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Interventions to prevent accidental injury to young people aged 15–24

Evidence briefing

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This work was undertaken by the Public Health Collaborating Centre on Accidental Injury on behalf of the Health Development Agency (HDA), but published after the functions of the HDA were transferred to the National Institute for Health and Clinical Excellence (NICE) on 1 April 2005. This document does not represent NICE guidance.

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Foreword

The Health Development Agency (HDA) was established in 2000 to help build the public health evidence base, with an emphasis on what works and a special focus on reducing inequalities in health. In April 2005, the functions of the HDA were transferred to the National Institute for Clinical Excellence (NICE) to form a new organisation, the National Institute for Health and Clinical Excellence (also known as NICE).

Wanless (2004) highlighted the need for appraising the effectiveness of public health interventions, not only to reduce health inequalities but also to maximise cost effectiveness. The government's white paper *Choosing Health* (Department of Health 2004) similarly reiterates the importance of building and maintaining an evidence base for public health. From April 2005 the HDA's evidence base work is continuing under the auspices of NICE.

The HDA had the task of mapping and synthesising the evidence across priority areas of public health. It developed a systematic approach to compiling the evidence, identifying gaps and making the evidence base accessible. The evidence briefing series was one of the ways used to disseminate the HDA Evidence Base (full details of the process of developing the Evidence Base and the associated methodological activities can be found in: Graham and Kelly 2004; Kelly et al. 2002, 2003, 2004; Killoran and Kelly 2004; Swann et al. 2005).

This evidence briefing is a review of reviews about the effectiveness of public health interventions to prevent accidental injury to young people aged 15–24. The necessity for reviewing reviews, or tertiary-level research, stems from the proliferation, over the last decade or more, of systematic and other types of review in medicine and public health. Other evidence briefings have covered:

- Accidental injuries in children and older people
- Ante-and post-natal home visiting programmes
- Breastfeeding
- Drug misuse
- Health impact assessment
- HIV prevention
- Housing
- Management of obesity and overweight
- Prevention and reduction of alcohol misuse
- Prevention and reduction of exposure to second-hand smoke
- Prevention of sexually transmitted infections
- Prevention of low birth weight
- Public health interventions for increasing physical activity among adults
- Smoking and public health
- Teenage pregnancy and parenthood
- Youth suicide prevention.

Taken together, these briefings provide a comprehensive synthesis of the evidence drawn from review-level literature, including systematic reviews. They are available on the NICE website at: www.publichealth.nice.org.uk

These evidence briefings have been based on evidence drawn from systematic and other kinds of reviews. This means that the type of evidence that does not traditionally find its way into reviews has not been considered in detail for these documents. In another evidence series, 'evidence reviews', the scope of the coverage is extended to primary research, other kinds of evidence and other types of study. Evidence reviews published to date include:

- Drug misuse prevention among young people
- Self-management of chronic illness
- Worklessness and health
- Work, non-work, job satisfaction and psychological health.

The construction of the Evidence Base involved collaboration with a number of partners who have an interest or expertise in practical and methodological matters concerning the drawing together of evidence and its dissemination. In particular, the HDA acknowledged the following: the Centre for Reviews and Dissemination at the University of York; the EPPI-Centre within the Institute of Education at the University of London; Health Evidence Bulletins Wales; the ESRC UK Centre for Evidence Based Policy and Practice at Queen Mary College, University of London and its nodes at the City University London and the MRC Public Health Sciences Unit at the University of Glasgow; members of the Cochrane and Campbell collaborations; the United Kingdom and Ireland Public Health Evidence Group and the Public Health Evidence Steering Group. The latter acted as overall guide for the evidence-building project.

Colleagues in these institutions and organisations have made a significant contribution to the framework used to assess the evidence.

Every effort has been made to ensure this briefing is as accurate and up-to-date as possible. We welcome readers' comments on the content – including its accuracy – and will make every effort to correct any matters of fact in subsequent editions. Comments can be made via our website at: www.publichealth.nice.org.uk

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Summary

Accidental injury is a major cause of mortality and morbidity in young adults aged 15–24. This age group, which has received far less attention than children and older people, includes the period from late adolescence and the transition to early adulthood.

This evidence briefing is a review of reviews of interventions to prevent accidental injury to young people in the 15–24 age group. The following research questions form the basis of the briefing:

- what constitutes effective interventions for the prevention of accidental injury to young people and young adults?
- what current activities to prevent accidental injury demonstrate signs of success?
- what kind of measures provided by schools, colleges, further education, workplaces, leisure services or pubs and clubs might be effective?
- what professional and non-professional interventions have been effective?
- what lessons can be learnt from interventions with deprived or disadvantaged groups, and geographic initiatives, eg for homeless and/or unemployed young people, and neighbourhood renewal programmes?
- what are the costs and benefits of accidental injury prevention initiatives?

This briefing uses the term 'accidental injury'. There has been considerable debate in the international literature about the use of the terms 'accidents' and 'accidental injury' (Davis and Pless 2001; Green et al. 2003). The term 'accidental injury' was used by England's Accidental Injury Task Force and also as the title of the Health Development Agency's Collaborating Centre, so the term has been retained in this briefing.

The briefing is structured to focus on three settings:

- roads, ie as a vehicle user (passenger or driver), cyclist, motorcyclist or pedestrian
- work, school or further education
- leisure, including entertainment and sport.

Review-level papers were selected from a comprehensive literature search (see Appendix 1). Reviews were selected on the basis that their titles and abstracts (if available) fulfilled all of the following criteria:

- reviewed interventions for the prevention of unintentional injuries
- focused on effectiveness, costs or benefits of such interventions
- addressed the age range or part of the age range of interest (15–24)
- published in English.

Studies were excluded if they originated from developing countries (because of lack of transferability to the UK) or addressed intentional injury. Search parameters were from January 1999 to September 2004.

The searches yielded 4068 references, which were reduced to 471 after sifting. Twenty-two systematic reviews were identified for critical appraisal. Two members of the research team independently conducted critical appraisal of the reviews. Eight reviews were included for data extraction.

