Physical activity and the environment

Review One:

TRANSPORT

NICE guideline PH8 (published January 2008) has been updated and replaced by NG90.

New recommendations have been added on strategies, policies and plans to increase physical activity in the local environment (1.1.1 to 1.1.3); active travel (1.2.1 to 1.2.4 and 1.2.6 to 1.2.9); public open spaces (1.3.1 to 1.3.3). NICE has deleted some recommendations from the 2008 guideline because the evidence has been reviewed and the recommendations have been updated.

This evidence review is relevant to the updated guideline.

See the guideline for more details.

NICE Public Health Collaborating Centre – Physical activity

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CONTENTS

Executive Summary

This report examines the evidence for the effectiveness of transport interventions in increasing physical activity.

Studies were included in the review if they assessed the effect of an intervention related to modifying the transport environment (systems concerned with the movement of people from origin to destination). The outcome of the intervention had to include one measure of physical activity behaviour (including walking/cycling/modal shift).

All intervention study designs were included except studies that examined correlates of transport behaviour.

Twenty six studies were included, comprising 20 before and after measures studies (of which 3 used a comparison or control area) and 6 studies presenting only data from after the intervention.

The studies covered six main areas:

- Traffic calming
- Multi use trails
- Closing or restricting use of roads
- Road user charging
- Cycle infrastructure
- Safe routes to school

Traffic calming

The evidence from five studies (one (2++), two (2-) , one (3+) and one (3-) quality) tends to suggest that traffic calming can lead to small self-reported and observed increases in walking and cycling (including children's play) both in the short and in the long term. However, three studies (one 2+), two (2-) reported either no significant change in self reported and observed levels of walking or cycling, or slight declines in walking and cycling in the short and long term.

The evidence is applicable to the UK.

The evidence from one (2++), two (2-) and one (3+) quality studies suggests that traffic calming interventions may be useful in enabling children specifically to benefit from physical activity through play outdoors in the short and long term.

2. Multi-use trails

Evidence from three studies (one (2++) and two (2+) quality) suggests that introduction of multi-use trails can lead to increases in levels of walking and cycling in both the short and long term. However, one US (2++) quality study found decreases in walking and cycling following the introduction of a multi-use trail.

The evidence from the UK studies is applicable to the UK while the evidence from the US and Australian studies may not be directly applicable.

There is some evidence to suggest that the setting of the delivery of the intervention may influence its effectiveness in the short term and long term. Specifically, trails located closer to population centres may be better used.

3. Closing or restricting use of roads.

There is evidence from three (2-) quality studies to suggest that closing or reducing the capacity of roads can lead to long term increases in levels of walking within the area of the scheme. One (2-) quality study suggests that closing or reducing the capacity of roads can lead to increases in cycling.

Evidence from three (2-) quality studies would suggest that it is important that a wider range of measures is introduced to support road closures.

There is some evidence to suggest that the setting of the delivery of the intervention through location in city or town centres can lead to short term increases in cycling and long term increases in walking.

There is evidence from two (2-) quality studies that closing or restricting use of roads can result in a decrease in road traffic casualties.

There is some evidence to suggest that more intense interventions can lead to long term increases in walking and cycling.
This evidence is likely to be applicable in the UK, with appropriate adaptations.

4. Road user charging

There is evidence from one (2++) and one (2-) quality studies to suggest that introduction of road user charging schemes and changes to the road system can lead to short term increases in levels of walking and long term increases in cycling within the area of the scheme.

There was evidence of either no change or a decrease in road traffic casualties as a result of the road user charging interventions.

The evidence comes from UK studies and so is directly applicable.

5. Cycle infrastructure

Evidence from one (2+), three (2-), one (3++), and two (3-) quality studies suggests that the introduction of cycle infrastructure can lead to long term increases in levels of cycling within the area of the scheme.

Cycle infrastructure interventions may result in important positive public health outcomes alongside increasing cycling, notably a reduction in cycle casualties.

It appears that cycle infrastructure in both urban and rural areas can be effective in increasing cycling.

It is likely that this evidence is applicable to the UK, with appropriate modification for existing infrastructure and cultural issues.

6. Safe routes to school

There is evidence from one (2+) and one (3+) quality studies to suggest that introduction of safe routes to schools schemes can lead to short term increases in levels of walking and cycling within the area of the scheme.

This evidence may be applicable to the UK with some caution.

Included studies

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Merom D, Bauman A, Vita P, Close G. (2003) An environmental intervention to promote walking and cycling-the impact of a newly constructed Rail Trail in Western Sydney. Prev. Med.,36:235-242

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Scottish Office (1999) The Community Impact of Traffic Calming Schemes. Final Report. Prepared by Ross Silcock. Edinburgh: Scottish Office.

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Social Research Associates (2001) Gloucester City Council. Safer City Project – 2000, 2001. Leicester: Social Research Associates.

Sustrans (2005) Monitoring Report 2005. Case Study: Ford Green, Stoke.

Sustrans (2006a) Survey of cycling and walking activity at Stedfastgate, Edinburgh. Sustrans.

Sustrans (2006b) Links to Schools Surveys, Trade Mills, Newhaven. Sustrans.

Transport for London (2006) Central London Congestion Charge. Fourth Annual Monitoring Report: June 2006. www.tfl.gov.uk/tfl/cclondon/pdfs/FourthAnnualReportFinal.pdf accessed 17th July 2006

Troelsen L. (2004) Evaluation of Odense - the National Cycle City. Copenhagen: Ministry of Transport.

Webster D, Tilley A, Wheeler A, Nichols S, Buttress S. (2006) TRL Report 654. Pilot Home Zone schemes: Summary of the schemes, TRL: Crowthorne

1. Introduction

1.1. Background to this review

The National Institute for Health and Clinical Excellence ('NICE' or 'the Institute') has been asked by the Department of Health (DH) to develop guidance on a public health programme aimed at improving the environmental factors that promote physical activity.

This guidance is in response to a number of developments in the fields of physical activity and public health in recent years, including:

- A growing recognition of the influence of the environment as a determinant of the behaviour of individuals and communities;
- A corresponding increase in published research on the environment and physical activity
- A desire by public health professionals to work in partnership with local authorities and other key agencies on public health programmes
- A need to complement interventions targeted at individuals with programmes that have the potential to have a larger population impact.

1.2. The need for guidance

1.2.1. Physical activity and ill health

Increasing activity levels will contribute to the prevention and management of over 20 conditions and diseases including coronary heart disease, diabetes, cancer, and weight management; and can help to improve mental health.

In 2004 the DH estimated the cost of inactivity in England to be £8.2 billion annually – including the rising costs of treating chronic diseases such as

coronary heart disease and diabetes. The contribution of inactivity to obesity is estimated to cost a further £2.5 billion each year.

Around 35% of men and 24% of women (aged 16 plus) are physically active enough to meet the current national recommendations (achieving at least 30 minutes of at least moderate activity on 5 or more days a week). Seventy per cent of boys and sixty-one percent of girls aged 2-15 years achieve the recommended physical activity levels (at least 60 minutes of at least moderate intensity physical activity each day). Physical activity varies according to age, gender, class and ethnicity.

1.2.2. Trends in physical activity and active transport

Trends between Health Surveys for England in 1997, 1998, 2003 and 2004 found small increases in physical activity levels between 1997 and 2004. (Dept of Health 2006) Data from national travel surveys show that the distance people walk and cycle has declined significantly in the last three decades (Department of Transport., 1995; Department for Transport., 2005). The average distance walked per person per year has fallen from 255 miles in 1975/6 to 192 miles in 2003. Bicycle mileage for the same years fell from 51 to 34 miles per person per year. However, it is important to note the absence of published confidence intervals, the use of different physical activity questionnaires in the Health Surveys for England, and the failure of many transport surveys to capture off-road travel.

1.2.3. Physical activity and the environment

The environment can influence people's ability to be active (Department of Health., 2004). For example, the design and layout of towns and cities can encourage or discourage access on foot or by bike, while building design can encourage (or discourage) the use of stairs. Access to parks, the countryside and other green space, as well as specific features of green space, can help people to be more active.

Many components of the environment can be modified by public sector agencies through changes to policy and practice. Action can be taken in partnership with workplaces or other key organisations.

1.3. The nature of evidence on the environment

There are a number of significant challenges associated with undertaking a review of the evidence of physical activity environmental interventions. Firstly, the search strategy needs to broad enough to capture studies from non-traditional sources. Many environmental studies are published in journals that are not indexed in public health databases, or are in the 'grey' literature (such as government reports or case studies). Secondly, few studies report levels of walking and cycling as a study outcome, or present unvalidated measures that are difficult to equate to established measures of physical activity.

Finally, a wider range of study types tends to be used in the environmental field, with more of a focus on case studies or uncontrolled pre and post studies, increasing the risk of bias.

1.4. Scope of the reviews

1.4.1. Aspects of the environment that will be covered

NICE guidance will be based on the findings from five reviews on specific aspects of the environment:

- Transport
- Urban planning
- The natural environment (urban and rural)
- Building design
- National, regional or local policy influencing physical activity through the environment.

This report presents the findings from the Transport review.

1.4.2. Population groups that will be covered

The general population, including both children and adults. The guidance will investigate the effectiveness of interventions across the broad social gradient, rather than focusing on those in the poorest circumstances and those in the poorest health.

1.4.3. Areas that will not be covered

The influence of national fiscal policy on physical activity levels.

1.4.4. Outcomes

The primary aim is to recommend environmental interventions that are likely to increase physical activity levels in the general population by: incorporating physical activity into every day life; increasing formal or informal recreational activity (including active play); increasing active travel.

Other outcomes will also be considered if they are possible consequences of environmental interventions aimed at increasing physical activity. For example the impact of cycling programmes on the incidence and severity of casualties among cyclists.

1.4.5. Review team

This review has been carried out by a team from the Public Health Collaborating Centre (CC) for Physical Activity. The Collaborating Centre is an alliance between the British Heart Foundation Health Promotion Research Group (University of Oxford) and the British Heart Foundation National Centre for Physical Activity and Health (Loughborough University).

2. Methodology

2.1. Literature Search

The following search terms and databases were used. References were downloaded into a Reference Manager database and de-duplicated resulting in 19,376 references. Key international and national experts and lead organisations were contacted in order to source any potential references (26 references). In addition the CC drew on any possible references from personal libraries (12 references). References of included studies were also checked which resulted in no additional records. Searching all the databases took ten days in total.

2.1.1. Search terms

All search strategies were designed by the CC and NICE. Tailored search terms were used appropriate to a particular database. Search terms followed the same order (1) transport terms and (2) physical activity terms. Typical search terms included:

Automobile, autos, car or commuter, driver, congestion, mechanised transport, non-motor, pedestrian, trail AND physical activity, exercise, walk, bicycle, bike, travel mode, trip, active travel.

A full search for MEDLINE is presented in Appendix C.

All searches were made from January 1990 to the most recently published version of the database (July 2006), Searches were also limited by searching for human studies.

2.1.2. Databases searched

Medline; Embase; Cinahl; PsychInfo; SPORTDiscus; TRIS on line; Global Health; Geobase; Cochrane Library; ISI Science Citation Index and Social Science Citation Index; Sociological Abstracts; Cambridge Scientific Abstracts (CSA) ERIC, CSA Environmental Sciences

2.1.3. Selection of studies for inclusion

The agreed search strategy resulted in 19, 414 titles, which were screened for relevance by one person. A pilot screening was performed independently by two researchers on 15% of the 19,376 total hits from the electronic databases in order to assess sensitivity of screening. This pilot assessed titles and abstracts against relevance of a possible study relating to both a transport intervention and assessing physical activity outcomes.

43 titles were assessed to be relevant and the full papers were retrieved, and were independently checked by two people against in-out criteria. All these 43 were subjected to independent full paper assessment by two people using the appropriate critical appraisal tool and 26 studies were accepted for full data extraction (17 were rejected), using a standard form (Appendix C).

Studies were included if they assessed the effect of an intervention related to modifying the transport environment (systems concerned with the movement of people from origin to destination). The outcome of the intervention had to include one measure of physical activity behaviour (including walking/cycling/modal shift).

