# Cycling infrastructure for reducing cycling injuries in cyclists

## Protocol information

**Review number: INJ0156**

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## Abstract

### Background

### Objectives

### Search methods

### Selection criteria

### Data collection and analysis

### Main results

### Authors' conclusions

## Plain language summary

**[Summary title]**

[Summary text]

## Background

## Description of the condition

Physical activity has many benefits for health including a reduced risk of cardiovascular disease (Schnohr 2006; Oja 2011), cancer (Inoue 2008; Schnohr 2006), type 2 diabetes (Hu 1999) and other causes of mortality (Andersen 2000; Matthews 2007; Savela 2010). A lack of physical activity is a dominant factor in the rise in obesity levels (Prentice 1995); yet data from England suggests that fewer than half of all adults and less than a third of children meet the recommended guidelines of physical activity levels (DH 2011). Inequalities exist in terms of the amount of physical activity undertaken, resulting in inequity in the consequent health benefits attained. For both sexes, participation in exercise decreases with increasing age, with women and girls being less likely to be active than men and boys (DH 2011). People from ethnic minorities and low income families are less likely to take part in exercise than other ethnic and socioeconomic groups (NHS 2006).

Previous and current UK governments have stated their commitment to increasing the nation's physical activity levels, and thus its health, evidenced by the number of published consultation documents and action plans over the last decade (for example, "Choosing activity: a physical activity action plan" (DH 2005); "Be active, be healthy" (DH 2009); "Healthy weight. Healthy lives" (DH 2008); and "Start Active, Stay Active" (DH 2011)). This commitment is no doubt fuelled by the estimated annual costs to the National Health System (NHS) for treating obesity-related diseases, which are expected to rise to £10 billion by 2050, while the costs to the wider society are expected to rise to £49.9 billion per year (McCormack 2007). The economic benefit of decreased morbidity and mortality from a 1% unit reduction in the percentage of sedentary people in the UK is estimated at £1.44 billion (mean of £2423 per additional active person per year) (CJC 2005).

Cycling is a physical activity that confers multiple benefits. It is a readily accessible form of physical activity that can fit more readily into an individual's daily routine than other activities (Hillsdon 1996; Cavill 2008). It has additional wider public health benefits gained as a result of fewer car journeys in terms of reducing emissions (Lindsay 2011) and improving the local environment through reduced congestion and community severance (McClintock 2002). Cycling also offers a cheaper form of transport for those who are socially disadvantaged and who are less likely to have access to a car than the socially advantaged. Thus, the benefits from increased cycling rates are clearly wide ranging.

The physical environment is known to play a key role in impacting physical activity such as cycling (NICE 2008; Fraser 2010 ). A barrier to increased cycling rates is the fear of injury (TfL 2008; Rivara 2011). Cyclists are vulnerable road users who are frequently in close proximity to larger and faster motorized vehicles which offer the occupants some protection if an accident occurs, unlike the cyclist. Cyclists report fear of injury from lack of segregated cycling routes, the volume and speed of traffic and driver behaviour (TfL 2008). In 2008, in England there were 115 pedal cyclist fatalities and 2450 reported seriously injured casualties (DfT 2010). There are many more cycle related injuries that are not reported to the police and thus do not appear on the police databases but which nevertheless require medical attention (Cross 1977; Amoros 2011). Indeed, it is estimated that two thirds of cycle-motor collisions are unreported to the police (Cross 1977; Amoros 2011) and half of these result in injury (Cross 1977). Inequalities exist in cyclist injuries with a risk of cyclist injury being 20% to 30% higher in lower socioeconomic groups than higher socioeconomic groups (Hasselberg 2001; Engström 2002). In 2008, cyclist casualty rates were around 29 per 100,000 in the most deprived 10% of areas of England compared to 20 per 100,000 in the least deprived (DfT 2010). Thus to maximise the public health benefits of increased cycling rates it is necessary to minimize the risk of cycling injuries and people's fear of cycling.