Key findings

- Legislation and enforcement have been effective interventions in preventing accidental injury to young people in this age range.

- Interventions that use environmental measures and protective equipment have also been shown to be effective.
- Stand-alone educational interventions have not been shown to be effective, but when combined with other approaches such as legislation and engineering, may be successful. However, with multi-factorial intervention programmes it is difficult to attribute the degree of success to any single element.

- Road interventions such as raising the legal drinking age from 18 to 21, random breath testing, seat belt legislation, compulsory protective helmets for motor-cyclists and bicyclists, lowering the drink-driving limit (blood-alcohol concentration) and graduated driver licensing schemes have been shown to be successful.

- Within the sports and leisure setting, legislative measures, such as the mandatory use of mouthguards and face protectors, and modifications to the rules of games, have been shown to be effective in reducing injuries. Other successful sports interventions include the use of equipment such as helmets and eye protectors, taping previously injured ankles, strength training and conditioning exercises.

- There is scant review-level evidence of effective interventions to reduce accidental injuries among the 15–24 age group within the workplace, or in pubs and clubs. No reviews specifically addressed injuries in schools.

- There is very little review-level evidence on the relative effect of interventions between different groups of the population such as disadvantaged or deprived groups of young people, or those living in different geographical areas. Insufficient detail is provided within the review-level material to determine whether professionals or non-professionals delivered the interventions.

- There is a little review-level information on the cost effectiveness and benefits of injury prevention programmes.

Introduction

Aims of this briefing

This briefing aims to:

- identify all relevant systematic reviews, syntheses, meta-analyses and review-level papers on public health interventions to prevent accidental injury to young people aged 15–24
- review these papers and highlight effective ways to prevent accidental injury in this population and particularly those in disadvantaged and vulnerable groups
- identify cost-effectiveness data for interventions that aim to prevent accidental injury to young people aged 15–24
- highlight any gaps in the evidence and make recommendations for future research.

Note that this briefing uses the term 'accidental injury'. There has been considerable debate in the international literature about the use of the terms 'accidents' and 'accidental injury' (Davis and Pless 2001; Green et al. 2003). The term 'accidental injury' was used by England's Accidental Injury Task Force and also as the title of the Health Development Agency's Collaborating Centre, so the term has been retained in this briefing.

Who is this briefing for?

This briefing is intended to inform policy and decision-makers, NHS providers, public health physicians and other public health practitioners in the widest sense. It is designed to be accessed by a variety of users including those simply looking for headline findings, those wanting complete and detailed syntheses, and those who need to track back to the original primary and secondary sources.

Background

Accidental injury is a major cause of mortality and morbidity in young adults aged 15–24 – an age group that has received far less attention than children or older people. Young adults are injured as they go about their daily lives – as they travel around, while they are at home and work, and during sports and leisure activities. At times they are exposed to particularly hazardous conditions such as cycling on busy roads.

The 15–24 age group includes the period from late adolescence and the transition to early adulthood. During this period of increasing social and financial independence, young people are starting in further and higher education or in work, leaving their childhood homes and are exposed to new situations and activities, such as learning to drive a car.

What is the scale of the problem?

Injuries: a global problem

Accidental injuries are a major public health problem, representing 12% of the global burden of ill health. Globally, in the 15–29 age range, accidental injuries feature five times in the top 15 causes of death, with road traffic injuries ranking 2nd, drowning 5th, fires 8th, falls 13th and poisoning 15th (Peden et al. 2004). Those injuries that do not kill can result in considerable ill health and disability, and substantial costs to individuals, families and society. Fortunately, injuries are preventable through a range of multi-agency activities, with all sectors including health responsible for engaging in prevention activity and advocacy (Peden et al. 2004).

Accidental injury mortality

The relative importance of different types of injury deaths in young adults varies between countries. In England and Wales in 2003, accidental injuries were the major cause of death in young people, accounting for 952 deaths (38% of all deaths) in the 15–24 age group (V01–X59)* (Office for National Statistics 2004).

Young men were disproportionately represented in these figures, with 777 (82%) of the deaths occurring in men and 175 (18%) in women. In comparison, 248 children aged 0–14 died as a result of an accident in 2003 but the male to female ratio was not so marked, 62% compared with 38% (Office for National Statistics 2004).

Accidental injury deaths in young people are dominated by transport accidents, particularly road traffic casualties. In young adults, transport accidents (V01-V99) were the most common type of accident deaths in 2003, accounting for 79% of the total, followed by poisoning by exposure to noxious substances (X40-X49), 10%; falls (W00-W19) 3%; accidental drowning and submersion (W65-W74), 2%; and other accidental threats to breathing (W75-W84), 2% (Office for National Statistics 2004).

Young adults are particularly at risk as car drivers and passengers. Between 2000 and 2002, the fatality rate for all car drivers of both sexes peaked in the 20–24 age range: 17% of male and 13% of female drivers who died were aged 20–24; 12% of male and 9% of female drivers who died were aged 16–19 years. The peak for car passengers was even younger: 32% of male car passengers and 18% of all female passengers who died were aged 16–19 (Department for Transport 2004).

Accidental injury morbidity

In addition to deaths from injury, a larger number of non-fatal injuries occur. Falls and sports and exercise injuries are particularly dominant types of non-fatal injuries. An estimate of non-fatal accidents of young people aged 16–24 is available from the Health Survey for England in 2001 and 2002 (Malbut and Falaschetti 2003).

- A total of 16% of young men and 8% of young women reported having at least one 'major' accident in the previous 6 months. (Major accidents were defined as accidents where a doctor was consulted or a hospital was visited.)
- Annual major accident rates per 100 persons were estimated to be 36 for young men and 18 for young women.
- The proportions reporting at least one 'minor' accident within the previous 2 weeks was 11% for young men and 6% for young women. (Minor accidents were defined as accidents, which caused pain or discomfort for more than 24 hours.)
- The annual minor accident rate per 100 persons was estimated to be 357 for young men and 177 for young women, demonstrating how frequently minor accidents occur.
  (Malbut and Falaschetti 2003).