All intervention study designs were included except studies that examined correlates of transport behaviour.

The main reason for exclusion of studies was that they did not measure physical activity as an outcome.

Effectiveness was examined over the following timescales:

- in the short term (up to and including one year)
- in the longer term (over one year)

Table 1 Numbers of studies at searching, assessing for relevance and data extraction and quality appraisal stages of review

	Data sources			
	Electronic databases	Expert & lead organisations	Personal libraries	Total
Searching				
Number of hits	19376	26	12	19414
Assessing relevance for review				
Number of studies assessed	12	19	12	43
Data extraction and quality appraisal				
Number of included review studies	4	12	10	26

2.2. *Study Type and Quality Appraisal*

Each study was categorised by study type (categorised as type 1-4) and graded for quality using a code '++', '+' or '-', based on the extent to which the potential sources of bias had been minimised (NICE, 2006, p27.). The studies were categorised into the following study types:

Type 1 Systematic reviews, meta-analyses of RCTs (randomised controlled trials), or RCTs

Type 2 Systematic reviews of, or individual, non-randomised controlled trials, case-control studies, cohort studies, controlled before-and-after (CBA) studies, interrupted time series (ITS) studies, correlation studies.

Type 3 Non-analytic studies (for example, case reports, case series studies, after only studies)

Studies were quality appraised against NICE quality criteria (NICE 2006) appropriate for study types, and subsequently classified into one of three categories (++, + or -).

NICE Quality Criteria

Does the study describes its methods and results
Where was the study published?
Who published the study?
Was the study peer reviewed?
Who funded the study?
Were the study samples shown to be representative of the study population in baseline and follow-up (where applicable)?
Was the method/instrument used to assess physical activity or travel mode appropriate to the research question(s) of the study? (i.e. capable of measuring the outcome under consideration)
Did the study provide details of the measures used?
Did the study take into account any potential confounders?

++ **All or most** of the data are adequately described and the conclusions of the study are thought very unlikely to alter (low risk of bias).

+ **Some** of the data are adequately described and the conclusions of the study are thought unlikely to alter (risk of bias)

- **Few or no** data are adequately described and the conclusions of the study are thought likely to alter (high risk of bias)

No Type 1 studies were found. Twenty studies were categorised as type 2 with the remaining 6 as type 3. Table 2 shows the majority of the type 2 studies were categorised as '+' or '-' quality. The main reasons for studies being assessed as (-) quality were failure to describe methods adequately and to take into account any potential confounders.

Table 2 Study type and quality

Study type and quality	Authors
2++	Morrison et al., 2004; Evenson et al., 2005; Merom et al., 2003; Durham City Council., 2006
2+	Babtie., 2001; Sustrans., 2006a; Sustrans., 2006b; Ashton-Graham., 2003; Sustrans., 2005
2-	Kirby., 2001; Social Research Associates., 1999; Webster et al., 2006 ; Social Research Associates., 2001; Gemzoe., 2001; Cairns et al., 1998a; Cairns et al., 1998b; Transport for London., 2006 ; Hartman., 1990 ; Mamoli., 2003; Troelsen et al., 2004
3++	Cope et al., 2003
3+	DETR.,1999; Boarnet et al., 2005
3-	Scottish Office., 1999; CTC., 1995a; CTC., 1995b

2.3. Study categorisation

2.3.1. Description of studies

The 26 studies are described in Section 4 and presented in the Evidence Table. They included:

- 20 before and after measures studies (Morrison et al., 2004; Evenson et al., 2005; Merom et al., 2003; Durham City Council., 2006; Babtie., 2001; Sustrans., 2005; Sustrans., 2006a; Ashton-Graham., 2003; Sustrans., 2006b; Kirby., 2001; Social Research Associates., 1999; Social Research Associates., 2001; Troelsen et al., 2004, Webster et al., 2006; Gemzoe., 2001; Cairns et al., 1998a; Cairns et al., 1998b; Transport for London., 2006; Hartman., 1990 ; Mamoli., 2003)
- three of the before and after studies used a comparison area (Evenson et al., 2005; Hartman., 1990; Troelsen et al., 2004),
- 6 after measures only studies (DETR.,1999; Scottish Office., 1999; Cope et al., 2003; CTC., 1995a; CTC., 1995b; Boarnet et al., 2005).

These studies tested a range of different transport related environmental interventions and fell into six different approaches (see section 3 for full definitions):

- Traffic calming
- Multi use trails
- Closing or restricting use of roads
- Road user charging
- Cycle infrastructure

- Safe routes to school

All interventions included some direct change to the transport infrastructure, with some interventions including home zone initiatives, safety improvements to street lighting and crime reduction, promotion of multi use trails, media campaigns, policy and fiscal changes and whole school approaches.

2.3.2 Country of studies

Nearly two thirds of the studies were conducted in the UK. Table 3 presents the studies by country and lead author.

Table 3 Study type and quality

Country of origin	Authors
UK	Morrison et al., 2004; Babtie., 2001; Kirby., 2001; Social Research Associates., 1999; Webster et al., 2006; Social Research Associates., 2001; DETR.,1999; Scottish Office., 1999; Sustrans., 2006a; Sustrans., 2006b; Cairns et al., 1998b; Durham City Council., 2006; Transport for London., 2006 ; Cope et al., 2006; Sustrans., 2005
USA	Evenson et al., 2005; Boarnet et al., 2005),
Australia	Merom et al., 2003; Aston-Graham., 2003
Denmark	Gemzoe., 2001; Troelsen et al., 2004
Italy	Mamoli., 2003
Austria	CTC., 1995b
Germany	Cairns et al., 1998a
Netherlands	Hartman., 1990; CTC., 1995a

All interventions were delivered at the level of a local road, community or geographical area associated with the environmental intervention.

2.3.3 Length of outcome measures

- Three studies measured short term outcomes (up to and including 12 months follow up) only: (Morrison et al., 2004; Merom et al., 2003; Sustrans., 2006a).

- Thirteen studies measured longer term outcomes (over 12 months follow up) only (Webster et al., 2006; CTC., 1995a; Evenson et al., 2005; Sustrans., 2006b; Cairns et al., 1998a; Cairns et al., 1998b; Durham City Council., 2006; Aston-Graham., 2003; Hartman., 1990; Mamoli., 2003; CTC., 1995a; CTC., 1995b; Sustrans., 2005).

- Four studies measured both short and longer term outcomes (under 12 months and over 12 months follow up) only (Babtie., 2001; Social Research Associates., 1999; Scottish Office., 1999; Boarnet et al., 2005).

- Four studies assessed outcomes, at approximately 12 month time points, using annual panel surveys (Gemzoe., 2001; Transport for London., 2006; Troelsen et al., 2004; Cope et al., 2003).

- Two (2-) quality studies did not report the time period for their follow up measures (Kirby., 2001; DETR.,1999).

The focus of this review meant that many of the included studies came from the road transport literature. It is important to note that reporting levels of walking and cycling as a study outcome is a relatively recent phenomenon in the transport literature, and still a relatively rare occurrence (compared to studies from a public health paradigm), with studies generally tending to reflect transport planners' focus on the car as the dominant and normative mode of travel. Such studies would typically measure traffic vehicle counts or road traffic casualties rather than physical activity.

In addition, the evidence hierarchy practised within public health is not reflected within transport research. For example, use of controlled research designs is rare, and issues such as data capture, contamination and bias make some public health study designs inappropriate, with causality being very difficult to

demonstrate. Consequently, researchers of 'natural experiments' occurring within road transport often apply poorer quality study designs.

2.4. Assessing applicability

Each study was assessed on its external validity: that is, whether or not it was directly applicable to the target population(s) and setting(s) in the scope. This assessment took into account whether the study was conducted in the UK, any barriers identified by studies or the review team, with references as appropriate, to implementing each intervention in the UK, (NICE, 2006).

2.5. Synthesis

It was not appropriate to use meta-analysis to synthesise the outcome data as interventions, methods and outcomes were heterogeneous. This review is restricted to a narrative overview of all studies that met the inclusion criteria and contained sufficient data for data extraction and quality assessment. The effects of studies were examined within the categories of the type of transport intervention, stratified by study quality. The evidence statements were developed using NICE criteria (NICE, 2006, p37), outlined below.

- The best available evidence of the effect of an intervention
- The strength (quality and quantity) of supporting evidence and its applicability to the populations and settings in question
- The consistency and direction of the evidence base

Where there was insufficient evidence to identify specific examples of effective transport interventions, evidence statements were drafted upon the general

direction of the body of evidence within each category of transport interventions. This review did not produce any evidence statements based upon any cost-effectiveness data.

3. Traffic Calming: Summary of Findings

3.1. The studies

'Traffic calming' describes an approach to constraining vehicle speeds, notably by self-enforcing traffic engineering measures, such as speed bumps. It is often implemented to reduce casualty numbers on an area-wide basis on local roads and in residential areas. Traffic calming often accompanies the implementation of 20 mph speed limit zones. There is strong evidence for the effectiveness of traffic calming in reducing road traffic casualties (Elvik, 2000), although this is not the subject of this current review.

Eight UK based studies (six uncontrolled before and after studies, one case study, and one intervention with post-only data) provide evidence for the effectiveness of traffic calming on levels of walking, cycling and children's outdoor play.

Babtie (2001) examined the effect of 20mph speed limit zones employing a wide range of traffic calming measures across six sites including road narrowings, pavement 'build outs', road humps and cushions, and mini-roundabouts.

The DETR (1999) looked at traffic calming among a number of interventions in a deprived inner urban residential area. This study was principally concerned with pedestrian security issues. Road humps were reported as the traffic calming measure.

Kirby (2001) assessed the introduction of 20 mph speed limit zones which employed a range of traffic calming measures including road humps and cushions, and priority working.

Morrison et al. (2004) focused on a deprived outer urban housing estate bisected by a main road which was traffic calmed using speed cushions, two zebra crossings with adjacent railings, and creation of parking bays.

Social Research Associates (1999) looked at changes in town centres after by-passes had been built around the towns but did not report on the types of traffic calming measures implemented within the town centres.

Social Research Associates (2001) looked at a city-wide approach to speed management, which included traffic calming and 20 mph zones among a range of other measures such as speed cameras, posters, and pavement widening but did not provide details of the types of traffic calming measures implemented.

The Scottish Office (1999) looked at speed tables, round top humps, flat top humps, speed cushions and kerb 'build outs' used in three Scottish residential area traffic calming schemes and a number of trunk road traffic calming schemes.

Webster et al. (2006) reported on the use of gateway entrances, 20 mph zones, echelon parking, use of road humps and chicanes, shared surfaces, tree and shrub planting.

3.2. Evidence of efficacy

One (2++) quality study (Morrison et al., 2004) showed that 20% of adults said they walked more as a result of the traffic calming scheme, which was corroborated by the pedestrian count which recorded 'substantial increases at most sites and in most age groups' in the short term. In addition, 11.8% of children reported to play out more, 12.5% reported to walk more, 11.6% reported to be allowed to cycle more in the short term. One (2+) quality study (Babtie., 2001) reported observed pedestrian volumes as generally slightly lower following implementation, and 'no significant changes in cycling' or changes in the numbers of children playing outdoors However, some residents reported that they let their children play out more (although this was not quantified).

One (2-) quality study (Kirby., 2001) showed that 25% of residents reported walking or cycling more following the introduction of the scheme, and 60% of respondents felt that more children played in the street. Another (2-) quality

study (Webster et al., 2006) reported increases in children playing in the street outside their own home (self reported and observed) across seven locations, as well as a slight increase in the long term in adults talking, gardening and watching children, although they reported 'little evidence for increased walking and cycling'

Two (2-) quality studies, reported 'slight declines in walking and cycling' in the long term (self reported and observed) (Social Research Associates., 1999) and 'declines in walking and cycling across a range of trip purposes' in the long term (Social Research Associates., 2001). In both studies data on the level of decline was not provided.