## Description of the intervention

One key approach to reducing the fear and risk of injury for vulnerable road users such as cyclists is through engineering and, in particular, through transport infrastructure. Transport infrastructure refers to those physical measures within the built environment which are in place to enable traffic to flow safely and thus allow society to function fully. Transportation infrastructure generally develops over time and is frequently designed with the needs of the motorized vehicle user being of most importance (WHO 2004). Within this, infrastructure specific to cycling includes measures to manage cycle traffic and motorized traffic, to varying degrees, in mixed traffic conditions. It generally takes one of three main forms. Firstly, there is cycling infrastructure that manages the road space for shared use by both motor vehicles and cyclists and includes cycle lanes. Secondly, there is cycling infrastructure which separates cycle traffic from motorized traffic. This may include special routes for use exclusively by cyclists but which may also be shared with pedestrians. Thirdly, management of the traffic network represents a third form of cycling infrastructure and includes traffic regulations that ban certain types of traffic from making particular turns and speed management.

## How the intervention might work

The role of infrastructure in reducing the fear of cycling is evidenced by research that has found that changes in infrastructure can positively influence cycling rates (Garrard 2008; Winters 2010; Yang 2010) with cyclists choosing to use routes serviced by bicycle facilities. In terms of injury prevention, research also indicates that infrastructure is effective at reducing injuries ( Rodgers 1997; Moritz 1998; Lusk 2011). Reducing the risk of cycling injury may also reduce the social inequalities seen in cycle injuries. As an injury prevention strategy, cycling infrastructure is particularly potent for several reasons. Firstly, it is population based and thus can reach large numbers of the population, secondly its passive mode requires no actions from individuals and thirdly, changes are made only once, thus requiring no reinforcement (Reynolds 2009).

## Why it is important to do this review

There has been one previous review of cycling infrastructure and its impact on cycling crashes and injuries. This review identified a number of features that alter the risk of a crash and injury (Reynolds 2009), with on-road 'clearly-marked, bike-specific facilities' providing greater protection to cyclists than on-road cycling with traffic or off-road cycling with pedestrians. The promotion of cycling and walking is highly topical with recently published reports on schemes to promote cycling in the UK (TfL 2008; Sloman 2009). With much on-going research in this area new results are frequently being published. There is

no Cochrane review of this topic as previous cycling-related Cochrane reviews have focused on the use of cycle helmets ( Thompson 1999; Macpherson 2008) and cyclist visibility (Kwan 2006) to reduce cyclist injuries. The current review of measures to promote cycling and walking by NICE will not assess infrastructure (NICE 2011). There is, therefore, an urgent public health need for a Cochrane review to assess the effectiveness of cycling infrastructure on cycling injuries and to identify those structures which are most effective at reducing injuries.

# Objectives

The objectives of this review are to:

1. evaluate the effects of different types of cycling infrastructure on reducing cycling injuries in cyclists, by type of infrastructure;

2. evaluate the effects of cycling infrastructure on reducing the severity of cycling injuries in cyclists;

3. evaluate the effects of cycling infrastructure on reducing cycling injuries in cyclists with respect to age, sex and social group.

# Methods

## Criteria for considering studies for this review

### *Types of studies*

We will include randomised controlled trials (RCTs), cluster randomised controlled trials, controlled before-and-after studies and non-randomised controlled trials.

### *Types of participants*

We will include studies which invole adult or child cyclists, or both.

### *Types of interventions*

Cycling infrastructure generally takes one of three main forms.

1. Firstly, there is cycling infrastructure that aims to manage the shared use of the road space for both motor vehicles and cyclists, and includes:

i) cycle lanes - these are part of the road and are indicated, often by a white line and a bicycle icon painted on the lane, and appropriate signage. These are to be used exclusively by cyclists. This includes contraflow cycle lanes where two-way cycling is allowed on a street that allows motorized traffic to travel only one way. Cycle lanes may be advisory or mandatory. If the latter, motor traffic is excluded by regulation;

ii) shared use of a bus lane - these are similarly defined by appropriate markings and signage;

iii) advanced stop lines - these are marked as a box at a junction and, extending across the width of the road, they allow cyclists to wait in front of the queuing traffic while the signal is red and to leave the intersection ahead of the motorized traffic when the signal turns green;

iv) bicycle routes - cyclists share the road with motorized vehicles but the route is signed as a preferred route and may avoid particular busy roads;

v) any of the above where the lanes and stop lines have been painted in colour to make them more noticeable to other road users.