The two most common types of major accidents were falls and accidents during sport and exercise. For young men, the sport/exercise major accident rate was 13 per 100 and for females 3 per 100 persons; the rate for major falls, excluding sports/exercise, was 8 for young men and 6 for young women. Of major accidents reported by young men and women, 11% and 10% respectively affected the victim's activities for a month or more.

Significant reductions in major accident rates were seen between 1995–1997 and 2001–2002 for both young men (from 42 to 36 per 100 persons) and young women (from 22 to 18 per 100 persons) (Malbut and Falaschetti 2003).

A finding of relevance to the health inequalities agenda was that no association was found between major accident rates in young adults (aged 16 to 24) and three socio-economic indicators: social position (based on current or former occupation of the household reference person), household income or area deprivation (Malbut and Falaschetti 2003). That is, young people seemed to experience the same rate of accidents regardless of where they lived, their household income or their social position.

* ICD-10 International Classification of Disease – 10th revision. This was used for the first time in the 2001 mortality statistics. Diagnoses of diseases and other health problems are translated into alphanumeric codes, eg V01–X59 relate to accidental injuries).

Causes of injury

Many factors determine a young person's risk of accidental injury and the types of injury that occur:

- **personal factors** include age, gender, ethnicity, physical and mental health, and level of education about the risk of injury
- **environmental factors** include the characteristics of transport, housing, leisure and public places
- **socio-economic factors** include poor quality, overcrowded housing and unemployment
- **lifestyle factors** include use of drugs, smoking and risk-taking behaviour (eg speeding, not using a seat belt).
  (British Medical Association 2001)

The causes of injury are multi-faceted and inter-related. An understanding of young people's exposure to the risk of hazards within different environments can help to identify preventive opportunities.

Exposure to risk on the roads

The way in which young people travel needs to be considered in conjunction with accidental injury mortality and morbidity statistics. The *National Travel Survey: 2004* (Department for Transport 2005) shows the major modes of travel of young men aged 17–20 were: walking (26%), driving a car (25%), being a car passenger (23%) and bicycling (3%). The corresponding figures for young women aged 17–20 were: walking (26%), driving a car (25%), being a car passenger (31%) and bicycling (1%). There are gender differences in that women tend to be car passengers more and cycle less. The *National Travel Survey* shows that as people grow older, walking declines as the major mode of travel and car driving increases (Department for Transport 2005).

In 2001, fewer young people held driving licences than in the early 1990s: 32% of men and 27% of women aged 17–20 held driving licences in 2001. This rose to 79% of men and 67% of women aged 21–29. There are various reasons for this lower rate: more young people are students and cannot afford cars, and insurance costs are high for drivers under 25. This trend has also been noted in other parts of Europe (Department for Transport 2005).

Newly qualified drivers, the majority of whom are also young drivers, are at particularly high risk of accidents. One in five new drivers has an accident in the first year of driving. The 17–21 age group is also over-represented in collisions that cause injury. The reasons for this higher risk include deficiencies in driving skills, and poor attitudes and behaviour, which can lead to unnecessary exposure to danger. Speed is a significant factor in young driver casualties (Department of Health 2002).

Exposure to risk in the leisure environment

The sport and leisure module of the General Household Survey examines participation rates of adults of different ages in sports, games and physical activities. In 2002, young adults had higher participation rates in these activities than any other age group, and male participation was significantly higher than female (Fox and Rickards 2004). A total of 83% of 16–19 year old men and 78% of 20–24 year old men had been involved in at least one sport, game or physical activity in the previous 4 weeks. This compared with 70% of 16–19 year old women and 62% of 20–24 year old women. The most popular activities cited by young men were soccer, snooker/pool/billiards, walking and cycling. For young women the most popular activities were walking, keeping fit/yoga, swimming and snooker/pool/billiards (Fox and Rickards 2004).

Current cross-government activities, such as *Walking and cycling: an action plan* (Department for Transport 2004), that aim to increase walking and cycling and physical activity could increase the number of accidental injuries associated with these activities among young people.

Key stakeholders

The prevention of accidental injury is relevant to many aspects of national, regional and local public policy, and requires involvement of many sectors including: government departments, public health, road safety, transportation, highways, schools and further and higher education, employers, sporting organisations, urban planners, architects, mass media and voluntary agencies. The broad range of relevant sectors reflects the extent to which accidental injury influences are dispersed throughout society.

In specific settings, it is important to tailor the composition of multi-sectoral action to the situation. For example, road safety programmes can involve road safety

officers, transportation and highways agencies, police, ambulance services, local authorities and private leisure service providers.

Policy context

Accidental injury was identified as a public health priority in the 1999 white paper on public health, *Saving Lives: Our Healthier Nation* (Department of Health 1999). This paper set a national target for injury reduction:

> *'To reduce the death rates from accidents by at least one fifth and to reduce the rate of serious injury from accidents by at least one tenth by 2010.'*

Accidental injury features less prominently in the main report of the 2004 white paper, *Choosing Health* (Department of Health 2004), but a summary of action on this topic is included in the Summary Annex of the report.

The report, *Preventing Accidental Injury – Priorities for Action* (Department of Health 2002), identified an urgent need to update our knowledge of accidental injury among 15–24 year olds. Particular emphasis was placed on the need for more information about the possible links between alcohol/illicit drug use and accidental injury in this age group.

Longer-term priority areas related to the 15–24 age group identified by the Accidental Injury Task Force were to reduce the burden of death and injury in young adults by targeting young drivers and other young vehicle occupants, and by targeting young people playing sports, who sustain 50% of all sports and recreational injuries (Department of Health 2002).

Public service agreements (PSAs) for the 2005–2008 spending review for two government departments, the Department for Transport and the Office of the Deputy Prime Minister, include targets related to injury (HM Treasury 2004):

> *'Reduce the number of people killed or seriously injured in Great Britain in road accidents by 40%, and the number of children killed or seriously injured by 50%, by 2010 compared with the average for 1994–98, tackling the significantly higher incidence in disadvantaged communities.'*
> (Department of Transport PSA, target 5)

(This PSA is based on the Department for Transport's target set out in *Tomorrow's roads: safer for everyone*, Department for Transport 2000.)