One (3+) quality case study (DETR.,1999); and one (3-) quality case study (Scottish Office., 1999) both reported increases in self-reported walking and cycling. DETR 1999 showed short term unquantified increases among children . Scottish Office, (1999) showed increases in walking from 15-34%, and for walking and 7-18% for cycling in the short and long term.

These results are summarised in Table 1.

Table 1

Quality		++	+	-
Outcome	+ve	Morrison (2++)	DETR (3+)	Kirby (2-) Webster (2-) Scottish Office (3-)
	0		Babtie (2+)	
	-ve			SRA 1999 (2-) SRA 2001 (2-)

The evidence from five studies (one (2++), two (2-) , one (3+) and one (3-) quality) tends to suggest that traffic calming can lead to small self-reported and observed increases in walking and cycling (including children's play) both in the short and in the long term. However, three studies (one 2+), two (2-) reported either no significant change in self reported and observed levels of walking or cycling, or slight declines in walking and cycling in the short and long term.

3.3. Key questions

3.3.1. What is the aim/objective of the intervention?

The traffic calming schemes were primarily focused on reduction of road traffic casualties and did not explicitly aim to increase cycling or walking. Measures such as road humps, which slow traffic speed, may have some benefits for pedestrians and cyclists using these areas. However, traffic calming schemes vary in their nature through size of scheme, intensity of traffic calming measures and details of implementation. For example some studies included 'home zone' style initiatives while others combined traffic calming approaches in a town centre with the building of a bypass around the town.

3.3.2. How does the content of the intervention influence effectiveness?

Five studies reported they were effective in increasing levels of walking and cycling including children's play outdoors.

One UK based (2++) quality study (Morrison et al., 2004) focused on a deprived outer urban housing estate bisected by a main road which was traffic calmed using speed cushions, two zebra crossings with adjacent railings, and creation of parking bays. In this study 20% of adults said they walked more as a result of the scheme, which was corroborated by the pedestrian count which recorded 'substantial increases at most sites and in most age groups'. One UK based (2-) quality study (Kirby., 2001) assessed the introduction of 20 mph speed limit zones which employed a range of traffic calming measures including road humps and cushions, and priority working (which gives vehicles from one direction

priority). Over 25% of residents surveyed reported that they walked or cycled more and 60% reported that more children played out in the street. One (2-) paper (Webster et al., 2006) reported the use of gateway entrances, 20 mph zones, echelon parking (which involves vehicles being parked at approximately 45 degrees to the pavement), use of road humps and chicanes, shared surfaces (where there is no separate pavement in locations where speeds driven are generally under 10 mph), tree and shrub planting. There was a 9% increase in observed play outside their own home in children following the implementation of Home Zones, but little evidence for increased walking and cycling'. This may have been due to the relatively small scale of Home Zone areas, often comprising only a few streets (Webster et al., 2006). One UK based (3+) quality study (DETR., 1999) reported that traffic calming was one of a number of interventions in a deprived inner urban residential area. This study was principally concerned with pedestrian security issues. Road humps were reported as the traffic calming measure. A survey of residents' attitudes and behaviours reported increased walking among children although no quantification was provided. One UK based (3-) quality study (Scottish Office.,1999) reported that speed tables (elevated sections of carriageway often used at junctions), round top humps, flat top humps, speed cushions (which do not comprise the full width of the carriageway) and kerb 'build outs (which reduce carriageway width) ' were used in three Scottish residential area traffic calming schemes studied where residents reported an increase in walking and cycling from 7-18% and 15-34% respectively. It is noted that none of the residents of the five trunk road traffic calming schemes reported changes in levels of walking or cycling.

One UK based (2+) quality study (Babtie., 2001) of the effect of 20mph speed limit zones employing a wide range of traffic calming measures across six sites including road narrowings, pavement 'build outs', road humps and cushions, and mini-roundabouts, reported pedestrian volumes 'slightly lower' and no change in cycling among adults and children across six schemes, although some parents reported that they let their children play out more. This reported increase in children playing out was not quantified.

One UK based (2-) quality paper (Social Research Associates., 1999) did not report on the types of traffic calming measures implemented within town centres after by-passes had been built around the towns. The overall intervention resulted in 'slight decreases' in walking and cycling. These decreases were not quantified. This may have been due to lack of restraint measures and lack of initiatives to encourage walking and cycling (Social Research Associates, 1999). A second UK based (2-) quality paper (Social Research Associates, 2001) of a city-wide approach to speed management, which included traffic calming and 20 mph zones, among a range of other measures such as speed cameras, posters, and pavement widening, did not provide details of the types of traffic calming measures implemented. It reported that walking and cycling levels among adults had declined across a range of trip purposes by the end of the five year project (although the level of decline was not quantified). However, all independent travel purposes eg go to school, visit local shops, cycle, increased among children.

In summary, there is insufficient evidence to make any firm conclusions about the extent to which the specific content of traffic calming interventions influences their effectiveness. In part this is because the range of interventions is too diverse. One paper (Babtie., 2001) offered an explanation for the lack of changes in walking and cycling and suggested that it may be necessary to promote motor vehicle speeds lower than 20mph to reduce the deterrent to walking and cycling. Overall there appears to be no clear reason why some interventions were successful at increasing walking and cycling and others were not.

3.3.3. How does the way that the intervention is carried out influence effectiveness?

The eight studies all reported use of physical traffic calming measures. Some types of measure, such as road humps, may be more effective at reducing vehicle speeds than others although the specific design and intensity of measures may be important. Data on traffic calming measures did not include detailed information about the individual installations. There was thus insufficient

evidence to support any particular means of increasing walking and cycle use through traffic calming

3.3.4. Does the effectiveness depend on the job title/position of the deliverer?

None of the papers provided data addressing this question. Therefore, there is insufficient evidence to make clear inferences about the impact of the job title/position of the deliverer of the intervention.

3.3.5. Does the site/setting of delivery of the intervention influence effectiveness?

Of the five studies reporting increases in walking and cycling or children's outdoor play all were in urban areas and two were located in deprived urban areas and one (2++) quality study was implemented in an outer urban housing estate in Glasgow (Morrison et al., 2004). One (3+) quality study was implemented in an inner urban area of Leicester (DETR., 1999). One (2-) quality study of 20 mph zones in Hull did not identify issues concerning the site or setting of the intervention. (Kirby., 2001). However, traffic calming schemes tend to be prioritised towards deprived areas where casualty rates are often high. One (3-) quality study reported increases in walking and cycling in three residential areas in Scottish towns (Scottish Office., 1999). A fifth study, (2-) quality of Home Zones reported increases in time spent outdoors by adults and children. Home Zones comprise the most intense level of traffic calming resulting in speeds around 10 mph and so this change may be least surprising. However, there is insufficient evidence to make any firm conclusions about the setting of the delivery of the intervention not least because of the lack of evidence concerning traffic calming in rural areas.

3.3.6. Does the intensity (or length) of the intervention influence effectiveness/duration of effect?

The intensity of the interventions varied considerably from Home Zones to traffic calming in town centres. Home Zones require intense use of traffic calming measures in order to achieve speeds no higher than 10mph whereas traffic calming in 30 mph speed limit areas will require less intense use of speed reducing measures. There is insufficient evidence from these studies to make any firm conclusions about the intensity (or length) of the intervention influence.

3.3.7. How does the effectiveness vary with age, gender, class, ethnicity etc?

Five studies included data concerning effectiveness of increasing walking and cycling among adults or children or an increase in children playing outdoors (Morrison., 2004; Kirby., 2001; Webster et al., 2006; DETR., 1999; Scottish Office., 1999). However, only for three of the studies were pedestrians observed or cycle counts undertaken (Morrison., 2004; Babtie., 2001; Webster et al., 2006). In addition, one of these studies (Babtie., 2001) reported that although counts recorded no increase in children playing out of doors some parents reported that they let their children play out more. However, and on balance, children may be an age group which benefits particularly as a result of traffic calming, not least through parent's greater willingness to let them play out. **In summary, the evidence from one (2++), two (2-) and one (3+) quality studies suggests that traffic calming interventions may be useful in enabling children specifically to benefit from physical activity through play outdoors in the short and long term.**

3.3.8. What are the barriers to implementation?

There was insufficient evidence from the studies to make clear inferences about barriers to implementation.

3.3.9. What are the non-physical activity outcomes of the intervention?

Most traffic calming schemes do not explicitly aim to increase walking and cycling, but do have a substantial impact on reducing casualties (e.g. Elvik, 2000). These outcomes have not been examined in this review.

3.4. Applicability (of evidence from efficacy studies) to UK population/setting.

All eight of the studies were UK located and are therefore applicable to the UK. However. traffic calming is only likely to be applicable to populations or settings included in the studies– the success of broader application is uncertain.

Five studies reporting a positive effect on walking and cycling were from the UK and are therefore applicable in the UK.

3.5. Implementability of intervention.

All of the studies would be highly feasible to implement in UK residential and city centre settings with appropriate political support. Some adaptation may be necessary to reflect any local concerns about design and types of traffic calming measures implemented. Consideration may also be needed to levels of political and public support. Promotion of increased opportunities for children to play outdoors safely and increased opportunities for walking and cycling because of an improved environment may also be important in the promotion of future traffic calming schemes.

Traffic calming summary evidence statement:

The evidence from five studies (one (2++), two (2-) , one (3+) and one (3-) quality) tends to suggest that traffic calming can lead to small self-reported and observed increases in walking and cycling (including children's play) both in the short and in the long term. However, three studies (one 2+), two (2-) reported either no significant change in self reported and observed levels of walking or cycling, or slight declines in walking and cycling in the short and long term.

The evidence is applicable to the UK.

The evidence from one (2++), two (2-) and one (3+) quality studies suggests that traffic calming interventions may be useful in enabling children specifically to benefit from physical activity through play outdoors in the short and long term.

4. Multi use trails: Summary of Findings

4.1. The studies

Multi-use trails are routes open to cyclists and pedestrians, but closed to motor traffic. They include routes developed for recreational purposes and/or utility trips such as travel to work, school or shops. Studies in this section generally include evaluations of the usage of specific linear routes, which may include sections of a larger network of walking/cycling routes. This is distinct from the later section 'cycle infrastructure' which addresses the impact of an overall network of cycle routes.

Four studies, two UK based, one Australian based and one US based (1 controlled before and after study and three uncontrolled before and after studies) provide evidence for the effectiveness of multi-use trails in increasing walking and cycling.

Evenson et al., (2005) documented the changes in physical activity occurring among adults following the construction of a multi-use trail.

Merom et al., (2003) assessed the impact of a local promotional campaign around a newly constructed Rail Trail in Western Sydney, Australia.

Sustrans., (2005) focused on findings from route user surveys conducted either side of a series of on-going route improvements aimed at increasing levels of cycling and walking activity in Stoke, England.

Sustrans., (2006a) assesses the impact of both signing and production of a leaflet on the use of a section of the National Cycle Network in Edinburgh, Scotland.

4.2. Evidence of efficacy of Multi-use trails

The (2++) quality controlled before and after study conducted in the USA (Evenson et al., 2005) showed negative results; reporting that 'walking for

transportation did not significantly change' and 'participants who used the trail were also more likely to decrease their bicycling time from baseline'. However, the other three studies reported increases in walking and cycling: one Australian based (2++) quality study reported increases in self-reported physical activity and bicycle counts (Merom et al., 2003); and two UK 2(+) quality studies (Sustrans, 2005; Sustrans, 2006a) showed increases in self-reported and observed walking and cycling.

Two studies measured short-term outcomes of promotions of trail use (Merom et al., 2003; Sustrans, 2006a). The Australian study (Merom et al., 2003) found that there was a significant increase in mean daily bikes counted in the intervention areas four months after the trail launch and an increase in mean cycling time among those living <1.5km from the trail (but a decrease among those living >1.5km from the trail). One UK study found that the number of pedestrians who reported that they were walking more than they were one year earlier rose from 5.6% pre-intervention to 37.6% post intervention of signing and the production of a leaflet on a section of the National Cycle Network (although no quantification is given as to the level of increase in walking across the pedestrians surveyed) (Sustrans, 2006a). The number of cyclists who reported that they were cycling more than they were one year earlier also rose, from 10% pre-intervention to 53.1%, seven months post the intervention.

