile highlighting the improvements it can have on children's physical activity. This will have benefits for their current and future health. Habits formed in childhood can be carried into later life, and it has been shown that physical activity in childhood may be an important predictor of adult activity.²³

7. Effects on community

People's social networks and social support are important for health. Social networks refer to the number and frequency of social contacts between people and social support includes emotional and practical support (e.g. listening to people's problems, providing a lift in a car).⁶² Social capital is another term used in discussion of people's social ties. The OECD define it as "the networks together with shared norms, values and understanding that facilitate cooperation within and between groups".⁶³ It is a concept which is receiving attention at an international and national level.⁶⁴ Unlike social networks and social support, which operate at an individual level, social capital may operate at a group or community level.⁶⁵ Measures of social capital include numbers of social contacts, types of social support available, views about the local area (such as personal safety, attractiveness of the physical environment), involvement in local groups (such as residents association or social clubs) and trust.

7.1. The importance of social networks, social support and social capital on health

Social networks and social support can have positive effects on people's health. One of the most commonly cited studies showing this positive effect was conducted in Alameda county in the US in the 1960's and 1970's.⁶⁶ After measuring people's social networks, participants were followed up over time to see how their health developed. It was shown that, even after accounting for the effects of being overweight and personal habits such as drinking, smoking and exercise which are known to affect health, the risk of dying was least for those people who had the most social connections. There is evidence from similar studies in Europe to support this protective effect.⁶⁷ Other benefits conferred by social support include better outcome after the development of disease,⁶⁸ and better mental health.⁶⁹

The effect of social capital on health across the island of Ireland has been examined by the Institute of Public Health.¹⁵ In this study it was shown that, even after accounting for other factors which may affect health (such as age, smoking, body weight and exercise), people who were dissatisfied with the area they lived in (which included heavy traffic, parking on residential streets, car crime and noise), were less likely to have good mental health, be very satisfied with their own health or have a very good quality of life compared to people living in areas with few local

problems. A higher proportion of people living in Dublin City perceived their locality to have a lot of problems than people living in small towns. Poorer health was also observed for people with less frequent social contact, poorer social support, less trust in their neighbours and those less actively involved in local organizations.

7.2. Effect of transport on social networks and social capital

Transport policy affects social networks mainly through community severance. Community severance is separation of different areas within a community by the flow of traffic,¹² and can break social networks and change the quantity or quality of support they can provide. Roads and traffic create real and perceived barriers to social contact. For example, children may not be allowed to visit friends unaccompanied because of parental concern over road traffic accidents. A study illustrating the effect of traffic on social contacts in three streets was performed in San Francisco.⁷⁰ It was found that people living on the street with lightest traffic had twice as many acquaintances and three times as many friends as those people who lived on the street with the heaviest traffic.

A study in Galway which examined a number of measures of social capital across different neighborhoods found that, compared with people living in “car-dependent” localities (those which are designed to be negotiated in cars, with amenities spread out over a large area and emphasis on roads and parking over pavements), people who lived in “walkable”, pedestrian orientated localities (those with pedestrian areas, sidewalks, meeting spaces, and local shops) were more likely to know and trust their neighbours and to participate in organizations.⁷¹ Neighbourhoods which are built to be pedestrian friendly may encourage people “bumping into” each other. This process protects and promotes social networks, and encourages a greater number of people to use public space and local services, which together influences social capital.

8. Social inclusion

8.1. Poverty and social inclusion

Poverty and social exclusion are important pathways to poor health.⁷² In the South, the government states that “people are living in poverty if their income and resources (material, cultural and social) are so inadequate as to preclude them from having a standard of living which is generally regarded as acceptable by Irish society”.⁷³ The government has responded with a plan of action across the social sectors which aims “to build a fair and inclusive society and ensure that people have the resources and opportunities to live a life with dignity and have access to quality public services that underpin life chances and experiences”.⁷³

Social inclusion is a concept which is closely linked to poverty, but has a broader scope and refers to a process which places people on the margins of social and community life.⁷⁴ It can be a consequence of poverty. However, people can be socially excluded without being poor - for example, because of their race, gender, sexuality or because of where they live.⁷² Access to resources such as education, employment, social networks and support, healthcare services and recreational facilities form a basis to social inclusion.