2. Secondly, there is cycling infrastructure which separates cycle traffic from motorized traffic and may include special routes exclusively for cycle traffic, but which may be shared with pedestrians either in mixed or segregated conditions. These include:

i) cycle tracks - these lie alongside a road but cyclists are separated from motorized vehicles perhaps by a kerb or other physical barrier such as bollards. They may be one-way or, more frequently, two-way;

ii) cycle paths - these are paths which are separate from the road and significantly they may be marked to segregate cycle traffic from pedestrian traffic, or they may be shared with pedestrians.

3. Thirdly, management of the network represents a third form of cycling infrastructure. This includes:

i) separation of traffic movements - through direction signage differentiated by vehicle type, or through regulatory means for example, traffic regulations that ban certain types of traffic from making particular turns;

ii) bicycle phases at traffic signals - these operate at a junction and allow cyclists to cross an intersection at a separate time from motorized vehicles;

iii) speed management - achieved either by physical measures, such as the use of narrowed roads or speed bumps, or by the imposition of speed limits including widespread 20 mph zones.

Examples of cycling infrastructure may be placed on continuous roads or at intersections. In some situations there will be more than one infrastructure feature in place. The effect of individual features will be determined where possible.

Comparisons will either be:

a) routes or intersections used by cyclists that do not have cycling infrastructure in place and thus comparisons may be made

of a site either before and after the infrastructure was put in place or between two or more different sites some of which have the infrastructure in place and some which do not; or

b) routes or intersections which have different types of infrastructure in place.

### *Types of outcome measures*

#### Primary outcomes

Studies for inclusion must include a measure of cycling injuries sustained as a result of cycling. This will be:

- self-reported injuries;
- medically attended injuries.

We will include injuries sustained as a result of maintenance issues of infrastructure, such as uneven surfaces. We will not include studies that report only injuries sustained while racing, mountain biking or playing.

#### Secondary outcomes

Secondary outcomes will be:

- crash rates for cyclists, expressed as crashes per million bike-km;
- cycling rates, as cycling infrastructure may increase cycling rates thus benefiting the wider public health while having no impact on injury rates.

## Search methods for identification of studies

Search strategies will be developed iteratively. Results from the search will be assessed to determine whether the strategy is identifying relevant papers and adjusted as required.

### *Electronic searches*

The Injuries Group Trials Search Co-ordinator will search the following:

1. Cochrane Injuries Group Specialised Register (latest update);
2. Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library*, latest Issue);
3. MEDLINE (OvidSP) (1946 to present);
4. PubMed (www.ncbi.nlm.nih.gov/sites/entrez/) (most recent three months);
5. EMBASE Classic + EMBASE (OvidSP) (1947 to present);
6. ISI Web of Science: Science Citation Index Expanded (SCI-EXPANDED) (1970 to present);
7. ISI Web of Science: Conference Proceedings Citation Index-Science (CPCI-S) (1990 to present).

The review authors will search the following:

1. OpenSIGLE (system for Information on grey literature in Europe) (http://opensigle.inist.fr/);
2. TRANSPORT (OvidSP) (includes databases from: Transportation Research Information Services (TRIS), International Transport Research Documentation (ITRD), TRANSDOC) (1988 to present);
3. GEOBASE (1980 to present);
4. Index to Theses (1970 to present);
5. SafetyLit (1800 to present);
6. TRANweb (1976 to present);
7. Transport Research International Documentation (TRID) (1923 to present);
8. Transport Research Laboratory database (1966 to present).

The search strategy in Appendix 1, which was formulated in MEDLINE, will be adapted as necessary for use in each of the other databases.

### *Searching other resources*

We will use the search engine Google Scholar to help identify relevant research and policy documents and will systematically search the internet recording details of websites searched, date, search terms used and results. We will also search the reference lists of included studies, previously published reviews and other relevant material for further studies. We will contact key individuals, such as those who have previously published relevant work, to ask if they can identify any unpublished or ongoing research.