Two studies measured long term outcomes for walking and pedestrian levels (Evenson et al., 2005; Sustrans., 2005). One US study (Evenson et al., 2005) conducted surveys between 19 and 28 months after the introduction of a multi-use trail. They found that participants who used the trail were less likely to increase their walking by more than 30 or 45 minutes per week from baseline, while cycling decreased from baseline 'although the estimates were somewhat imprecise due to the low prevalence of bicycling'. One UK study (Sustrans., 2005) found that the number of pedestrian users of a newly surfaced route increased by 83% following the intervention and that cycling also increased by 112%, three years post the intervention.

Evidence from three studies (one (2++) and two (2+) quality) suggests that introduction of multi-use trails can lead to increases in levels of walking and cycling in both the short and long term. However, one US (2++) quality study found decreases in walking and cycling following the introduction of a multi-use trail.

Key Questions

4.2.1. What is the aim/objective of the intervention?

Each study directly sought to increase walking and cycling use. Three studies demonstrated an effect on walking and/or cycling levels in residents and those travelling in the area (Merom et al., 2003; Sustrans., 2005; Sustrans., 2006a). Two interventions sought to provide information to encourage use of a new or existing trail (Merom et al., 2003; Sustrans., 2006a) One intervention aimed to increase use through the re-surfacing of an existing trail (Sustrans., 2005), and another intervention aimed to provide a new facility for these activities (Evenson et al., 2005).

4.2.2. How does the content of the intervention influence effectiveness?

The three studies which were effective in increasing levels of walking and cycling were each located in residential areas of cities. Two UK (2+) quality studies were part of wider cycle and pedestrian networks with one linked to an existing Safe Routes to School scheme (Sustrans., 2005; Sustrans., 2006a). These interventions are of practical value for utility trips including journeys to work or school. Both reported increases in walking and cyclist post intervention. One Australian (2++) quality study reported smaller increases in trail usage from 1.6% to 5.6% and it is unclear whether the trail was used for utility journeys or was predominantly used for recreational physical activity and used most by those living within close proximity (Merom et al., 2003).

In one US (2++) quality study (Evenson et al., 2005), which showed no effect, additional incentives may have been needed beyond the provision of the trail itself to encourage people to walk or cycle.

In summary, the evidence would suggest that introduction of multi-use trails can lead to increases in walking and cycling in the short and long term. However, there is insufficient evidence to suggest whether or not signage and promotional interventions can lead to increases in trail use. Moreover, trails may need to form part of a wider network of paths and routes which provide pedestrians and cyclists with sufficient facilities in order to overcome barriers to the use of these modes of transport. In addition, the prevailing cultural attitudes locally and nationally towards walking and cycling may also have a role in the usage of new facilities.

4.2.3. How does the way that the intervention is carried out influence effectiveness?

Two studies used construction or surfacing of trails. One study used local media advertising and a map of a new trail, and another signage and an information leaflet to promote the use of an existing trail. There was insufficient evidence to support any particular means of increasing walking and cycle use of trails

4.2.4. Does the effectiveness depend on the job title/position of the deliverer?

None of the papers provided data addressing this question. Therefore, there is insufficient evidence to make clear inferences about the impact of the job title/position of the deliverer of the intervention.

4.2.5. Does the site/setting of delivery of the intervention influence effectiveness?

The three studies that showed an effect delivered a trail in residential settings in cities. One (2+) quality study was implemented in the capital city of Scotland (Sustrans., 2006), another (2+) in a small city in the Midlands in England

(Sustrans., 2005), and a third in a major Australian city (Merom et al., 2003). This Australian study had a greater impact on people living close to the trail. In contrast the US (2++) quality study (Evenson et al., 2005) evaluated the impact of a multi use trail in central North Carolina, with a population density of only 44 persons/sq km. It may be that proximity to a large population centre, such as a city, has an influence on effectiveness. In addition, it may be that country-specific and local factors like car dependence and ownership, land use patterns and culture may impact on the attractiveness of walking and cycling both for transport as well as leisure and other purposes. **There is some evidence to suggest that the setting of the delivery of the intervention may influence its effectiveness in the short term and long term. Specifically, trails located closer to population centres may be better used.**

4.2.6. Does the intensity (or length) of the intervention influence effectiveness/duration of effect?

In two of the studies (Evenson et al., 2005; Sustrans., 2005) the intensity of the intervention remained constant (as the intervention was the building of the trail itself). In the two other studies the intervention involved short-term elements such as use of media information to publicise the existence of a trail (Merom et al., 2003) and written materials (Sustrans., 2006a). There were no clear correlations between the use of public information and trail use. There is insufficient evidence to make any firm conclusions about the influence of the intensity (or length) of the intervention**.**

4.2.7. How does the effectiveness vary with age, gender, class, ethnicity etc?

Two studies included data according to age, gender, disability and non-English speaking background. The number of children using the trails increased in one study (Sustrans., 2005) while decreasing in another, although at the same trail the number of older users, aged 60+, increased (Sustrans., 2006a). Both studies reported increases in use among women. One study also reported increases in

use among those with a registered disability (Sustrans., 2005). One Australian study reported a slightly lower awareness of a trail among those adults from a non-English speaking background (Merom et al., 2003). There is insufficient evidence to assess any differential effect of the interventions by socio-demographic or cultural factors.

4.2.8. What are the barriers to implementation?

None of the studies specifically addressed barriers to implementation. In the opinion of the reviewers, in order for these interventions to be successful land has to be available and this is likely to be more problematic in areas of significant population density. There will be issues of land purchase cost as well as construction but equally political will at the local and national levels to ensure that walking and cycling infrastructure is prioritised. However, overall there is insufficient evidence from these studies to make any firm conclusions about barriers to implementation.

4.2.9. What are the non-physical activity outcomes of the intervention?

There was no evidence of any other outcomes from the multi-use trails interventions.

4.3. Applicability (of evidence from efficacy studies) to UK population/setting.

Two of the studies were from the UK and thus provide directly applicable evidence. The evidence from the US and Australian studies may be applicable to multi-use trails in similar settings in the UK provided that cultural and socio-political factors are taken into account. **In summary, the evidence from the UK studies is applicable to the UK while the evidence from the US and Australian studies may not be directly applicable.**

4.4. Implementability of intervention.

The two UK studies show that the intervention is highly applicable to the UK. In addition, the US and Australian interventions are similar to many multi-use trails that are part of the existing National Cycle Network.

Multi-use trails summary evidence statement

Evidence from three studies (one (2++) and two (2+) quality) suggests that introduction of multi-use trails can lead to increases in levels of walking and cycling in both the short and long term. However, one US (2++) quality study found decreases in walking and cycling following the introduction of a multi-use trail.

The evidence from the UK studies is applicable to the UK while the evidence from the US and Australian studies may not be directly applicable.

There is some evidence to suggest that the setting of the delivery of the intervention may influence its effectiveness in the short term and long term. Specifically, trails located closer to population centres may be better used.

5. Closing or restricting use of roads: Summary of Findings

5.1. The studies

This section concerns studies of the effect of closing roads to vehicles, or restricting the use of roads by vehicles. This can include short sections of carriageway from which private motorised traffic is excluded for certain periods of certain days, through to complete pedestrianisation schemes.

Three studies, one UK based, one German based and one Danish based (all uncontrolled before and after studies) provide evidence for the effect of closing or restricting use of roads on walking and cycling.

Cairns et al., (1998a) assessed the effects of an environmentally friendly transport policy in Luneburg, Germany.

Cairns et al., (1998b) assessed the impact of a road closure (with exemptions) on a section of Orpington High Street, England.

Gemzoe L., (2001) charted the increasing use of public space by pedestrians in Copenhagen which have been recorded in a series of surveys of the inner city since the 1960s.

5.2. Evidence of efficacy

One German (2-) quality study (Cairns et al., 1998a) reported observed increases in both walking and cycling. One Danish (2-) quality study (Gemzoe., 2001) reported long-term increases in observed walking and one UK (2-) quality study (Cairns et al., 1998b) reported short term increases in observed walking. This study found an overall 19% increase of pedestrian flows in the short-term following the introduction of a road closure (with exemptions), ten months post the intervention (Cairns et al., 1998b). No data were provided with regards to cycling although cyclists were one of the exempt categories of road users.

The German study reported significant increases in both walking and cycling in the short term in the town of Lüneburg. Changes in traffic flows on the ring road and major roads included a 58.7% increase for cyclists and a 48.3% increase for pedestrians, between 1991 and 1994. The main road closures took place in 1993. (Cairns et al., 1998a) No other data were provided. One study reported significant long term increases in walking after streets were pedestrianised in inner Copenhagen. After the first street closures in the 1960s the number of pedestrians doubled and thereafter pedestrian activity increased three to four fold by 1995 as people tended to stay longer in the streets (Gemzoe., 2001) No other data were provided.

There is evidence from three (2-) quality studies) to suggest that closing or reducing the capacity of roads can lead to long term increases in levels of walking within the area of the scheme. One (2-) quality study suggests that closing or reducing the capacity of roads can lead to increases in cycling

5.3. Key Questions

5.3.1. What is the aim/objective of the intervention?

The interventions sought to improve conditions for pedestrians (or pedestrians and cyclists) as well as among public transport passengers using the city centres or high streets through restricting or banning vehicular traffic.

5.3.2. How does the content of the intervention influence effectiveness?

All three interventions took different approaches, but it would appear that an important component of the interventions was that wider measures were taken to support road closures.

In the (2-) quality study of Copenhagen, (Gemzoe., 2001), traffic changes were enforced by road closures and pedestrianisation implemented by the local city council in order to improve the pedestrian and overall environmental quality.

One (2-) quality study sought to encourage people to leave their cars at home, especially for short journeys and to travel by public transport, bicycle or on foot

(Cairns et al., 1998a). Road closures, pedestrianisation, construction of a large cycle network, and improvements to public transport were implemented. The local town council supported the implementation of this scheme having devised an environmentally friendly transport policy.

One (2-) quality study sought to improve the environment, conditions for buses, pedestrians and those shopping in a local High Street (Cairns et al., 1998b). A Traffic Regulation Order and signing prohibited general motor traffic between 10am and 4pm. This followed an extensive consultation and discussion period.

In summary, on the basis of 3 (2-) quality studies, the evidence would suggest that it is important that a wider range of measures is introduced to support road closures.

5.3.3. How does the way that the intervention is carried out influence effectiveness?

As shown above, it appears that the use of physical closures of streets and pedestrianisation and signs to prohibit certain types of vehicular traffic, needs to be carried out alongside supportive policies and measures.

5.3.4. Does the effectiveness depend on the job title/position of the deliverer?

There are insufficient data available to assess the impact of the job title/position of the deliverer on the intervention.

5.3.5. Does the site/setting of delivery of the intervention influence effectiveness?

All three studies were located in central urban areas although there were some significant differences in infrastructure environments. One (2-) quality study was implemented within a capital city, Copenhagen, with a transport policy which sought to keep car traffic stable as well as undertake measures to improve the walking environment over the past three decades (Gemzoe., 2001). One (2-) quality study was focused on a historic town in Germany which sought to address

'daunting forecasts of further [traffic] growth' during the late 1980s (Cairns et al., 1998a). Protecting the town from the effects of motor traffic was an essential backdrop to the intervention. One (2-) quality study was located in the High Street of a south-east London Borough. A section of the High Street was closed during the off- peak period to certain types of traffic but still catered for over 700 vehicles per hour, including violations of the ban (Cairns et al., 1998b). **There is some evidence to suggest that the setting of the delivery of the intervention through location in city or town centres can lead to short term increases in cycling and long term increases in walking.**

5.3.6. Does the intensity (or length) of the intervention influence effectiveness/duration of effect?

The intensity of the interventions varied considerably from city centre bans and restrictions on motor traffic to a number of streets in a capital city centre and a smaller city centre, and a vehicle restricted area in one section of a High Street. In one (2-) quality study it was reported that the number of pedestrians staying in the space had grown proportionately with the number of car-free square metres that had been made available to pedestrians, that is, for every 14 metre^2 made available for pedestrian use, a new person had arrived (Gemzoe., 2001). There were evidence from one study for correlations between effectiveness of intervention and intensity or length of the intervention programme with the largest increases in walking and cycling (Cairns.,1998a; Gemzoe., 2001)) being in locations where at least a number of streets had been restricted to motor traffic. **There is some evidence to suggest that more intense interventions can lead to long term increases in walking and cycling.**

5.3.7. How does the effectiveness vary with age, gender, class, ethnicity etc?

No data were reported as to the effectiveness of closing roads according to age, gender, class or ethnicity.