The following groups are identified by the government in the South as being vulnerable to poverty and social exclusion:⁷³

- Women
- Children and young people
- Older people
- People with disabilities
- Travellers
- Prisoners and ex-prisoners
- Areas marked by exclusion – urban and rural disadvantage
- Migrants and ethnic minorities.

In the North, the Programme for Government expresses a determination to tackle inequality and the document “New TSN – The Way Forward Towards an Anti-Poverty Strategy”, will inform a high level policy for tackling poverty and social exclusion in Northern Ireland.⁷⁵

8.2. “Transport poverty” and health

Access to transport is a key element of social inclusion. Not all members of society have fair and equal access to public transport. For example, people with disabilities may find it difficult to access buses, poorer people may not be able to afford public transport and infrequent public transport may make certain localities more isolated. Thus, poor access to the resource of transport is, of itself, a social exclusion.

Transport is also required for access to other resources that form the basis of social inclusion. These include travel to work or school, visiting family and friends, access to a GP or hospital, shopping, and access to recreational facilities. “Transport poverty” describes the lack of real travel choice for those who experience exclusion from transport, and as a consequence lack choice in their destinations and activities.⁷⁶ It is an important barrier to other resources necessary for a generally acceptable standard of living.

Some of the health effects of poor access to transport are caused by preventing access to health protecting and promoting resources. These include recreational facilities for exercise, family and friends for social support, shops which sell a variety of fresh, healthy food, GP and healthcare facilities and chances for employment.

Poor transport facilities can also contribute to a perception of poor local services amongst a community, and thus have effects on social capital. An All-Ireland study by the Institute of Public Health showed that, compared with people who felt their locality had good services, people who felt their locality had poor services were less likely to have excellent/very good general health or good mental health, and were less likely to be very satisfied with their health or have a very good quality of life.¹⁵

8.3. The effects of transport initiatives on access and social inclusion

Improving everyone’s access to transport will promote social inclusion. Positive health effects proceed from improving individual access to resources which protect and promote health. Key issues identified in this regard include affordability, availability and accessibility.⁷⁶ This can be achieved through removal of barriers, such as the pricing or frequency of public transport, and improving the quality of public transport to make its use more appealing.⁷⁶

9. Conclusion

The scope and probability of the effects that transport may have on health have been highlighted. These health impacts are brought to bear through a number of potential pathways, which have been described in this document and are summarized in Table 9 below.

Through careful consideration of these impacts, transport policy makers are in a powerful position to promote the positive and mitigate the negative effects which their decisions may have on the public's health.

Table 9: Some potential health impacts of transport, including size and certainty of effect

Pathway	Health impact	Impact size	Impact certainty
Accidents	Injuries	Large	High
Air pollution	Mortality	Large	Medium
	Hospital admission due to respiratory and cardio-vascular disease		
	Other long-term effect	Moderate/small	?
Noise	Annoyance/well being	Moderate	Low
	Cardiovascular disease		
Physical activity	Cardiovascular disease, diabetes, cancer	Large	Medium-high
Community severance	Mortality, mental health and well-being	Moderate	Low