We will search the following websites:

- Pedestrian and Bicycle Information Center (www.bicyclinginfo.org/);
- Cycling Embassy of Great Britain (www.cycling-embassy.org.uk/);
- AAA Foundation for Traffic Safety (www.aaafoundation.org/);
- Australian Road Research Board (www.arrb.com.au/home.aspx);
- Swedish National Road and Transport Research Institute (www.vti.se/en/);
- Transport Canada (www.tc.gc.ca/eng/menu.htm);
- Transportation Research Board (www.trb.org/Main/Home.aspx);
- Injury Control Resource Information Network (www.injurycontrol.com/icrin/);
- Harborview Injury Prevention and Research Center (http://depts.washington.edu/hiprc/);
- CTC (UK) (www.ctc.org.uk/).

We will handsearch abstracts of the following relevant conferences:

- World Conference on Injury Prevention and Safety Promotion (first to 11th);
- Australian Cycling Conference (first to fifth);
- NZ Cycling Conference (first to eighth);
- European Transport Conference (first to 40th).

## Data collection and analysis

A two-stage screening process will be undertaken. Search results will be imported into an EndNote library and duplicates removed. Two authors will independently scan titles and abstracts of articles for relevance according to the pre-determined criteria for study inclusion.

### *Selection of studies*

Possibly relevant papers will be retrieved in full. The full papers will then be reviewed independently, once again by two authors, for relevance. Papers retained at this second review stage will be included in the final review. Disagreement at either stage will be dealt with by deferment to a third author. Reasons for exclusion of a paper will be recorded. Details of all papers retained at the full article stage will be inputted into a Microsoft Access file to aid monitoring of data.

### *Data extraction and management*

Two authors will independently extract data. We will use a data extraction form which will be designed specifically for this review and will be pre-tested. Authors will extract data on:

- study design;
- date of study;
- country of origin;
- characteristics of the study population such as age, sex, socioeconomic group;
- characteristics of the intervention and control areas such as urban or rural environment, residential or commercial or industrial or educational, higher or lower capacity roads;
- nature of the intervention such as length of cycle lane, position at an intersection or continuous road;
- length of follow up or data collection;
- data on outcomes measures of interest.

If data are not available we will contact authors in an effort to obtain relevant data. Any disagreements on data will be deferred to a third author. If sufficient data are available about the infrastructure we will comment on the quality using the Cycle Infrastructure Design (DfT 2008) as a guide.

### *Assessment of risk of bias in included studies*

Two authors will independently undertake critical appraisal of the included studies to assess their quality. The following sources of bias will be considered for RCTs:

- random sequence generation (selection bias);
- allocation concealment (selection bias);
- blinding (performance bias and detection bias);
- blinding of participants and personnel (performance bias);
- blinding of outcome assessment (detection bias);
- incomplete outcome data (attrition bias);
- selective reporting (reporting bias);
- other bias.

It is anticipated that, due to the nature of the intervention, the majority of the studies will be non-RCTs and thus in the quality assessment we will consider selection bias based on the degree of similarity between the control and intervention areas, performance and detection bias will be based on an assessment of whether data collection and analyses were performed by a researcher blind to location or time of data collection and attrition bias will consider length of time of data collection before and after installation of intervention. We will also assess reporting bias, that is whether authors appeared to be selective in terms of the results they reported. The review authors will give a brief description of possible sources of each type of bias and rate the risk of bias as high risk, low risk, or unclear or unknown risk. Once again, the findings of the two review authors will be examined for discrepancies and discrepancies resolved by deferment to a third review author.

### *Measures of treatment effect*

To account for variations in exposure we will express self-reported or medically-attended injuries as injuries per million bike-km, where sufficient data are provided. Alternatively, we will report the number of injuries per hours of cycle use or number of injuries per cyclist, depending on how injuries are reported in the included studies. Where there is sufficient information, we will include a differentiation of injury rates by severity according to fatal, serious injury and slightly injured. We will also differentiate between injuries sustained as a result of a collision with other traffic, for example motor vehicles, other bicycles or pedestrians, and injuries relating to having ‘fallen off’ due to collision with obstacles both within the road and adjacent to the road.