5.3.8. What are the barriers to implementation?

All three interventions required political support in order to ratify policy decisions There is, however, insufficient evidence to make any firm conclusions about the barriers to implementation.

5.3.9. What are the non-physical activity outcomes of the intervention?

None of the studies reported any adverse consequences of the interventions. There was evidence of a reduction in personal injury accidents by 13.5% from 422 to 365 in one year (1993/94) in one study (Cairns et al., 1998a). In another study (Cairns et al., 1998b) personal injury accidents declined from 15 in the three years prior to the scheme to 1 between April 1996 to February 1997 during the hours of operation of the restriction. **). In summary, in two studies there was evidence of a decrease in road traffic casualties as a result of closing or restricting use of roads interventions.**

5.4. Applicability (of evidence from efficacy studies) to UK population/setting.

The evidence from the UK study is likely to be directly applicable to other UK settings (Cairns et al. 1998b). The evidence from the other two studies comes from Germany (Cairns et al, 1998a) and Denmark (Gemzoe, 2001) and are likely to be applicable across a broad range of populations or settings, assuming adaptations are made to suit UK political and cultural environments.
In summary the evidence is likely to be applicable in the UK, with appropriate adaptations.

5.5. Implementability of intervention.

In the opinion of the reviewers, both non-UK studies would be highly feasible to implement in UK city and town centre settings. Some adaptation may be necessary to reflect any local concerns about design and types of road network capacity reduction measures implemented. Consideration may be needed to levels of political and public support. Promotion of increased opportunities for walking and cycling because of an improved environment may also be important

for future closure or restricted use of roads schemes. It is of note that small area schemes in similar settings are already being implemented across the UK as part of local authority town and city-centre management programmes

Closing or restricting use of roads: summary evidence statements

There is evidence from three (2-) quality studies to suggest that closing or reducing the capacity of roads can lead to long term increases in levels of walking within the area of the scheme. One (2-) quality study suggests that closing or reducing the capacity of roads can lead to increases in cycling.

Evidence from three (2-) quality studies would suggest that it is important that a wider range of measures is introduced to support road closures.

There is some evidence to suggest that the setting of the delivery of the intervention through location in city or town centres can lead to short term increases in cycling and long term increases in walking.

There is evidence from two (2-) quality studies that closing or restricting use of roads can result in a decrease in road traffic casualties.

There is some evidence to suggest that more intense interventions can lead to long term increases in walking and cycling.

This evidence is likely to be applicable in the UK, with appropriate adaptations.

6. Road user charging: Summary of Findings

6.1. The studies

Road user charging (or 'congestion charging') is the approach of charging motor vehicle users to drive on particular roads at particular times. The primary objective is usually to offer a disincentive to motor vehicle use, in order to reduce congestion, pollution, or conflict between different road user types. The intervention can include an environmental component of signing both on the carriageway and street signs, entry and exit barriers and cameras.

Two UK based studies (2 uncontrolled before and after studies) provide evidence for the effectiveness of road user charging schemes in increasing walking and cycling.

Durham City Council., (2006) reported on the impact of Road User Charging within the Peninsula area of the city of Durham on vehicle numbers and a set of objectives which included improved pedestrian safety and conflicts with motor traffic.

Transport for London (2006) reviewed the impact of the congestion charge in London on modes of travel used.

6.2. Evidence of efficacy

One (2++) quality UK study reported observed increases in walking (Durham City Council., 2006) following the introduction of road user charging. Outcomes were measured in the short term for pedestrian levels. This study found an overall 10% increase of pedestrian activity following the introduction of a road user charge and infrastructure improvements, 12 months post the intervention. No other data were provided.

The other study was also based in the UK and (2-) quality. This reported statistically significant increases in cycling kilometres travelled, increasing from 4% of total distance travelled in 2002 to 7% of total distance travelled in 2005 (from approx 70,000km to 100,000km) representing an increase of 30% over baseline in 2002) Transport for London., 2006). The study measured outcomes in the long term for cycling, finding an overall 24% increase in cycling levels over 3 years from the baseline pre intervention measure, as a result of fiscal and infrastructure improvements to a central city zone. No other data were provided, including for pedestrians.

There is evidence from one (2++) and one (2-) quality studies to suggest that introduction of road user charging schemes and changes to the road system can lead to short term increases in levels of walking and long term increases in cycling within the area of the scheme.

6.3. Key Questions

6.3.1. What is the aim/objective of the intervention?

Both interventions were primarily focused on reducing traffic congestion and pedestrian safety, and did not explicitly set out to promote walking or cycling.

6.3.2. How does the content of the intervention influence effectiveness?

One (2++) quality study was focused within a geographically compact commercial and shopping city centre (Durham City Council., 2006). Road user charging was enforced by payment to exit an area of the city centre. This road user charge was enforced from Monday to Saturday between 10am-4pm. Access was protected by the installation of bollards in the centre of the carriageway. The local city council supported the implementation of this scheme following extensive and generally supportive public consultation.

One (2-) quality study was focus on a much larger capital city commercial and business area, supported extensively by a large mass public transport system

(Transport for London., 2006). The intervention was supported by direct political support from the metropolitan area authority. The congestion charge zone was well resourced to clearly mark the congestion charge zone, provide signing, enforcement cameras and staff to enforce non payment. Exemptions were offered to certain categories of vehicle, notably taxis, London licensed private hire vehicles, motorcycles, pedal cycles and buses.

In summary, on the basis of two studies, it is difficult to determine how the content of the schemes influenced effectiveness and the extent to which changes in levels of cycling and walking were due solely to the road user charging scheme itself or due to other factors. These factors could include improvements to public transport, and changes in commercial or business use.

6.3.3. How does the way that the intervention is carried out influence effectiveness?

Both studies used fiscal charges as a means of access control and improvements to city centre environments. They were, however, different in the way they were carried out and in scale. There was insufficient evidence to support any particular means of introducing a road user charging system.

6.3.4. Does the effectiveness depend on the job title/position of the deliverer?

There are insufficient data available to assess the impact of the job title/position of the deliverer on the intervention**.** However, in the opinions of the researchers, in the case of the road user charge in London the clear political support for the scheme from the Mayor of London was likely to have been a determining factor.

6.3.5. Does the site/setting of delivery of the intervention influence effectiveness?

Both studies delivered a similar road user charging system but within very different infrastructure environments. One (2-) quality study was implemented within a capital city, and the particular characteristics of the central city environment, transport system and population diversity may also contribute to the

success of this scheme (Transport for London., 2006). One (2++) quality study (Durham City Council., 2006) was implemented with geographically small area, bounded by a river within a medieval city structure and streets. There is insufficient evidence to make any firm conclusions about the setting of the delivery of the intervention.

6.3.6. Does the intensity (or length) of the intervention influence effectiveness/duration of effect?

The intensity of the interventions has remained consistent, with some relaxation of the charges to central zone area upon the weekend. The interventions are still underway. There has been a slight reduction in the increase of levels of cycling across the three years of one study (a decline of 3%), however it is not possible to assess if this is an attenuation of the intervention effect or the impact of other factors (Transport for London., 2006). There is insufficient evidence to make any firm conclusions about the intensity (or length) of the intervention influence.

6.3.7. How does the effectiveness vary with age, gender, class, ethnicity etc?

Both studies collected population level data, but did not record any characteristics of their samples. There is insufficient evidence to assess any differential effect of the interventions by socio-demographic or cultural factors.

6.3.8. What are the barriers to implementation?

The studies do not present data on any barriers to implementation. However, it seems likely that road user charging interventions will require political and public support and a public transport system that provides a choice to car use. There is, however, insufficient evidence to make any firm conclusions about the barriers to implementation.

6.3.9. What are the non-physical activity outcomes of the intervention?

It might be hypothesised that road user charging could lead to increased traffic speeds due to reductions in congestion and therefore increased severity of

casualties among cyclists and pedestrians. However, the London congestion charge study reported that there was actually a reduction of 4% in the number of cycles involved in accidents between 2003 and 2004. (Transport for London., 2006). There continues to be evidence of no disproportionate or detrimental impacts on the more vulnerable road users in or around the charging zone (Transport for London., 2006). This was in spite of an observed increase in traffic speeds within the road user charging zone: because the numbers of cars had reduced the speeds of the remaining cars increased. The other (2++) quality study reported no evidence of adverse effects (Durham City Council., 2006). **In summary, in the two studies there was evidence of either no change or a decrease in road traffic casualties as a result of the road user charging interventions.**

6.4. Applicability (of evidence from efficacy studies) to UK population/setting.

The evidence comes from UK studies and so is directly applicable.

6.5. Implementability of intervention.

In the opinion of the reviewers, road user charging interventions would be feasible to implement in other UK city settings with appropriate political and public support. Some adaptation would be necessary to reflect any local geographical and city designs, and existing public transport systems. Alternative public transport systems would need to be a realistic option to car use. Local infrastructure changes must also support walking and cycling transport above the needs of car users.

Road user charging summary evidence statement

There is evidence from one (2++) and one (2-) quality studies to suggest that introduction of road user charging schemes and changes to the road system can lead to short term increases in levels of walking and long term increases in cycling within the area of the scheme.

There was evidence of either no change or a decrease in road traffic casualties as a result of the road user charging interventions.

The evidence comes from UK studies and so is directly applicable.

7. Cycle infrastructure: Summary of Findings

7.1. The studies

Cycle infrastructure is defined as physical measures to support cycling, such as cycle lanes; paths; advanced stop lines at traffic signals; signage. This may form part of a town or city network of routes or may comprise a single section of infrastructure. While there may be some overlaps with the previous section 'multi-use trails', this section is mainly concerned with the impact of networks of cycle infrastructure.

Seven studies, one from the UK, two from The Netherlands, one from Australia, one from Austria, one from Italy, and one from Denmark (2 controlled before and after, 2 uncontrolled before and after, 1 post-intervention post-only data, and 2 case studies) form the basis of the evidence for the effectiveness of cycling infrastructure in leading to increases in cycling.

Ashton-Graham., (2003) examines the revival of cycling within the Metropolitan area of Perth, Western Australia. A combination of infrastructure, service provision, promotion and travel behaviour change tool have been applied to partially reverse a 15 year decline in walking, cycling and public transport use.

Cope et al., (2003) reports on data from the National Cycle Network route usage monitoring project which is analysed to examine the implications of the network for health, social inclusion, economic opportunities through tourism and recreation, and the nature of cyclists and cycling.

CTC., (1995a) provides a review of the Groningen (Netherlands) cycle network development and broader transport policies, and impact on cycle usage.

CTC., (1995b) provides a review of cycle network development in Graz (Austria), as part of broader transport strategy, and the impact on cycle usage.

Hartman., (1990) reports on the development of the cycle route network in Delft (Netherlands) and its impact on cycle usage.

Marmoli., (2003) reports on progress in the promotion of cycling in Padua (Italy) by charting the development of a number of cycle routes.

Troelsen (2004) reports (in an English summary of a full report in Danish) on work in Odense (Denmark) to increase bicycle use in the city by 20% by the end of 2002 from a 1999 baseline.

7.2. Evidence of efficacy of cycle infrastructure

All seven studies reported an increase in cycling. Five of these studies reported significant increases only in cycling : one Australian (2+) quality (Ashton-Graham., 2003); one Danish (2-) quality (Troelsen., 2004); one UK (3++) quality (Cope et al., 2003); and two Dutch and Austrian (3-) quality (CTC., 1995a; CTC., 1995b). One study (2-) quality reported significant increases in cycling and a significant decline in walking (Mamoli., 2003). One (2-) quality study reported a small increase in cycling, albeit from a very high baseline figure and a 'likely' decline in walking (Hartman., 1990). All seven studies measured outcomes in the long term. Cope et al (2003) reported increases in overall cycle use on three routes of 43%, 50.1% and 29.7%, between 1998 and 2001, using post-intervention only data (Cope et al., 2003).