> *'By 2010, reduce the number of accidental fire-related deaths in the home by 20% and the number of deliberate fires by 10%.'*
> (Office of the Deputy Prime Minister PSA, target 3)

(More detail is provided about this PSA in *The Fire and Rescue National Framework 2005/06*, Office of the Deputy Prime Minister 2004.)

Also of relevance to the risk of accidental injury is the government's promotion of physical activity. In addition to the emphasis given to this topic in *Choosing Health* (Department of Health 2004), the Department for Transport published an action plan in 2004 to promote walking and cycling (Department for Transport 2004). This includes suggestions for improvements to the environment and facilities for walkers and cyclists, and carefully targeted information about travel choice, health benefits and recreation opportunities.

Methodology

This evidence briefing describes a review of reviews addressing interventions to prevent accidental injury to young people aged 15–24. The search strategy identified primary studies, systematic reviews and non-systematic reviews.

Research questions

The following research questions form the basis of the review:

- what interventions are effective in preventing accidental injury to young people (aged 15–24)?
- what current activities to prevent accidental injury show evident signs of success?
- what kind of measures provided by schools, colleges, further education, workplaces, leisure services or pubs and clubs might be effective?
- what professional and non-professional interventions have been effective?
- what lessons can be learnt from interventions with deprived or disadvantaged groups and geographic areas (eg homeless and/or unemployed young people, neighbourhood renewal programmes)?
- what are the costs and benefits of accidental injury prevention initiatives?

The review is structured to focus on three settings:

- roads, ie as a vehicle user (passenger or driver), cyclist, motor cyclist or pedestrian
- work, school or further education
- leisure, including entertainment and sport.

Parameters of the review

Two previous systematic reviews of interventions to reduce accidental injuries in young people were identified. This review builds on and supplements these:

- a systematic review of the evidence on effectiveness of interventions in reducing accidental injuries across all settings in young people aged 15–24 (Coleman et al. 1996). This was carried out as part of the Department of Health's strategy to improve health in the key areas identified in *The Health of the Nation* (Department of Health 1992) and was cited within the terms of reference of the working group of experts advising the Accidental Injury Task Force (Department of Health 2002)
- a more recent systematic review of accidental injury across all settings in the 15–24 age group (Elkington et al. 2000). This was carried out in Australia and included systematic reviews published from 1986 to 1999 and primary studies published from 1996 to 1999.

Reviews were selected by a comprehensive literature search (see Appendix 1). Key search terms were developed using the research questions as a starting point. Keywords were divided into three main headings:

- target group
- accidents/accident prevention (including injury prevention) and safety measures
- public health/health promotion settings.

Searches combined the three groupings of search terms. A search protocol was developed with members of the research group and the Health Development Agency's health intelligence team. Electronic databases and websites searched are listed in Appendix 2. Abstracts and titles of retrieved references were stored in a Reference Manager database (version 11).

Inclusion/exclusion criteria

Reviews were selected on the basis that their titles and abstracts (if available) fulfilled all of the following criteria:

- reviewed interventions for the prevention of unintentional injuries
- focused on effectiveness, costs or benefits of such interventions
- addressed the age range or part of the age range of interest (15–24)
- published in English.

Where abstracts were not available, copies of the full documents were obtained.

Studies were excluded for either of these reasons:

- originating from developing countries (because of a lack of transferability to the UK) (NB: only primary studies were identified)
- addressed only intentional injury.

Selection/appraisal process

Two members of the research team scanned the results of the search independently to identify all material relevant to the research questions. Where both reviewers agreed that a study met the inclusion criteria, the reference was copied into a Reference Manager database.

The searches yielded 4068 references. After sifting, 471 references were stored in the working database. The database was scanned by two researchers to identify reviews.

Systematic reviews: methods

Twenty-four reviews were identified and appraised using a critical appraisal tool (see Appendix 3). Reviews were included when all the criteria of the critical appraisal tool were met. Three of the reviews were the product of multiple publications relating to the same study, so two were excluded, reducing the total to 22. All of these were retrieved for critical appraisal.

Two members of the research team independently conducted the critical appraisal. Results were compared and eight were included for review and inclusion in this evidence briefing. Seven were excluded, either because the reviews were literature reviews and not systematic reviews, or because the results of the review did not specifically address young people aged 15–24. Six were referred to a third reviewer and were subsequently excluded. One gave insufficient detail of the studies that had been reviewed (a request for further detail was made to the author but a response was not received).

Despite falling outside of the agreed search date parameters, the systematic review carried out by Coleman et al. (1996) was included for review because of its relevance to the UK and the importance placed on it by the Accident Injury Task Force. Coleman et al. (1996) identified no previous systematic reviews of relevance.

Two reviewers independently checked the reference lists of the eight included systematic reviews. Only two duplicate primary studies (all dates) were reviewed within the eight systematic reviews.

The eight systematic reviews included in this briefing cover injury settings as follows:

- all injury settings = 2
- community approach to injury prevention = 1
- sports injuries = 2
- roads = 3.

Two reviewers independently reviewed the eight systematic reviews and completed a data extraction form devised for the review (see Appendix 4).

Presentation of findings

References for systematic reviews included and excluded from the briefing are listed in Appendix 5. All the accepted papers (now referred to as Evidence Base papers) were compared and core themes identified. A summary of the Evidence Base papers is provided in the next section.

This is followed by a narrative synthesis of the key findings of the Evidence Base papers, largely using the review authors' own words. The level of detail about the primary studies within the Evidence Base papers differs across the reviews.

A number of evidence statements about the effectiveness of interventions were derived from the findings of the Evidence Base papers. It should be stressed that the evidence statements are not those of the review authors but are based on their review findings and have been referenced accordingly. All the evidence statements are based on review-level evidence. However, it must be noted that the quality of the evidence underlying the statements varies in the different reviews. Where evidence statements are supported by more than one review, this is noted.