For dichotomous outcomes we will assess treatment effect using relative risk with 95% confidence interval. For continuous outcomes we will assess treatment effect using differences in means and 95% confidence intervals, and for rates we will use rate ratios.

We will produce a 'Summary of findings' table, which will include data on the primary outcomes and an assessment of the

quality of the data, using GRADE.

### *Unit of analysis issues*

For those studies using a clustered design that have not adjusted for clustering when reporting their data, we will do this using the intra-class correlation coefficient (ICC) of the study, if available. We will calculate the design effect using the ICC and the average cluster size. Where ICCs are not reported we will use those from similar, published cluster randomised trials. For dichotomous outcomes the number experiencing the event and the number of participants will be divided by the design effect. For continuous outcomes we will divide the number of participants by the design effect. For rate outcomes we will adjust the number of events and the number of km travelled for clustering using the variance inflation factor (Donner 2000).

### *Dealing with missing data*

We will assess the number of dropouts for each included study and will report the number of participants who are included in the final analysis as a proportion of the number of participants who started the study. We will also assess the extent to which studies conformed to an intention-to-treat analysis. Where data are missing we will attempt to obtain the data from the authors.

### *Assessment of heterogeneity*

If there are sufficient studies, that is three or more, describing the same type of infrastructure we will stratify our analyses by type of infrastructure. For those studies that have been combined in a meta analyses, we will assess the heterogeneity of studies by inspection of the forest plot and, in particular, the confidence intervals of the individual studies; statistical tests of heterogeneity will be undertaken using the $Chi^2$ test, with significance defined as a P value of < 0.1, and the $I^2$ statistic. $I^2$ values above 30% suggest that moderate heterogeneity exists. In such cases, findings will be interpreted with caution. Subgroup analyses will be undertaken to explore possible reasons for heterogeneity.

### *Assessment of reporting biases*

We will assess publication bias by generating funnel plots and inspecting them for symmetry. For those meta-analyses using 10 or more studies, we will test for asymmetry using Egger's test. We will perform this calculation using Stata version 11.

### *Data synthesis*

Where there are three or more studies reporting the same outcomes we will perform meta-analyses. We will estimate pooled rate ratios and 95% confidence intervals for injury rates, pooled relative risks and 95% confidence intervals for dichotomous outcomes and pooled mean differences and 95% confidence intervals for continuous outcomes. Random-effects models will be used to allow for and to quantify the degree of heterogeneity between studies. If the review includes both randomised and non-randomised studies the primary analyses will be based on randomised studies with secondary analyses including both randomised and non-randomised studies.

If there are insufficient studies to undertake a meta-analysis the results from individual studies will be combined in a narrative review. For those studies included in a narrative review, the key characteristics and findings of the studies will be presented. Difference and similarities between studies will be examined.

### *Subgroup analysis and investigation of heterogeneity*

If there are sufficient data, that is two or more studies reporting relevant data, we plan to undertake several subgroup analyses. Firstly, we aim to consider the effectiveness of the infrastructure at reducing severity of injuries. Thus we will undertake a subgroup analysis according to fatal injury, serious injury and slightly injured. In addition we will undertake subgroup analyses comparing effect sizes between countries with and without cycle helmet legislation as compulsory wearing of a cycle helmet may affect the severity of injuries sustained. Secondly, we aim to evaluate the effectiveness of cycling infrastructure in reducing cycling injuries in cyclists with respect to age, sex and social group. Thus we will undertake subgroup analyses based on age (child versus adult), sex (male versus female) and social group (disadvantaged versus non-disadvantaged).

### *Sensitivity analysis*

Sensitivity analyses will be undertaken by rerunning the analyses and including only RCTs considered to be at low risk of selection bias in terms of adequate allocation concealment, detection bias in terms of blinded outcome assessment and attrition bias due to follow up of fewer than 80% of participants in each arm.