Evidence from one (2+), three (2-), one (3++), and two (3-) quality studies suggests that the introduction of cycle infrastructure can lead to long term increases in levels of cycling within the area of the scheme.

7.3. Key Questions

7.3.1. What is the aim/objective of the intervention?

All interventions sought to increase cycling and one of the interventions (Cope et al 2003) also sought to increase levels of walking. All studies addressed the development or enhancement of cycle route networks with six studies addressing city-wide cycle route networks seeking increases in cycle use across relatively large urban areas as opposed to a single linear route.

7.3.2. How does the content of the intervention influence effectiveness?

All seven studies showed positive effects on cycling. One (2+) quality study reported construction of a cycle route network consisting of local bicycle routes, principal shared paths, regional recreational paths, priority spot improvements, central area access, generic improvements and trip end facilities. The network also included signage, maps, promotional materials and media promotion (Ashton-Graham., 2003). This study reported a 13% increase in cycle use on the Local Bicycle Route corridors, in the long term.

Three (2-) quality studies reported interventions comprising a range of cycle infrastructure measures. One intervention provided two large tunnels for cyclists, three bridges, 3.3km of new bicycle tracks, 2.6km of streets that are bi-directional for cyclists but one-way for cars, 8.5km of bicycle lanes and tracks, and 10km of new asphalt pavement (Hartman., 1990). One intervention provided around 35km of the most basic infrastructural improvements (Mamoli., 2003). Another intervention included measures to make it easier for cyclists to cross traffic lights and junctions including a ‘green wave’ for cyclists, increased operational quality of the cycle paths, improvements in cycle parking in the city centre, at bus stops and at the railway station (Troelsen., 2004). These interventions increased cycle use by 3%, 7.5% and 20% respectively in the long term.

One (3++) quality study reported the construction of sections of a National Cycle Route network with dedicated paths for pedestrians and cyclists. On three separate routes cycle use increases were reported of 43%, 50.1% and 29.7% in the long term using post-intervention data (Cope et al,. 2003). Two (3-) studies controlled space for motor vehicles combined with increased space for bicycles in developing cycle route networks. One of these interventions also divided the city centre into four sectors whose boundaries can only be crossed by pedestrians, buses and cyclists (CTC., 1995a). The other intervention developed a city wide cycle network of 220km based on the German model of a ‘Cycle Friendly Town’ (CTC., 1995b). These interventions increased cycle use by 20%, and 7% respectively in the long term.

From this evidence it is difficult to suggest how the content of the intervention may have influenced effectiveness. It does appear however that in most cases very comprehensive multi-faceted approaches were taken to establishing infrastructure for cycling.

7.3.3. How does the way that the intervention is carried out influence effectiveness?

All studies used physical changes to, or adjacent to, the highway infrastructure including some dedicated facilities to improve journey times and reallocation of road space from private motor vehicle. However the evidence does not suggest how the way the interventions were carried out may have influenced effectiveness.

7.3.4. Does the effectiveness depend on the job title/position of the deliverer?

There is insufficient evidence to make clear inferences about the impact of the job title/position of the deliverer of the intervention.

7.3.5. Does the site/setting of delivery of the intervention influence effectiveness?

Six of the studies were focused on a single city and its cycle network: Perth, Australia; Delft, The Netherlands; Padua, Italy; Odense, Denmark; Groningen, The Netherlands; Graz, Austria. One UK study provided data for three cycle infrastructure interventions, only one of which was located in a city, with the other two in rural areas (Cope et al., 2003). Both urban and rural studies reported increases in cycle use. **It appears that cycle infrastructure in both urban and rural areas can be effective in increasing cycling.**

7.3.6. Does the intensity (or length) of the intervention influence effectiveness/duration of effect?

There is insufficient evidence to make any firm conclusions about the intensity (or length) of the intervention influence.

7.3.7. How does the effectiveness vary with age, gender, class, ethnicity etc?

One (3++) quality study included data for children, adults and older adults as well as by gender for adults (Cope et al., 2003). The data from this study showed that usage varied between children, adults, older adults (aged 60+) and between men and women across the three routes. The largest percentage increases were found among older adults, including substantial increases among older women and children. This study also included data on ethnicity in so far as over 95% of users were reported as white. However, there is insufficient evidence to assess any differential effect of the intervention by socio-demographic or cultural factors.

7.3.8. What are the barriers to implementation?

The studies do not present clear findings on barriers to implementation. However, it seems reasonable to assume that in order for these interventions to be successful it will require political and public support. This may be particularly so for city-wide cycle networks where the objective is provide a network of cycle infrastructure across an urban area and where the costs are likely to be substantially greater than for linear or single routes. In addition, in dense urban settlements common to many UK towns and cities road space reallocation away from provision for private motor vehicles may be required in order to implement cycle infrastructure. Past UK experiences suggests that this will often be politically contentious.

7.3.9. What are the non-physical activity outcomes of the intervention?

Two studies reported outcomes other than changes in physical activity: Troelsen (2004) reports that increase in cycling in Odense was associated with a decline of 20 per cent in the number of cyclists killed or injured in accidents involving more than one party. Mamoli., (2003) reported that the intervention resulted in an increase in public transport use. **Cycle infrastructure interventions may**

result in important positive public health outcomes alongside increasing cycling, notably a reduction in cycle casualties.

7.4. Applicability (of evidence from efficacy studies) to UK population/setting.

One of the studies is from the UK (Cope et al 2003) and its evidence can be directly applied to other UK settings. Evidence from other studies is from the Netherlands (two studies), Australia, Austria, Italy, and Denmark. There may be important issues of infrastructure (such as the layout of existing cities) or culture (such as acceptability of cycling) that will need to be accounted for when applying this evidence to the UK. However it is of note that evidence from European countries is routinely applied by traffic engineers in the UK when constructing cycle infrastructure. **In summary it is likely that this evidence is applicable to the UK, with appropriate modification for existing infrastructure and cultural issues.**

7.5. Implementability of intervention.

It is likely that the six non-UK studies would be, to a greater or lesser extent, feasible to implement in UK towns and cities settings. Some adaptation may be necessary to reflect any local concerns about design and types of cycle infrastructure interventions implemented. Consideration may be needed to levels of political and public support particularly where road space reallocation is required. Promotion of the health benefits through increased opportunities for walking and cycling because of improved physical environments may also be important for future cycle infrastructure interventions.

Cycle infrastructure summary evidence statement

Evidence from one (2+), three (2-), one (3++), and two (3-) quality studies suggests that the introduction of cycle infrastructure can lead to long term increases in levels of cycling within the area of the scheme.

Cycle infrastructure interventions may result in important positive public health outcomes alongside increasing cycling, notably a reduction in cycle casualties.

It appears that cycle infrastructure in both urban and rural areas can be effective in increasing cycling.

It is likely that this evidence is applicable to the UK, with appropriate modification for existing infrastructure and cultural issues.

8. Safe routes to school: Summary of Findings

8.1. The studies

Safe routes to school interventions aim to increase walking and cycle use through the implementation of physical infrastructure measures, typically paths for walking and cycling, away from motor traffic.

Two studies, one from the UK and one from the US (1 uncontrolled before and after study; 1 intervention post-only study) form the basis of the evidence for the effectiveness of safe routes to school interventions in increasing walking and cycling.

It is important to note that there are other 'Safe Routes to School' studies in the literature but these do not typically include an environmental component, instead relying on measures such as travel plans or walking buses.

Sustrans, (2005) is a (2+) quality study conducted in the UK, that provided a new shared-use path in a grassed verge adjacent to a main road. This path added to an existing traffic-free route in the local area.

Boarnet et al., (2005) is a (3+) quality study in the US, that focused on installation or widening of bicycle lanes, crosswalks and side walks, improvement or installation of side walks and or curb ramps as part of ten traffic improvement projects.

8.2. Evidence of efficacy

The (2+) quality study measured outcomes in the short term for walking and cycling (Sustrans., 2005). This UK study found an overall increase of 191% in cycling (15,199 journeys pre to 44,235 post) and an 82% increase in walking (27,383 journeys pre 49,900 post) one year after the implementation of a new path adjacent to a main road and a traffic-free route, measured at two locations. Journeys to school increased by 230% but remain at a relatively modest level.

The (3+) quality study reported significant increases in both walking and cycling (Boarnet et al., 2005) between one and eighteen months after safe routes to school interventions. This US study reported a 15.4% increase in walking or cycling among children who passed safe routes to schools projects compared with 4% who did not pass safe routes to schools projects, based on parental responses.

There is evidence from one (2+) and one (3+) quality studies to suggest that introduction of safe routes to schools schemes can lead to short term increases in levels of walking and cycling within the area of the scheme.

8.3. Key Questions

8.3.1. What is the aim/objective of the intervention?

Both interventions aimed to increase walking and cycle use through the implementation of physical infrastructure. Both were part of programmes targeted particularly towards increasing walking and cycling among school children across a number of locations.

8.3.2. How does the content of the intervention influence effectiveness?

There is insufficient detail of the interventions to assess how the content might have influenced effectiveness.

8.3.3. How does the way that the intervention is carried out influence effectiveness?

There is insufficient detail of the interventions to assess how the method might have influenced effectiveness.

8.3.4. Does the effectiveness depend on the job title/position of the deliverer?

There is insufficient evidence to assess the impact of the job title/position of the deliverer of the intervention.

8.3.5. Does the site/setting of delivery of the intervention influence effectiveness?

There is insufficient evidence to make any firm conclusions about the setting of the delivery of the intervention**.**

8.3.6. Does the intensity (or length) of the intervention influence effectiveness/duration of effect?

The intensity of the interventions varied between the two studies. The implementation of a shared-use path (Sustrans., 2005) contrasts with the implementation of a range of highway improvements for pedestrians and cyclists across ten interventions (Boarnet et al., 2005). There is insufficient evidence to make any firm conclusions about the intensity (or length) of the intervention influence.

8.3.7. How does the effectiveness vary with age, gender, class, ethnicity etc?

One study included data for children, adults and older adults as well as by gender for adults and older adults (Sustrans., 2005). The data in this study showed that use of the safe routes to school route was considerably greater among adults than among children. (comparing autumn 2004 with summer 2005). The largest number of users were men and older men (aged 60+). The other study included data for children only (Boarnet et al., 2005). There is therefore insufficient evidence to assess any differential effect of the intervention by socio-demographic or cultural factors.

8.3.8. What are the barriers to implementation?

The papers do not present data on barriers to implementation. However it is reasonable to assume that in order for these interventions to be successful it will require political and public support, from schools, parents and local authorities.

8.3.9. What are the non physical activity outcomes of the intervention?

Neither of the studies reported any other outcomes from these interventions.

8.4. Applicability (of evidence from efficacy studies) to UK population/setting.

The evidence from the UK study (Sustrans 2005) is directly applicable to the UK. The evidence from the US study (Boarnet et al 2005) may be applicable to the UK provided that account is taken of different approaches to school travel planning and culture of car use. **In summary this evidence may be applicable to the UK with some caution.**

8.5. Implementability of intervention.

It is likely that both studies would be feasible to implement in UK towns and cities settings. Some adaptation may be necessary to reflect any local concerns about design and types of safe routes to schools interventions implemented. Consideration may be needed to levels of political and public support. Promotion of the health benefits through increased opportunities for walking and cycling among children because of improved physical environments may also be important for future safe routes to schools schemes.

Safe routes to school summary evidence statement

There is evidence from one (2+) and one (3+) quality studies to suggest that introduction of safe routes to schools schemes can lead to short term increases in levels of walking and cycling within the area of the scheme.

This evidence may be applicable to the UK with some caution.