Each evidence statement indicates the country from which the evidence is derived, although it should be noted that if an evidence statement is based on findings from a number of primary studies (for example as in a meta-analysis) or if the country of origin is not clear from a review, then the country is not stated.

If a theme contains information derived from a number of review-level papers then the primary studies included within each review are identified. If primary studies are present in more than one review-level paper, review findings were checked for consistency and evidence statements modified so that the intervention effect is not unduly inflated.

Evidence statements categorise the evidence of effectiveness as follows.

- Evidence of effectiveness: derived from the review-level literature where the interpretation and/or conclusions of primary studies (more than one controlled trial) presented in the review/s consistently indicate effectiveness of an intervention.
- Evidence of ineffectiveness: derived from the review-level literature where the interpretation and/or conclusions of primary studies (more than one controlled trial) presented in the review/s consistently indicate ineffectiveness of an intervention.
- Currently, insufficient evidence of effectiveness: derived from the review-level literature where there is currently insufficient evidence from primary studies to confirm effectiveness or ineffectiveness of an intervention. The review/s may have identified evidence of effectiveness from only one primary study. Further investigation in good quality controlled trials is required.
- Conflicting evidence: derived from the review-level literature where the interpretation and/or conclusions of the primary studies within reviews are not in agreement.

A key remit of this briefing is to scrutinise the reviews for details on the effect on inequalities in health and the cost effectiveness of the interventions. Where this information is available it has been described under the relevant themes and is also reflected in the evidence statements.

A number of gaps in the review-level evidence and associated research recommendations are also identified and these are presented in the 'Gaps in the Evidence Base and recommendations for research' section of this briefing.

Peer review

A first draft of this briefing was sent to two peer reviewers and circulated to the members of Accidental Injury Reference Group in December 2005 for comment. A number of changes were made in light of the feedback received.

Evidence Base papers

The eight review-level papers that passed the critical appraisal process and were included in the Evidence Base are referenced below. Characteristics of the studies included in the papers are shown in Tables 1–8.

The full public health Evidence Base can be viewed at: www.publichealth.nice.org.uk

Coleman P, Munro J, Nicholl J et al. (1996) *The effectiveness of interventions to prevent accidental injury to young persons aged 15–24 years: a review of the evidence*. University of Sheffield: Medical Care Research Unit, School of Health and Related Research.

Elkington J, Hunter K, McKay L (2000) *A systematic review of the evidence on preventing injuries to young people (15–24 years)*. Sydney, Australia: Youthsafe. Available at www.youthsafe.org

Emery C (2003) Risk factors for injury in child and adolescent sport: a systematic review of the literature. *Clinical Journal of Sport Medicine* 13 (4):256–68.

Evans C, Fielding J, Brownson R et al. (Task Force on Community Preventive Services) (2001) Motor-vehicle occupant injury: strategies for use of child safety seats, increasing use of seat belts and reducing alcohol impaired driving. *Morbidity and Mortality Weekly Report* 50 (RR07):1–13.

Hartling L, Wiebe N, Russell K et al. (2004) Graduated driver licensing for reducing motor vehicle crashes among young drivers. *The Cochrane Database of Systematic Reviews* 2004, Issue 2.

Klassen T, MacKay J, Moher D et al. (2000) Community-based injury prevention interventions. *The Future of Children* 10 (1):83–110.

Olsen L, Scanlan A, MacKay M et al. (2004) Strategies for prevention of soccer related injuries: a systematic review. *British Journal of Sports Medicine* 38 (1):1–10.

Roberts I, Kwan I, the Cochrane Injuries Group Driver Education Reviewers (2001) School based driver education for the prevention of traffic crashes. *The Cochrane Database of Systematic Reviews* 2001, Issue 3.

Table 1: Characteristics of the studies in the included reviews (Coleman et al.)

Author, year, country	Objective, search dates	Inclusion/exclusion criteria	Outcomes	Number of primary studies included	Results/findings	Comment
Coleman et al. (1996) UK	To review effectiveness of interventions aiming to prevent accidents or minimise injury among adolescents and young adults aged 15-24 years Search dates 1964–1994	All studies assessing the effectiveness of an intervention for the prevention of accidental injury either specifically in 15–24 year olds, or in a population that may have relevance to this age group were included The authors reviewed interventions in a variety of settings, including road, sport, work, home and community Interventions were included if they sought to reduce the risk of accidents (primary prevention, eg driver education courses) or if they sought to reduce the severity of injury resulting from an accident (secondary prevention, eg bicycle helmets, airbags, car seat restraints)	Outcomes included: ● incidence of fatalities ● incidence of injury ● severity of injury ● increase in visibility of road users; self-reported behaviour ● attitudes, knowledge ● observed behaviour beliefs ● skills and values ● raised awareness	Across all settings, approximately 130 primary studies were identified (number estimated from report, not specifically stated by author) Based on the quality of evidence identified for each topic, Coleman and colleagues made recommendations for practice depending on whether the evidence to support the intervention was good (grade A), fair (grade B) or poor (grade C)	On the roads The authors concluded that there was good or fair evidence as follows. ● Driver education programmes were ineffective in reducing road traffic accidents involving young drivers ● Increasing the legal driving age and the legal drinking age, or introducing curfew laws that prohibit young people from driving late evening or early morning would have a positive impact on driver accident rates ● Air bags are effective in reducing the number of driver fatalities in frontal impacts ● Changes in bus fare pricing can be effective in reducing the number of casualties/km travelled ● Helmet use is associated with a reduced risk of head and upper facial injury in cycle accidents whether or not a motor vehicle is involved ● Legislation making cycle helmet use mandatory is effective in increasing the proportion of cyclists who wear a helmet, in decreasing numbers of head injured cyclists and in decreasing the number of bicycle accidents of any kind ● Full-face helmets can reduce the risk of facial injury in motorcycle accidents compared with 'traditional' helmets ● Legislation imposing an extended riding test, limiting provisional licenses to 2 years and an engine size limit of 125cc for learner riders is effective in decreasing the number of accidents among learner riders In the home The authors concluded that there was good or fair evidence as follows. ● Installation of smoke detectors is effective in reducing the risk of fires in some residential settings ● Community-oriented programmes comprising changes to the physical environment, information, education and supervision can be effective in reducing accident rates in both the home and work settings	The authors note that inclusion of literature on accident prevention in occupational and road settings is 'selective and indicative rather than comprehensive'. This may introduce selection bias and findings in these sections should be interpreted with caution
Specific mention of inequalities None identified						

Table 1: Characteristics of the studies in the included reviews (Coleman et al.) (cont.)