Adapted: Watkiss et al.⁴⁰

10. References

1. Doyle C, Metcalfe O, Devlin J. Health impact assessment, a practical guidance manual. Dublin: The Institute of Public Health; 2001.
2. Marmot M, Wilkinson RG. Social determinants of health. Oxford; New York: Oxford University Press; 1999.
3. Acheson D. Independent inquiry into inequalities in health report. London: The Stationery Office; 1998.
4. Mindell J, Ison E, Joffe M. A glossary for health impact assessment. *J Epidemiol Community Health* 2003;57:647-51.
5. Scott-Samuel A. Health impact assessment. *Br Med J* 1996;313:183-4.
6. Parry J, Steven A. Prospective health impact assessment: pitfalls, problems and possible ways forward. *Br Med J* 2001;323:1177-82.
7. Department for Regional Development. Pilot health impact assessment of the Proposed Regional Transportation Strategy. Belfast: Department for Regional Development; 2002.
8. Health Development Agency. HIA Gateway . Available at: http://www.hiagateway.org.uk/Resources/completed_hia_database/completedhialist.asp Accessed May 7, 2004.
9. Transport and health study group and Faculty of Public Health Medicine. Carrying out a health impact assessment of a transport policy - guidance from the Transport and Health Study Group: http://www.phel.gov.uk/hiadocs/hia_transport_policy_and_guidance.pdf (last accessed 07/05/04).
10. Dora C, Phillips M. Transport, environment and health. WHO regional publications, European series; No. 89. Copenhagen: WHO Regional Office for Europe; 2000.
11. Hunt R, Davis A, Falce C, Sinkler P, Crosbie H. Health update. Environment and health; road transport. London: Health Education Authority; 2000.
12. McCarthy M. Transport and health. In: Marmot M, Wilkinson RG, editors. Social determinants of health. Oxford; New York: Oxford University Press; 1999.
13. Joffe M, Mindell J. A framework for the evidence base to support health impact assessment. *J Epidemiol Community Health* 2002;56:132-138.
14. Balanda KP, Wilde J. Inequalities in mortality. A report on All-Ireland mortality data. Dublin: The Institute of Public Health in Ireland; 2001.
15. Balanda KP, Wilde J. Inequalities in perceived health. A report on the All-Ireland social capital and health survey. Dublin: Institute of Public Health in Ireland, 2003.
16. Kawachi I, Subramanian SV, Almeida-Filho N. A glossary for health inequalities. *J Epidemiol Community Health* 2002;2002:647-52.
17. National Roads Authority. Road accident facts Ireland, 2002. Dublin: National Roads Authority; 2003.
18. Central statistics office. Statistical year book of Ireland, 2003. Dublin: The Stationery Office; 2003.

19. Police Service of Northern Ireland. Northern Ireland - Casualties by Road User Type and Severity:1998 - 2002 http://www.psni.police.uk/calendar_stats2-3.doc. Accessed May 7, 2004.
20. Northern Ireland Statistics and Research Agency. Northern Ireland annual abstract of statistics 2003. Belfast: T.S.O; 2003.
21. Mayou R, Bryant B. Outcome in consecutive emergency department attenders following road traffic accidents. *Br J Psych* 2001;179:528-34.
22. Stellard P, Velleman R, Baldwin S. Prospective study of post-traumatic stress disorder in children involved in road traffic accidents. *Br Med J* 1998;317:1619-23.
23. Kuh DJ, Cooper C. Physical activity at 36 years: patterns and childhood predictors in a longitudinal study. *J Epidemiol Community Health* 1992;46:114-9.
24. Roberts I, Bunn J, Wentz R. How can we discover what works in the prevention of road traffic accidents. *BMC News and Views* 2001;2:1.
25. Lockwood I. ITE Traffic calming definition. *Institute of Transportation Engineers Journal* 1997;22.
26. Greenhalg T. How to read a paper: the basics of evidence based medicine. London: BMJ; 2000.
27. Petticrew M. Why certain systematic reviews reach uncertain conclusions. *Br Med J* 2003;326:756-8.
28. Elvik R. Area-wide urban traffic calming schemes: a meta-analysis of safety effects. *Accid Anal Prev* 2001;33:327-36.
29. Coggan D, Rose G A, Barker DJP. *Epidemiology for the uninitiated*. London: BMJ; 2003.
30. Bunn F, Collier T, Frost C, Ker K, Roberts I, Wentz R. Traffic calming for the prevention of road traffic injuries: systematic review and meta-analysis. *Inj Prev* 2003;9:200-4.
31. Vaa T. Speed limit reductions in built up areas: effects on speed and accidents (English translation made available through personal communication with author). Oslo: Institute of Transport Economics; 1997.
32. Morrison DS, Petticrew M, Thomson H. What are the most effective ways of improving population health through transport interventions? Evidence from systematic reviews. *J Epidemiol Community Health* 2003;57:327-33.
33. Elvik R. The safety value of guardrails and crash cushions: a meta-analysis of evidence from evaluation studies. *Accid Anal Prev* 1995;27:523-49.
34. Retting RA, Ferguson SA, McCartt AT. A review of evidence-based traffic engineering measures designed to reduce pedestrian-motor vehicle crashes. *Am J Public Health* 2003;93:1456-63.
35. Crowley F, Mac Dermott A. Road Safety Engineering. Evaluation of traffic calming schemes constructed on national roads 1993-1996. RS 460. Dublin: National Roads Authority. Available at: <http://www.nra.ie/PublicationsResources/DownloadableDocumentation/RoadSafety/d629.PDF> Accessed May 7, 2004.
36. Roads Service. Road Safety Engineering Report, Annual Report 1999. Report on road safety engineering measures implemented by the Roads Service from 1995/96 to 1998/99. Available at: <http://www.roadsni.gov.uk/Publications/specific/Road%20Safety%20Engineering%20Report.pdf> Accessed May 7, 2004.
37. Clancy L, Goodman P, Sinclair H, Dockery DW. Effect of air-pollution control on death rates in Dublin, Ireland: an intervention study. *Lancet* 2002;360:1210-4.