Evidence tables – traffic calming

Author and date	Study design and research type/quality	Research question	Study Population: setting; country; sample size	Description of intervention	Length of follow up	Physical activity outcome variables (inc measures)	Short term findings (<1 year)	Long term findings (> 1year)	Confounders/ potential sources of bias	Applicability to the UK
Morrison (2004)	before and after 2(++)	To assess impact of traffic calming scheme over and casualty reduction	Deprived outer urban housing estate residents. n=185	Traffic calming of a deprived outer urban housing estate using speed cushions, two zebra crossings with adjacent railings, and creation of parking bays	Surveys undertaken six months before and after implementation of traffic calming scheme	Pedestrian counts; self assessed pa; assessments of children's play, walking/cycling (survey)	20% adults said walked more as a result; corroborated by the pedestrian count which recorded 'substantial increases at most sites and in most age groups'). 11.8% of children reported to play out more, 12.5% reported to walk more, 11.6% reported to be allowed to cycle more.	N/A	Possible selection bias - Self report data on physical activity increase supported by pedestrian counts	Yes
Babtie (2001)	before and after 2 (+)	Evaluate various effects of self-enforcing 20 mph zones	Residents and road users. n not stated	20mph speed limit zones with road narrowings, pavement 'build outs', road humps and cushions, and mini-roundabouts	Before intervention, then 3 and 12 month follow-ups	Site observations; manual counts; assessment of level of children's play (survey)	No significant changes in levels of walking or cycling or changes in numbers of children playing in the street environment	N/A	Possible selection and recall bias	Yes

Kirby (2001)	before and after 2(-)	To review impact of the introduction of self-enforcing 20mph zones in Hull	Residents and road users in 85 schemes. n = 546	20 mph speed limit zones with road humps, cushions, and priority working.	CT	Self assessment of walking, cycling, children's play	Over 25% of residents said that they walked or cycled more since the scheme was introduced. 60% of respondents felt that more children played in the street. 'Little evidence for increased walking and cycling'.	N/A	Poorly reported methods - possible selection, recall and measurement bias and confounding	Yes
SRA (19999)	before and after 2(-)	To assess walking and attitudes to walking following by pass demo project	Residents and road users in six towns following bypasses and traffic calming. n=1446	Bypass construction and associated traffic calming	Varied from 9 to 27 months between towns	Counts of pedestrians and cyclists.	N/A	Slight declines in walking and cycling post intervention to the town centre	Poorly reported methods - possible measurement, and recall bias, no data presented on possible confounders	Yes
Webster (2006)	before and after 2(-)	Evaluate the effect of home Zones	Residents in 7 locations in England and Wales. Mean n 74 (in each location)	Changes to the street though gateway entrances, 20 mph zones, echelon parking, use of road humps and chicanes, shared surfaces, tree and shrub planting	4 years	Self assessment of walking, cycling, children's play	N/A	Little evidence for increased walking or cycling. Slight increase in the time spent playing outside the home (and adult activities such as chatting, gardening, and watching children.)	Poorly reported methods	Yes
SRA (2001)	before and after 2(-)	To assess the impact of the Safer City Project at the end of the 5 and final year through an annual survey	Residents and road users in Gloucester n=552	Traffic calming measures, and associated traffic management measures. Specific types of traffic calming measures not reported.	5 years	Self assessed walking and cycling	N/A	Adults walking reported to have declined between 1996 and 2000 for all travel purposes (although the level of decline was not quantified, and it	Poorly reported methods - possible measurement, and recall bias, no data presented on possible confounders	Yes

		of attitudes and perceptions						was noted that some people in traffic calmed areas are walking more). Cycle use declined for all travel purposes except for food shopping, going to the pub, and visiting friends (each remained at 1% of modal share).		
DETR (1999)	case study 3(+)	To assess attitudes to pedestrian security in Highfields, Leicester, after various traffic and non-traffic related interventions.	Residents of deprived inner urban area of Leicester with large Asian community (Highfields) n approx 200	blitz on prostitution', improved lighting, traffic calming; safe routes to destinations including schools.	one-off survey	Self-assessed walking and cycling	Reported increase in physical activity through children visiting local shops and parks.	N/A	No data presented on possible confounders - study used a retrospective measure of self-assessed physical activity	Yes
Scottish Office (1999)	intervention with post-only data 3(-)	To assess the community impact of traffic calming schemes	Residents in ten traffic calming scheme across Scotland. n=1750	Community traffic calming	Minimum of 6 months to follow up and no more than two years maximum. Before data gathering not stated	self-assessed walking and cycling	In three of the residential interventions there had been some increases in walking and cycling reported. For those who increased their walking and cycling after the interventions (ranged between 15-34% for walking and 7-18% for cycling) there may have been an increase in fitness, health and wellbeing but self-reported.		Possible selection and measurement bias and no adjustment by level of intervention	Yes

Evidence tables – multi use trails

Author and date	Study design and research type/quality	Research question	Study Population: setting; country; sample size	Description of intervention	Length of follow up	Physical activity outcome variables (inc measures)	Short term findings (<1 year)	Long term findings (> 1year)	Confounders/ potential sources of bias	Applicability to the UK
Evenson (2005)	controlled before and after 2(++)	Measure any change in physical activity occurring among adults that might be attributable to the construction of a multi-use trail.	Adults living in the local area – 11 census block groups, Durham North California USA. n=436	Construction of a multi-use trail.	Time between surveys ranged from 1 year and 7 months to 2 years and 4 months	Self-reported pa and trail use.	N/A	Walking for transportation did not significantly change. Participants who used the trail were less likely to increase their walking by >30 or 45 minutes per week from baseline. Participants who used the trail were also more likely to decrease the bicycling time from baseline, (although the estimates were somewhat imprecise due to the low prevalence of bicycling.)	Possible selection bias	Not directly
Merom (2003)	before and after 2(++)	To evaluate the impact of a local promotional campaign around a newly constructed	Residents and wider population living near a trail in sydney australia. n=450	Local promotional campaign around a newly constructed Rail Trail in western Sydney.	One follow-up 4 months after intervention	Observed trail use. Cycling and walking time.	Mean daily bike count in the monitored areas increased significantly after the trail launch. A significant increase in trail usage from	N/A	Possible selection bias	Not directly

		Rail Trail in western Sydney.					1.6% (of those aware of the trail) to 5.6% at follow-up was detected. Mean cycling time increased among those living <1.5km from the trail (but decreased among those living >1.5km).			
Sustrans (2006a) Stedfastgate	before and after 2(+)	To assess the impact of both signing and production of a leaflet on the use of a section of the National Cycle Network	Residents and all travelling in the area of Leith and N Edingburgh. n=2684	Signing and production of a leaflet on the use of a section of the National Cycle Network	7 months	counts of pedestrians and cyclists. Self assessed walking/cycling behaviour	Increase in walking and cycling among adults and increase in cycling among children. Decline in child pedestrians. 53.1% of cyclists in after survey compared to 10% in before survey reported that they were cycling more than they were one year previously. 37.6% of pedestrians in after survey compared to 5.6% in before survey reported that they were walking more than they were one year previously. The proportion of users who are starting to cycle again increased	N/A	Possible selection bias and no data presented on pssible confounders	Yes

							from 7.7% to 16.3%. Supported by manual count data			
Sustrans (2005) Ford Green	before and after 2(+)	Evaluate the impact of a series of ongoing route improvements aiming to increase levels of cycling and walking activity in Stoke.	Local residents and wider Stoke community. Over 38,000 observations	Route developments	3 years between before and after surveys	counts of pedestrians and cyclists.	N/A	Increase in user numbers especially pedestrians (83%); 17,499 more users are using the route in 2005 than in 2002, from 21,086 pedestrians in 2002, to 38,585 in 2005. There is a 112% increase in the number of cyclists accessing the route, with 4,112 extra cyclists using the route in 2005; a estimated 3,675 cyclists were accessing the route in 2002, increasing to 7,787 in 2005	Possible selection bias and no data presented on pssible confounders	Yes

Evidence tables – closing or restricting use of roads

Author and date	Study design and research type/quality	Research question	Study Population: setting; country; sample size	Description of intervention	Length of follow up	Physical activity outcome variables (inc measures)	Short term findings (<1 year)	Long term findings (> 1year)	Confounders/ potential sources of bias	Applicability to the UK
Gemzoe (2001)	before and after 2(-)	To chart the increasing use of public space by pedestrians in Copenhagen which have been recorded in a series of surveys of the inner city since the 1960s.	General population of Copenhagen, Denmark. n not stated	Increasing the use of public space by pedestrians in Copenhagen	Series of pedestrian counts undertaken between 1968 and 1995	pedestrian counts	N/A	Increases in pedestrian activity between 1968 and 1995 three to four fold. Number of people walking through the streets fairly constant after initial doubling when the first street was opened (ie closed to vehicles) in 1962.	Poorly reported methods - possible measurement, and recall bias, no data presented on possible confounders	Yes with adaption
Cairns (1998a) Luneburg	before and after 2(-)	To assess the effects of an environmentally friendly transport policy in Luneburg, Germany.	Residents and road users of Luneburg, Germany. n not stated	Environmentally friendly transport policy in Luneburg Germany	Baseline 1991; Intervention May 1993; follow-up May 1994	pedestrian/cyclist counts	Changes in traffic flows on ring road and major roads included a 58.7% increase for cyclists and a 48.3% for pedestrians between 1991 and 1994	N/A	Poorly reported methods	Yes with adaption
Cairns (1998b) Orpington	before and after 2(-)	To assess the impact of a road closure (with exemptions) of a section or Orpington High Street.	Local residents, shoppers, through traffic in Orpington, Kent. n not stated	Closing a road (with exemptions) to motor traffic in Orpington High Street, England.	one year	pedestrian counts	Average increase of 19% in pedestrian flows measured at a central point on Orpington High Street	N/A	Poorly reported methods	Yes

Evidence tables – road user charging

Author and date	Study design and research type/quality	Research question	Study Population: setting; country; sample size	Description of intervention	Length of follow up	Physical activity outcome variables (inc measures)	Short term findings (<1 year)	Long term findings (> 1year)	Confounders/ potential sources of bias	Applicability to the UK
Durham (undated)	before and after 2(++)	To reduce the volume of motor traffic accessing Peninsula area of Durham in order to improve pedestrian safety, improve access for the disabled, enhance the World Heritage Site whilst preserving the viability of the Peninsula as a working part of the City Centre.	Residents and visitors of Durham n not stated	Road User Charging within the Peninsula area of the city of Durham	12 months	pedestrian counts. Survey data of attitudes.	Overall increase in pedestrian activity of 10% following introduction of the road user charge. Plus a 10% increase since 2001 of users who felt that Durham was now a safer place for pedestrians	N/A	No data presented on possible confounders - Pedestrian and vehicle counts	Yes
TfL (2006)	before and after 2(-)	To review impact of congestion charge on modal split	Residents and road users of Central London n not stated	Congestion charge in central London	annual surveys	cycle counts. Distance cycled measure not stated	distance cycled increased from 4% of total distance travelled to 6% in first year (approx 70,000km to 90,000km)	distance cycled increased to 7% of total distance travelled in 2005 (approx 100,000km) representing an increase of 30%	Poorly decribed methods - other factors may have influenced travel including citywide cycle infrastructure and london	Yes

								over baseline in 2002	bombings.	