## Results

### Description of studies

### *Results of the search*

### *Included studies*

### *Excluded studies*

### Risk of bias in included studies

### *Allocation (selection bias)*

### *Blinding (performance bias and detection bias)*

CM had the original idea for the review and is the co-ordinator of the review. All authors have contributed to the protocol.



None known



*Amoros 2011*

Amoros E, Chiron M, Thelot B, Lauman B. The injury epidemiology of cyclists based on a road trauma registry. BMC Public Health 2011;11:653.

*Andersen 2000*

Andersen LB, Schnohr P, Schroll M, Hein H. All-cause mortality associated with physical activity during leisure time, work,

ports and cycling to work. Archives of Internal Medicine 2000;160:1621-8.

### *Cavill 2008*

Cavill N, Kahlmeier S, Rutter H, Racioppi F, Oja P. Economic analyses of transport infrastructure and policies including health effects related to cycling and walking: a systematic review. Transport Policy 2008;15:291-304.

### *CJC 2005*

CJC Consulting. Economic benefits of accessible green spaces for physical and mental health: scoping study. Oxford: CJC Consulting, 2005.

### *Cross 1977*

Cross KD, Fisher G. Identification of specific problems and countermeasure approaches to enhance bicycle safety. Santa Barbara, CA: Anacapa Science Inc, 1977.

### *DfT 2008*

Department for Transport. Cycle infrastructure design. London: HMSO, 2008.

### *DfT 2010*

Department for Transport London. Pedal cyclist casualties in reported road accidents: 2008 Road Accident Statistics Factsheet No. 4. London: HMSO, 2010.

### *DH 2005*

Department of Health. Choosing activity: a physical activity action plan. London: HMSO, 2005.

### *DH 2008*

Department of Health. Healthy weight. Healthy lives: a cross government strategy for England. London: HMSO, 2008.

### *DH 2009*

Department of Health. Be active, be healthy: a plan for getting the nation moving. London: HMSO, 2009.

### *DH 2011*

Department of Health. Start active, stay active: a report on physical activity from the four home countries' Chief Medical Officers. London: HMSO, 2011.

### *Donner 2000*

Donner A, Klar N. Design and analysis of cluster randomization trials in health research. Vol. Chapter 6.2. London: Arnold, 2000:84-100.

### *Engström 2002*

Engström K, Diderichsen F, Laflamme L. Socioeconomic differences in injury risks in childhood and adolescence: a nation-wide study of intentional and unintentional injuries in Sweden. Injury Prevention 2002;8:137-42.

### *Fraser 2010*

Fraser SD, Lock K. Cycling for transport and public health: a systematic review of the effect of the environment on cycling. European Journal of Public Health 2011;21(6):738-43.

### *Garrard 2008*

Garrard J, Rose G, Lo SK. Promoting transportation cycling for women: the role of bicycle infrastructure. Preventive Medicine 2008;46:55-9.

### *Hasselberg 2001*

Hasselberg M, Laflamme L, Weitoft GR. Socioeconomic differences in road traffic injuries during childhood and youth: a closer look at different kinds of road user. Journal of Epidemiology and Community Health 2001;55:858-62.

### *Hillsdon 1996*

Hillsdon M, Thorogood M. A systematic review of physical activity promotion strategies. British Journal of Sports Medicine 1996;30:84-9.

### *Hu 1999*

Hu FB, Sigal RJ, Rich-Edwards JW. Walking compared with vigorous physical activity and risk of type 2 diabetes in women: a prospective study. JAMA 1999;282:1433-9.

### *Inoue 2008*

Inoue M, Yamamoto S, Kurahashi N, Iwasaki M, Sasazuki S, Tsugane S. Total physical activity level and total cancer risk in men and women: results from a large-scale population-based cohort study in Japan. American Journal of Epidemiology 2008;168:391-403.

### *Kwan 2006*

Kwan I, Mapstone J. Interventions for increasing pedestrian and cyclist visibility for the prevention of death and injuries. Cochrane Database of Systematic Reviews 2006, Issue 4. Art. No.: CD003438 DOI: 10.1002/14651858.CD003438.pub2.