Author, year, country	Objective, search dates	Inclusion/exclusion criteria	Outcomes	Number of primary studies included	Results/findings	Comment
					Sports settings The authors concluded that there was good or fair evidence as follows. ● Changes to the rules of some sports (eg American football, ice hockey and rugby union) have significantly reduced the incidence of injuries ● Wearing of mouthguards – particularly those that are custom-made – significantly reduce the incidence of dental and oral injuries ● Wearing of stabilising belts are effective in preventing injuries to the back during weightlifting ● Ankle taping can be effective in the primary prevention of ankle injuries ● Eye protectors are effective in preventing sports-related eye injuries ● Modifications to the 'furniture' of the area of play (such as gymnastic landing mats) may be effective in reducing sporting injuries ● Interventions comprising a variety of approaches can be effective in reducing the incidence and severity of injuries in the sporting setting Cost effectiveness The authors concluded that there was good or fair evidence that interventions such as modification to the sporting environment or changes to sporting rules or regulations for the prevention of sporting-related injuries can result in significant healthcare savings	

Table 2: Characteristics of the studies in the included reviews (Elkington et al.)

Author, year, country	Objective, search dates	Inclusion/exclusion criteria	Outcomes	Number of primary studies included	Results/findings	Comment
Elkington et al. (2000) Australia	To identify proven and promising educational approaches and their potential alongside other strategies to create change regarding the safety of young people To identify those educational approaches for which there is evidence to suggest they are ineffectual or harmful to the health and safety of young people **Search dates for reviews** 1985–1999 **Search dates for original articles** 1996–1999	**Inclusion criteria** ● Systematic and non-systematic reviews ● RCTs ● Non-randomised group studies with and without control groups ● Young people aged 15–24 years ● All injury settings **Exclusion criteria** ● Studies/reviews quality-rated 'poor' ● Studies which presented only commentaries of injury programmes rather than clear evaluation of outcomes ● Studies on the prevention of suicide or self-harm	**Primary outcomes** ● Reduction in injuries ● Reduction in vehicle crashes **Secondary outcomes** ● Changes in knowledge, attitudes, observed behaviour, self-reported behaviour, subsequent traffic offences ● Time lost from practice and games	26 studies identified, 18 with a focus on unintentional injury; of these 18 studies there are: ● five systematic reviews – two of these (Munro, 1995 and Coleman et al. 1996) refer to publications picked up in this evidence briefing ● three non-systematic reviews ● ten original studies, none of which were RCTs; seven graded as 'reasonable' and three as 'fair' levels of evidence	**Roads** ● Significant reduction in injuries can be achieved through legislation, and awareness-raising and enforcement ● Proven interventions to reduce injuries include drink-driving limits, random breath testing, speed cameras, seat belt legislation, compulsory motorcycle and bicycle helmets ● 'Reasonable' evidence for graduated drivers' licensing schemes and raising minimum driving age ● Little evidence for effectiveness of stand-alone educational strategies ● Pre-driver education programmes may increase risk of injury to young people **Sport** Effective strategies for reducing injuries. ● Use of face and mouth guards ● Taping previously injured ankles ● Rule modification (rugby union) ● Eye protection in squash and rackets sports ● Equipment modification (inline skating) Little evidence for educational strategies **Workplace** Lack of evidence regarding effectiveness (only one study considered)	Review also includes articles on violence prevention although discussion of these findings is not included in this evidence briefing
Specific mention of inequalities ● Saffron (1999), in a follow-up study of traffic offenders appearing in court, found greater effect (reduced rate of re-offending) for those attending the Traffic Offenders Program (TOP) among lower socio-economic groups compared to those from higher socio-economic groups ● Harre (1998) conducted a before and after study with control among senior high school students from low-middle income households in Auckland, New Zealand. The school-based driver education programme showed no significant effects. Owing to possible bias in selection, the student group recruited to the study may have been performing below the academic average						

Table 3: Characteristics of the studies in the included reviews (Emery)

Author, year, country	Objective, search dates	Inclusion/exclusion criteria	Outcomes	Number of primary studies included	Results/findings	Comment
Emery (2003) Canada	To identify risk factors for injury in child and adolescent sport as well as potential prevention strategies that may modify risk factors and reduce injury in this population Search dates 1966–2002	Inclusion criteria ● Epidemiological study that assesses the association between any potential injury risk factor or prevention strategy and injury in child and adolescent sport ● Outcome includes a measure of injury sustained in sport ● Exposure measure includes some objective measurement of risk factor or intervention ● Study design includes a comparison group (cross-sectional, case control, cohort, quasi-experimental and randomised clinical trial all considered) ● Study contains original data Exclusion criteria ● Sport-related injury involving the following high-speed sports: bicycling, scootering, skateboarding, inline skating, tobogganing, skiing, snow boarding, boating ● Study reports exclusive examination of head or dental injuries or medical emergencies ● Prevention strategy involves protective equipment (ie helmets, knee braces) to modify risk of sport injury	Review inclusion criteria stipulated that outcome measures should include a measure of injury sustained in sport. Outcome measures in primary studies varied. Definitions of injury in primary studies varied and included: ● injury requiring medical attention ● injury resulting in physical complaint > 2 weeks or missed session(s) ● injury requiring the player to miss the next session or being unable to participate without considerable discomfort ● injury requiring missing at least one game or practice	A total of 46, of which four addressed prevention of injuries in adolescent sport; two were quasi-experimental non-RCTs and two were RCTs	● One quasi-experimental non-RCT found no effect of an intervention consisting of half time warm-up and stretching exercises. ● One quasi-experimental non-RCT suggested that a coach and player education, rehabilitation and conditioning programme revealed a significant protective effect in adolescent soccer players in a low-skilled division (RR=0.63 [0.42–0.94]) ● One RCT suggested that a practice session training programme including proprioceptive balance training using a wobble board resulted in a significant reduction of injury (RR=0.17 [0.09–0.32]) in female European team handball players ● One RCT suggested that a 7 week pre-season acceleration training programme demonstrated a protective effect (RR=0.42 [0.2–0.91]) in female high school soccer players	There is limited RCT evidence supporting preventive training programmes in specific sports in adolescents for reducing the risk of injury
Specific mention of inequalities None identified in intervention studies						

Table 4: Characteristics of the studies in the included reviews (Evans et al.)