Evidence tables – cycle infrastructure

Author and date	Study design and research type/quality	Research question	Study Population: setting; country; sample size	Description of intervention	Length of follow up	Physical activity outcome variables (inc measures)	Short term findings (<1 year)	Long term findings (> 1year)	Confounders/ potential sources of bias	Applicability to the UK
Ashton-Graham (2003)	before and after 2(+)	Measure the impact of cycle route network across the city	Residents and road users in Perth, Western Australia. n not stated	A combination of infrastructure, service provision, promotion and travel behaviour change tool in Perth	5 years	cycle counts	N/A	20% increase in cycle use between 1996 and 2001 at Central Business District, 13% increase in cycling across the Local Bicycle Route corridors between 1998 and 2001	Possible confounders not described and behavioural intervention was also part of intervention	Yes with adapt on
Troelsen (2004)	controlled before and after 2(-)	To increase bicycle use in Odense by 20% by the end of 2002 from 1999 baseline	Residents of Odense, Denmark. n not stated	Coordinated approach across Odense (Denmark) to increase bicycle use in the city	3 years	cycle counts	N/A	20% increase in cycle use by end of 2002 from 1999 calculated to be 35 million new cycling journeys during the 4 years.	Poorly described methods	Yes with adapt on
Hartman (1990)	controlled before and after 2(-)	To report the development of the cycle route network in Delft and its impact on cycle usage	Residents and road users in Delft, The Netherlands. n not stated	The development of the cycle route network in Delft (Netherlands)	Before and after study – 1982 and 1983 for before and 1985 and 1986 for after studies	walk and cycle counts	N/A	Cycle use increased from 40% to 43% across Delft after the cycle route measures were implemented. However, walking journeys are likely to have declined.	Poorly described methods	Yes with adapt on
Mamoli (2003)	before and after 2(-)	To report progress in the promotion of	Residents and road users, Padua, Italy. n	The promotion of cycling in Padua (Italy)	9 years	walk and cycle counts	N/A	Cycling increased from 10.5% to 18% of all trips between	Poorly described methods	Yes with adapt

		cycling in Padua, Italy	not stated					1991 and 2000, walking decreased from 32% to 18% (n favour of public transport).		on
Cope (2003)	intervention, post-only data 3(++)	Examine the implications of the UK National Cyle Network for health, social inclusion, economic opportunities through tourism and recreation, and the nature of cyclists and cycling,	All potential users of the NCN. Observations taken across 22 routes	Data from the National Cycle Network route usage monitoring project in UK	1998-2001	cycle and walk counts	N/A	43% increase in users at Elswick Riverside, 50.1% at Tarka Trial, Fremington, and 29.7% at Rishton	Possible selection and recall bias	Yes
CTC (1995) Groningen	case study 3(-)	Review of Groningen cycle network development and broader transport policies, and impact on cycle usage.	Residents and road users, Groningen, The Netherlands. n not stated	Groningen (Netherlands) cycle network development and broader transport policies	7 years	cycle use; modal share	N/A	20% increase in cycle use in 7 years. 57% of modal share	Poorly decribed methods	Yes with adapt on
CTC (1995) Graz	case study 3(-)	Review of Graz cycle network development, as part of broader transport strategy, and	Residents and road users of Graz, Austria. n not stated	Cycle network development in Graz (Austria)	12 years	walk and cycle counts	N/A	Cycle use reported to have increased from 7% in 1979 to 14% in 1991. Slight decrease in walking.	Poorly described methods	Yes with adapt on

		impact on cycle usage.								

Evidence tables – safe routes to school

Author and date	Study design and research type/quality	Research question	Study Population: setting; country; sample size	Description of intervention	Length of follow up	Physical activity outcome variables (inc measures)	Short term findings (<1 year)	Long term findings (> 1year)	Confounders/ potential sources of bias	Applicability to the UK
Sustrans (2006) TradeMills	before and after 2(+)	To assess the impact of new shared use path	Residents of Newhaven including school children and travelling public. n=479	New path	1 year	modal share	overall increase of 191% in cycling (15,199 pre 44,235 post) and an 82% increase in walking (27,383 pre 49,900 post) (across all routes)	N/A	Possible selection bias and possible confounders not described	Yes
Boarnet (2005)	intervention post only 3(+)	Evaluation examined the relationship between urban form changes and walking and bicycle travel to school.	People living in the vicinity of schools in california. n=1244	Multiple safe routes interventions	Survey administered between 1 and 18 months after the completion of the SRS project	modal share on journey to school	Proportion of pupils who walked or bicycled more after SRS project construction was significantly greater among children passing SRS projects along their usual route		Possible selection and recall bias	Not directly

Appendix A – Included studies

Ashton-Graham C. (2003) Network promotion: increasing bicycle use in Perth, Western Australia. In Tolley R. (ed) Sustainable transport. Planning for walking and cycling in urban environments. Cambridge: Woodhead Publishing.

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Appendix B – Excluded Studies

	Study Reference	Reason for exclusion
1	Brownson RC, Housemann RA, Brown DR, Jackson-Thompson J, King AC, Malone BR, Sallis JF. (2000) Promoting physical activity in rural communities, Am J. Prev Med.,18(3):235-241	Leisure focused
2	CTC (1995) More Bikes – Policy into Best Practice, Godalming: CTC. (Delft case study)	Limited data and reported in Hartman (1990)
3	Department for Transport (2004) Encouraging walking and cycling: Success stories, London: Department for Transport.	Insufficient data
4	Fietsberaad (2006) Continuous and integral: The cycling policies of Groningen and other European cycling cities. Publication No. 7. Rotterdam: Fietsbaraad.	Insufficient data
5	Gill T. (2006) Home Zones in the UK: History, Policy and Impact on Children and Youth, Children, Youth and Environments, 16(1):90-103.	Insufficient data
6	Gordon P. (2004) Use of a Community Trail among New and Habitual Exercisers: A Preliminary Assessment, Preventing Chronic Disease, 1(4):1-11	Non-transport focused
7	Morrison DS, Petticrew M, Thomson H. (2003) What are the most effective ways of improving population health through transport interventions? Evidence from systematic reviews. J. Epidemiol. Community Health, 57:327-333	Physical activity outcomes not included
8	Planerburo Sudstadt/Planungssgemeinschaft Verkehr (2001) Bike-Friendly Cities and Towns in NRW – Programme and Impact Analysis – Summary. Düsseldorf.	Insufficient data
9	Reed JA, Wilson DK, (2006) Awareness and use of a university recreational trail, J. Am. College Health, 54(4):227-230	Recreational physical activity outcome
10	Rietveld P. Daniel V. (2004) Determinants of bicycle use: do municipal policies matter? Transportation Research Part A, 38:531-550	Physical activity not included as determinant

11	Owen N, Humpel N, Leslie E, Bauman A, Sallis JF. (2004) Understanding environmental influences on walking; Review and research agenda, Am. J. Prev Med., 27(1):67-76	Review of physical activity and environmental attributes
12	Sælensminde K, (2004) Cost-benefit analyses of walking and cycling track networks taking into account insecurity, health effects and external costs of motorized traffic, Transportation Research Record Part A 38:593-606	Predicted economic savings from hypothetical increases in walking and cycling
13	Staunton CE, Hubsmith D, Kallins W. (2003) Promoting safe walking and biking to school: The Marin County success story, Am. J. Public Health, 93(9):1431-1434	Environmental modifications planned but not implemented
14	Sustrans (2005) Monitoring Report 2005. Case Study: Space Centre, Leicester Riverside. Sustrans.	No environmental modifications
15	Wang G, Macera CA, Scudder-Soucie B, Schmid T, Pratt M, Buchner D, Heath G. (2004) Cost analysis of the build environment: The case of bike and pedestrian trails in Lincoln, Neb, Am J. Public Health, 94(4):549-553	Not an intervention study
16	Wang G, Macera CA, Scudder-Soucie B, Schmid T, Pratt M, Buchner D. (2004) Cost effectiveness of a bicycle/pedestrian trail development in health promotion, Preventive Medicine, 38:237-242	Not an intervention study
17	Boarnet M G, Day K, Anderson C, McMillan T, Alfonzo M. (2005). California Safe Routes to School Program. Impacts on Walking, Bicycling and Pedestrian Safety. Journal of the American Planning Association 71; 3 (2005).	Included in Boarnet (2005)

Appendix C – Example search strategy

OVID Medline

Transport terms

1. automobile$1.tw.
2. autos.tw.
3. (car or cars).tw.
4. commut$3.tw.
5. driver$1.tw.
6. congestion.tw.
7. (mechanised transport$ or mechanized transport$ or motor$4 transport$ or personal transport$).tw.
8. (public transport$ or private transport$ or community transport$ or affordable transport$ or rural transport$ or sustainable transport$ or green transport$).tw.
9. (motoring or motorist$1).tw.
10. motor vehicle$.tw.
11. motorcycle$.tw.
12. motorbike$.tw.
13. road us$3.tw.
14. traffic.tw.
15. vehic$4.tw.

16. railtrail$.tw.
17. railway$.tw.
18. railroad$.tw.
19. (bus or buses).tw.
20. tram.tw.
21. streetcar.tw.
22. subway.tw.
23. underground.tw.
24. non-auto.tw.
25. non-motor$4.tw.
26. travel$4.tw.
27. pedestrian$.tw.
28. trail$1.tw.
29. (speed hump$1 or speed bump$1).tw.
30. (path$1 or footpath$).tw.
31. Transportation/
32. exp Motor Vehicles/
33. exp Railroads/
34. Automobile Driving/
35. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34

Physical activity terms

1. (physical adj5 (fit$4 or train$3 or activ$3 or endur$4)).tw.
2. (exercis$3 adj5 (fit$4 or train$3 or activ$3 or endur$4)).tw.
3. (leisure adj5 (centre$1 or center$1 or facilit$)).tw.
4. (fitness adj5 (centre$1 or center$1 or facilit$)).tw.
5. ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$) adj5 gym$).tw.
6. ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$) adj5 physical activit$).tw.
7. ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$) adj5 (circuits or aqua$)).tw.
8. ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$) adj5 exercis$).tw.
9. ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$) adj5 (keep fit or fitness class$ or yoga)).tw.
10. ((decreas$ or reduc$ or discourag$) adj5 (sedentary or deskbound)).tw.
11. sport$3.tw.
12. walk$3.tw.
13. running.tw.
14. jogging.tw.
15. bicycl$3.tw.
16. (bike$1 or biking).tw.
17. (swim$1 or swimming).tw.
18. (exercis$3 adj5 aerobic$1).tw.
19. rollerblading.tw.

20. rollerskating.tw.
21. skating.tw.
22. exertion$1.tw.
23. travel mode$1.tw.
24. trip$1.tw.
25. active travel$1.tw.
26. active transportation.tw.
27. multimodal transportation.tw.
28. recreation$1.tw.
29. stair$.tw.
30. exp Exertion/
31. Physical Fitness/
32. exp "Physical Education and Training"/
33. exp Dancing/
34. exp Sports/
35. exp Yoga/
36. pilates.tw.
37. Exercise Therapy/
38. exp Fitness Centers/
39. Recreation/
40. "Play and Playthings"/

41. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40

Combine 35 (transport) AND 41 (physical activity) to get final result.

Appendix D: Glossary

CBA	controlled before and after
CPHE	Centre for Public Health Excellence
DfT	Department for Transport
DH	Department of Health
CC	Collaborating Centre
NHS	National Health Service
NICE	The National Institute for Health and Clinical Excellence
NSF	national service frameworks
PDF	portable document format
PHCC	Public Health Collaborating Centre
PDG	Programme Development Group
QALY	Quality-adjusted life year
RCT	randomised controlled trial

Home zones	Residential areas in which road space is shared between drivers of motor vehicles and other road users, with the wider needs of residents (including people who walk and cycle, and children) in mind.
National Cycle Network	A network of over 10,000 km of walking and cycling routes across the UK coordinated by Sustrans
Traffic calming	An approach to constraining vehicle speeds, notably by self-enforcing traffic engineering measures, such as speed bumps
Priority working	Gives vehicles from one direction priority.
Echelon parking	Vehicles being parked at up to approximately 45 degrees to the pavement.
Speed tables	Elevated sections of carriageway often used at junctions
Road network capacity reduction	Reducing highway space available to all or some motorised modes of transport
Round top humps	Speed bumps with a rounded (instead of flat) top
Speed cushions	Speed bumps that do not comprise the full width of the carriageway
Multi-use trails	Routes open to cyclists and pedestrians, but closed to motor traffic.
Road user charging	Charging motor vehicle users to drive on particular roads at particular times

Cycle infrastructure	Physical measures to support cycling, such as cycle lanes; paths; advanced stop lines at traffic signals; signage.
Safe routes to school	Aim to increase walking and cycle use through the implementation of physical infrastructure measures, typically paths for walking and cycling, away from motor traffic.

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