38. Environmental Protection Agency. Limit values for pollutants measured. Available at: <http://www.epa.ie/air/monitoring/Webfiles/pollutantlimits.htm>. Accessed May 7, 2004.
39. Environment and Heritage Service. Air quality monitoring in Northern Ireland, 2002. A Report Produced for the Department of the Environment in Northern Ireland in partnership with the Chief Environmental Health Officers Group. Available at: <http://www.ehsni.gov.uk/pubs/publications/AQReport.pdf.pdf>. Accessed May 7, 2004.
40. Committee on the medical effects of particles (COMEAP). Non-biological particles and health. London: HMSO; 1995.
41. Committee on the medical effects of particles (COMEAP). Quantification of the effects of air pollution on health in the United Kingdom. London: HMSO; 1998.
42. EC. Externalities of Energy (ExternE). The final report of the ExternE Core Transport Project. Brussels: European Commission, Directorate General XII, Science, Research and Development; 2000.
43. Watkiss P, Brand C, Hurley F, Pilkington A, Mindell J, Joffe M, et al. Informing transport health impact assessment in London. London: Research and Development Directorate, NHS Executive; 2000.
44. World Health Organisation. Health aspects of air pollution with particulate matter, ozone and nitrogen dioxide. Report of a WHO working group. Available at: <http://www.who.dk/document/e79097.pdf> Accessed May 7, 2004.
45. Department of the environment transport and the regions. The air quality strategy for England, Scotland, and Wales and Northern Ireland. London: The Stationery Office; 1999.
46. Department of environment, food and rural affairs,. The role of the highways agency in local air quality management. Annex 2: Traffic management on trunk roads to influence air pollution. Available at: <http://www.defra.gov.uk/environment/airquality/laqm/ha/12.htm>.
47. Berglund B, Lindvall T, Schwela DH, eds,. Guidelines for community noise: World Health Organisation. Available at: <http://whqlibdoc.who.int/hq/1999/a68672.pdf>, 1999.
48. Department of the environment transport and the regions. Workshop on the non-auditory effects of noise: Institute for the environment and health and Department of Health/Department of environment, transport and the regions; 1997.
49. Department of the environment transport and the regions. Health effects of noise assessment methods: a review and feasibility study. A review by the National Physical Laboratory and the Institute of Sound and Vibration Research for the Noise and Nuisance Policy Unit: Department of the environment, transport and the regions; 1999.
50. Butler MP, Graveling RA, Pilkington A, Boyle AI. Non-auditory effects of noise at work: a critical review of literature post 1988. Prepared by the Institute of Occupational Medicine for the Health and Safety Executive. Suffolk: HSE Books; 1999.
51. European Commission. Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise. Available at: http://europa.eu.int/eur-lex/pri/en/oj/dat/2002/l_189/l_18920020718en00120025.pdf Accessed May 7, 2004.