Author, year, country	Objective, search dates	Inclusion/exclusion criteria	Outcomes	Number of primary studies included	Results/findings	Comment
Evans et al. (2001) United States (Task Force on Community Preventive Services)	To conduct systematic reviews of interventions related to motor vehicle occupant injury designed to increase use of child safety seats, increase use of safety belts and reduce alcohol impaired driving **Search dates** 1966–2000	**Inclusion criteria** ● RCTs ● Non-randomised group studies ● Studies were primary investigations of interventions selected for evaluation, rather than guidelines or reviews ● Studies conducted in established market economies ● Studies compared outcomes among groups exposed to the intervention with outcomes of groups not exposed to the intervention or less exposed to the intervention **Exclusion criteria** ● Studies that were not primary investigations of intervention programmes, eg guidelines, reviews	**Primary outcomes** Non-fatal injury, fatal injury, alcohol-related fatal crash outcomes **Secondary outcomes** Behaviour – use of safety belts. Observed, self-reported and police reported	A total of 175 papers: ● 63 papers relate to use of safety belts ● 71 papers relate to alcohol-impaired driving Remainder consider child safety seats No additional detail is provided on individual study design	The Task Force on Community Preventive Services recommends that there is 'strong' evidence for state public health laws for the following areas (number of studies from which evidence is derived is given in brackets) ● Minimal legal drinking age of 21 years (n = 33) ● Required use of safety belts (n = 34) ● Primary and enhanced enforcement of safety belt laws (n = 13 and 16 respectively) ● Lower legal Blood Alcohol Concentration (BAC) limit to 0.08% for adults (n = 9) ● Use of sobriety checkpoints (n = 23) The Task Force on Community Preventive Services recommends that there is 'evidence' for a lower legal BAC for young inexperienced drivers (n = 6)	
Specific mention of inequalities None identified						

Table 5: Characteristics of the studies in the included reviews (Hartling et al.)

Author, year, country	Objective, search dates	Inclusion/exclusion criteria	Outcomes	Number of primary studies included	Results/findings	Comment
Hartling et al. (2005) Canada	To examine the effectiveness of graduated driver licensing (GDL) systems in reducing crash rates of young drivers GDL has been proposed as a means of reducing crash rates among novice drivers by gradually introducing them to higher risk situations **Search dates** Up to October 2003	**Inclusion criteria** ● Ecological studies (defined as those in which the intervention of interest is applied across an entire population) of GDL programmes ● Studies compared outcomes pre- and post-implementation of a GDL programme within the same jurisdiction ● Studies compared outcomes between jurisdictions with and without GDL ● Studies compared outcomes pre- and post implementation and between jurisdictions ● Studies reported at least one objective, quantified outcome ● GDL programmes had to have a minimum of three stages: – i) an initial period limited to supervised driving – ii) an intermediate stage allowing for unsupervised driving under one or more conditions that involve lower risk – iii) unrestricted licensure	**Primary outcome measures** Overall crash rates of teenage drivers (ie crashes involving fatalities, injuries and property damage) **Secondary outcome measures** Rates of injury crashes, hospitalisations, fatality crashes, night-time crashes, alcohol crashes, traffic violations and the amount of property damage **Summary measure** Percentage change for each year after the intervention year, using 1 year prior to the intervention as the baseline rate. Results were calculated for the different crash types (overall, injury, night-time, alcohol, and those resulting in hospitalisation) and were presented for 16 year olds alone	A total of 13 studies evaluating 12 GDL programmes that were implemented between 1979 and 1998 in: ● USA (n = 7) ● Canada (n = 3) ● New Zealand (n = 1) ● Australia (n = 1)	● Reductions in crash rates were seen in all jurisdictions and for all crash types ● Among 16 year old drivers, the median decrease in per population overall crash rates during the first year was 31% (range 26–41%) ● Per population injury crash rates were similar (median 28%, range 4–43%) ● Results for all teenage drivers, rates per licensed driver and rates adjusting for internal controls were generally reduced when comparing within jurisdictions ● All of the studies reported positive findings, with reductions for all types of crashes among all teenage drivers. However the size of the reductions varied, and it is not possible to say which aspects of GDL programmes have the biggest effect ● The authors conclude that the existing evidence shows that GDL is effective in reducing the crash rates of young drivers, although the magnitude of the effect is unclear	The authors note: ● the variability in the design and strength of different programmes ● that ecological studies are recognised as methodologically weaker ● that studies with short follow-up periods may be reporting misleading findings ● that a limitation of the review is that specific recommendations cannot be made regarding programme design ● that caution should be exercised when comparing results across studies because of the many factors that could influence crash rates
Specific mention of inequalities None identified						

Table 6: Characteristics of the studies in the included reviews (Klassen et al.)