### *Lindsay 2011*

Lindsay G, Macmillan A, Woodward A. Moving urban trips from cars to bicycles: impact on health and emissions. Australian and New Zealand Journal of Public Health 2011;35:54-60.

### *Lusk 2011*

Lusk AC, Furth PG, Morency P, Miranda-Moreno LF, Willett WC, Dennerlein, JT. Risk of injury for bicycling on cycle tracks versus in the street. Injury Prevention 2011;17:131-5.

### *Macpherson 2008*

Macpherson A, Spinks A. Bicycle helmet legislation for the uptake of helmet use and prevention of head injuries. Cochrane Database of Systematic Reviews 2008, Issue 3. Art. No.: CD005401 DOI: 10.1002/14651858.CD005401.pub3.

### *Matthews 2007*

Matthews CE, Jurj AL, Shu X, Li H-L, Yang G, Li Q, et al. Influence of exercise,walking, cycling, and overall nonexercise physical activity on mortality in Chinese women. American Journal of Epidemiology 2007;165:1343-50.

### *McClintock 2002*

McClintock H. The mainstreaming of cycling policy. In: McClintock H, editors(s). Planning for cycling. Principles, practices and solutions for urban planners. Cambridge UK: Woodhead Publishing Ltd, 2002.

### *McCormack 2007*

McCormack B, Stone I. Economic costs of obesity and the case for government intervention. Obesity Reviews 2007;8:161-4.

### *Moritz 1998*

Moritz WE. Adult bicyclists in the United States: characteristics and riding experience in 1996. Transportation Research Record 1998;1636:1-7.

### *NHS 2006*

NHS The Information Centre. Health Survey for England 2004. The health of minority ethnic groups. Summary of key findings. London: HMSO, 2006.

### *NICE 2008*

National Institute for Health and Clinical Excellence. Promoting and creating built or natural environments that encourage and support physical activity. NICE Public Health Guidance 8. London: National Institute for Health and Clinical Excellence, 2008.

### *NICE 2011*

National Institute for Health and Clinical Excellence. Walking and cycling: local measures to promote walking and cycling as forms of travel or recreation. Public Health Guidance Final Scope. London: National Institute for Health and Clinical Excellence, 2011.

### *Oja 2011*

Oja P, Titze S, Bauman A, de Geus B, Krenn P, Reger-Nash B, et al. Health benefits of cycling: a systematic review. Scandinavian Journal of Medicine and Science in Sports 2011;21:496-509.

### *Prentice 1995*

Prentice AM, Jebb SA. Obesity in Britain: gluttony or sloth? BMJ 1995;311:437-9.

### *Reynolds 2009*

Reynolds CO, Harris AM, Teschke K, Cripton PA, Winters M. The impact of transportation infrastructure on bicycling injuries and crashes: a review of the literature. Environmental Health 2009;8:47.

### *Rivara 2011*

Rivara F, Sattin RW. Preventing bicycle-related injuries: next step. BMJ 2011;17:215.

### *Rodgers 1997*

Rodgers GB. Factors associated with the crash risk of adult bicyclists. Journal of Safety Research 1997;28:233-41.

### *Savela 2010*

Savela S, Koistinen P, Tilvis RS, Strandberg AY, Pitkälä KH, Salomaa VV, et al. Leisure-time physical activity, cardiovascular risk factors and mortality during a 34-year follow-up in men. European Journal of Epidemiology 2010;25:619-25.

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Schnohr P, Lange P, Scharling H, Jensen JS. Long-term physical activity in leisure time and mortality from coronary heart disease, stroke, respiratory diseases, and cancer. The Copenhagen Study. European Journal of Cardiovascular Prevention and Rehabilitation 2006;13:173-9.

*Sloman 2009*

Sloman L, Cavill N, Cope A, Muller L and Kennedy A. Analysis and synthesis of evidence on the effects of investment in six Cycling Demonstration Towns. Report for Department for Transport and Cycling England. London: HMSO, 2009.

*TfL 2008*

Transport for London. Cycling in London. Final report 2008. http://www.tfl.gov.uk/assets/downloads/businessandpartners/cycling-in-london-final-october-2008.pdf (accessed 6 November 2011).