52. Kelleher C, Nic Gabhainn S, Friel S, Corrigan H, Nolan G, Sixsmith J, et al. The National Health and Lifestyle Surveys: Survey of Lifestyle, Attitudes and Nutrition (SLAN) and the Irish Health Behaviour in School-Aged Children Survey (HBSC). Dublin; Galway: Health Promotion Unit, Department of Health and Children; Centre for Health Promotion Studies, National University of Ireland; 2003.
53. Central Surveys Office, Northern Ireland Statistics and Research Agency. Northern Ireland Health and Social Wellbeing Survey 2001(Bulletin No. 1).
54. Irish Universities Nutrition Alliance. North/South Ireland Food Consumption Survey, Summary Report. Dublin: Food Safety Promotion Board; 2001.
55. US Department of health and human services. Physical activity and health: a report of the Surgeon General. Atlanta: US Department of health and human services, Centres for disease control and prevention, National centre for disease prevention and health promotion; 1996.
56. National nutrition surveillance centre. Dietary habits of the Irish population: results from SLAN. Annual report 2003. Dublin: Health promotion unit, Department of Health and Children; Department of Public Health Medicine and Epidemiology, University College Dublin; 2003.
57. Serdula MK, Ivery D, Coates D, Freedman DS, Williamson DF, Byers T. Do obese children become obese adults? *Prev Med* 1993;22:166-77.
58. Whitaker RC, Wright JA, Pepe MS, Sudal KD, Dietz WH. Predicting obesity in young adulthood from childhood and parental obesity. *New Engl J Med* 1997;337:926-7.
59. Becker MH. The health belief model and personal health behaviour. *Health educ monogr* 1974;2:324073.
60. Azjen I. From intention to action: a theory of planned behaviour. In: Kuhl J, Berkman J, editors. *Action-control: from cognition to behaviour*. New York: Springer' 1985.
61. World health organisation. The Ottawa Charter for health promotion. Geneva: World Health Organisation, 1986.
62. Stansfeld SA. Social support and social cohesion. In: Marmot M, Wilkinson RG, editors. *Social determinants of health*. Oxford; New York: Oxford University Press; 1999.
63. Cote S, Healy T. The well-being of nations: The role of human and social capital. Paris: Organisation for Economic Co-operation and Development, 2001.
64. National Economic and Social Forum. The policy implications of social capital. Dublin: National Economic and Social Forum; 2003.
65. Lynch J, Due P, Mutaner C, Davey-Smith G. Social capital - is it a good investment strategy for public health. *J Epidemiol Community Health* 2000;54:404-8.
66. Berkman LF, Syme SL. Social networks, host resistance and mortality: a nine-year follow-up study of Alameda County residents. *Am J Epidemiol* 1979;109:186-203.
67. Kaplan GA, Wilson TW, Cohen RD, Kauhanen J, Wu M, Salonen JT. Social functioning and overall mortality: prospective evidence from the Kupio ischemic heart disease risk factor study. *Epidemiology* 1994;5:495-500.
68. Williams RB, Barefoot JC, Califf RM, et al. Prognostic importance of social and economic resources among medically treated patients with angiographically documented coronary artery disease. *JAMA* 1992;267:520-4.

69. Stansfeld SA, Fuhrer R, Shipley M. Types of social support as predictors of psychiatric morbidity in a cohort of British Civil Servants (Whitehall II Study). *Psychol Med* 1998;28:881-92.
70. Appleyard D, Lintell M. The environmental quality of city streets: the resident's viewpoint. *Am Instit Planners J* 1972;38:84-101.
71. Leyden KM. Social capital and the built environment: the importance of walkable neighbourhoods. *Am J Public Health* 2003;93:1546-51.
72. Burke S. Setting targets for the National Anti-Poverty Strategy: A background research paper. Dublin: Institute of Public Health in Ireland; 2001.
73. Office for Social Inclusion. National action plan against poverty and social exclusion 2003-2005. Dublin: Office for Social Inclusion; 2003.
74. Shaw M, Dorling D, Davey-Smith G. Poverty, social inclusion and minorities. In: Marmot M, Wilkinson RG, editors. *Social determinants of health*. Oxford; New York: Oxford University Press; 1999.
75. Office of the First Minister and Deputy First Minister. *New TSN - The Way Forward Towards an Anti-Poverty Strategy*. A consultation document. Belfast: Office of the First Minister and Deputy First Minister, 2004.
76. Department of transport. Social inclusion and the provision of public transport. Available at http://www.dft.gov.uk/stellent/groups/dft_mobility/documents/pdf/dft_mobility_pdf_506795.pdf.