*Thompson 1999*

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*WHO 2004*

Peden M, Scurfield R, Sleet D, Mohan D, Hyder AA, Jarawan E, et al; editors. World report on road traffic injury prevention 2004. Geneva: World Health Organization, 2004.

*Winters 2010*

Winters M, Brauer M, Setton EM, Teschke K. Built environment influences on healthy transportation choices: bicycling versus driving. Journal of Urban Health: Bulletin of the New York Academy of Medicine 2010;87:969-93.

*Yang 2010*

Yang L, Sahlqvist S. McMinn A. Griffin SJ, Ogilvie D. Interventions to promote cycling: systematic review. BMJ 2010;341:c5293. [10.1136/bmj.c5293]

### Other published versions of this review

### Classification pending references

## Data and analyses

## Figures

## Sources of support

### Internal sources

- No sources of support provided

### External sources

- This Cochrane protocol has been funded by the National Institute for Health Research Public Health Research (NIHR PHR) Programme (Project: 11/3020/04), UK
  The views and opinions expressed therein are those of the authors and do not necessarily reflect those of the NIHR PHR Programme or the Department of Health.

## Feedback

## Appendices

### 1 Search strategy

**MEDLINE (OvidSP)**

1. exp Bicycling/
2. (cycl* and commuter*).ab,ti.
3. (cycl* adj3 physical activity).ab,ti.
4. (bicycle* or cycl*).ab,ti.
5. 1 or 2 or 3 or 4
6. *Environmental Health/
7. *Safety/
8. *Accident Prevention/
9. *Accidents, Traffic/pc [Prevention & Control]
10. *public health/ or *urban health/
11. *city planning/ or *environment design/ or *urban renewal/
12. *Urbanization/
13. exp Accidents, Traffic/pc [Prevention & Control]
14. ((cycl* or bicycl*) adj3 (lane* or route* or track* or road* or path*)).ab,ti.
15. "speed management".ab,ti.
16. traffic*.ab,ti.
17. 15 and 16
18. ((on-road or off-road) adj3 (lane* or path*)).ab,ti.

19. (roundabout* or junction* or pathway* or sidewalk*).ab,ti.
20. (bicyl* or cycl*).ab,ti.
21. 19 and 20
22. (infrastructure adj3 (transport or change or management)).ab,ti.
23. (cycl* adj3 (segregate or share or separate)).ab,ti.
24. (pedestrian* adj3 cycl*).ab,ti.
25. ((cycl* or bicyl*) adj4 signal*).ab,ti.
26. ((cycl* or bicyl*) adj3 facilit*).ab,ti.
27. 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 17 or 18 or 21 or 22 or 23 or 24 or 25 or 26
28. 5 and 27
29. exp *"Wounds and Injuries"/
30. (accident* or crash* or fatal* or wound* or injur* or trauma* or fracture* or lacerat*).ab,ti.
31. 29 or 30
32. 28 and 31
33. clinical trials as topic.sh.
34. randomi?ed.ti,ab.
35. randomized controlled trial.pt.
36. controlled clinical trial.pt.
37. (controlled adj3 (('before and after') or trial* or study or studies or evaluat*)).ab,ti.
38. randomi?ed.ti,ab.
39. placebo.ti,ab.
40. ((before adj3 after) or (interrupted adj3 time)).mp.
41. randomly.ti,ab.
42. (trial or study).ti.
43. groups.ti,ab.
44. (observed or observation*).sh,ti,ab.
45. exp device approval/
46. ((program* or trial* or stud*) adj3 (compar* or intervention or evaluat* or appropriate* or effect* or sustain*)).ab,ti.
47. (random* adj3 allocat*).ab,ti.
48. exp prospective studies/
49. exp program evaluation/
50. exp follow-up studies/
51. exp comparative study/
52. exp cohort studies/
53. exp evaluation studies/
54. exp treatment outcome/
55. or/33-54
56. exp animals/
57. exp humans/
58. 56 not (56 and 57)
59. 55 not 58
60. 32 and 59

## Graphs