Author, year, country	Objective, search dates	Inclusion/exclusion criteria	Outcomes	Number of primary studies included	Results/findings	Comment
Klassen et al. (2000) Canada	To define community-based interventions and systematically review relevant literature to ascertain the effectiveness of such approaches in reducing childhood unintentional injuries Search dates 1966–1998	Inclusion criteria ● Studies included a control group that did not receive the intervention ● The target population was between 0 and 19 years of age ● Studies examined the effectiveness of a community-based intervention ● Studies reported injury rates or change in an injury-reducing behaviour	Most of the studies examined safety behaviours; only four studies examined injury outcomes .	A total of 32 trials that evaluated the effect of a community-based injury control intervention in child injury rates, safety behaviours, or the use of safety devices were identified in this review. This article focuses on 28 studies (6 of which were RCTs) targeting: ● bicycle helmet use (n=12, of which two were evaluations of the same intervention) ● automobile restraint use (n=5) ● pedestrian safety interventions (n=4) ● general injury prevention (n=4) ● adolescent alcohol use and vehicle safety (n=3) Another four studies were aimed at reducing the frequency of playing with guns, reducing football injuries, improving road safety behaviours of bicyclists, and improving burn prevention practices. However as only one study addressed each of these outcomes and none of the interventions had a positive impact, these studies are not discussed in this evidence briefing.	Programmes targeting bicycle helmet use Of 12 studies identified (NB: 11 interventions were identified; two studies were evaluations of the same intervention), four were relevant to 15–24 year olds. All four were non-randomised controlled trials. ● In one USA study, the review authors suggest that education and legislation significantly increased self-reported observed helmet use in the target group (children were aged under 16 years) compared with education alone in an adjacent community and a control community with no formal education or legislative effects in place ● One USA study found that multiple strategies, including school-based education, public/parent education and an economic incentive, significantly increased observed helmet use in the target population (children were aged 5 to 15) compared with a control community with the same characteristics (no further details provided) ($p < 0.001$) ● A Swedish study found that school-based education, public/parent education and an economic incentive resulted in a 3.1% decrease in the annual rate of bicycle injury leading to hospital care in the target group (children were aged under 16 years), compared with decreases of 2.9%, 2.2%, 3.4% and 1.1% in four control cities. Statistical significance was not reported ● A Canadian study found no significant effect of an education intervention on self report of risk-taking behaviour in the target population (children were from grades 8, 9 and 10; details of ages not provided – usual age range of children in these grades is 13–15/16) compared with a control group of same age teenagers from the same city (no further details provided) Programmes targeting motor vehicle restraint use Of five studies identified, one non-randomised controlled trial was relevant to the 15–24 year old age. This study found no significant effect of an educational intervention (in the form of emotionally charged information – not further defined) on seat belt use in the target population (children were high school students; details of age not provided – usual age range of junior and senior high school students is 12–17/18 years) compared with a control group of high school students in the same city. Only knowledge about the use of seat belts significantly increased in the target group compared to controls ($p < 0.01$).	Based on all identified studies, the authors make a number of comments, as follows. Programmes targeting bicycle helmet use Only two RCTs of community-based helmet promotion programmes were included in this review and nearly all studies focused on helmet or ownership use; only one looked at injury outcomes. The design of evaluations and the limited outcomes explored suggest that caution is warranted when interpreting results Programmes targeting motor vehicle restraint use Additional well-designed RCTs of community-based interventions that use these strategies would be useful to corroborate the findings of numerous non-randomised studies. Rigorous community-based studies focusing on motor vehicle restraint use among adolescents are also needed
Specific mention of inequalities One study looking at general injuries, Davidson et al. (1994), took place in a deprived community (Harlem, USA), targeting children aged 5–16 years and their parents/carers. A package of measures including school-based education, engineering and environmental improvements, economic incentives and community activities (eg sports, arts) was effective in reducing targeted injuries presented to hospital over a 9 year campaign period in the intervention group (post-intervention decrease of 50% in target group; post-intervention decrease of 30% in a control community in the same city)						

Table 6: Characteristics of the studies in the included reviews (Klassen et al.) (cont.)

Author, year, country	Objective, search dates	Inclusion/exclusion criteria	Outcomes	Number of primary studies included	Results/findings	Comment
					Pedestrian safety interventions Of four studies identified, none were relevant to the 15–24 age range. **General safety campaigns** Of four studies identified, one non-randomised controlled trial was relevant to the 15–24 age range. This study found that following school-based education, engineering and environmental improvements, economic incentives and community activities such as sports and arts, hospital presentation of injuries targeted by the campaign (all injuries related to vehicles, outdoor falls, assaults and guns) significantly decreased in the target group (children were aged 5 to 16) over the 9 years from 1983 to 1991 compared with rates of non-targeted injuries (poisoning, burns, etc – no others stated) in a control community during the same period ($p < 0.001$). **Programmes targeting adolescent alcohol use and vehicle safety** Of three studies identified, two were relevant to the 15–24 year old age, one RCT and one non-randomised controlled trial. ● One USA RCT found a significant effect of a school-based curriculum on knowledge about alcohol, its physiological effects, and resisting pressure to drink among the target population (adolescents were grade 10 students; details of age not provided – usual age range of grade 10 students is 15/16 years) and again in the 12th grade (details of age not provided – usual age of grade 12 students is 17/18 years), with no change among controls (higher knowledge scores with intervention, $p < 0.001$, however it is not clear whether this relates to comparison between groups or within the target group) ● One USA non-randomised controlled trial found a significant effect of a week-long module on injury control and crash safety information in a high school physics course on knowledge, reported seat belt use when riding as a passenger, and intention of always wearing a seat belt in the intervention group at 2 year follow up (increase in knowledge with intervention, $p = 0.001$). Seat belt use increased from 70% to 80% in the intervention group, but only 67% to 70% among controls (increased use of seat belts with intervention, $p = 0.01$)	**Pedestrian safety interventions** Future investigations using rigorous methodological designs are necessary to quantify the benefits or shortcomings of environmental approaches, because they are gaining popularity over educational interventions **General safety campaigns** Future campaigns should employ rigorous study designs to evaluate programme impact. As the success of broad-based programmes is likely to depend on an impetus for change that comes from community constituencies, randomly assigning a community to receive the intervention, whether or not the community expresses a desire for change, may diminish programme success **Programmes targeting adolescent alcohol use and vehicle safety** The failure to influence adolescent behaviour may reflect interventions that were poorly designed for this age group

Table 7: Characteristics of the studies in the included reviews (Olsen et al.)

Author, year, country	Objective, search dates	Inclusion/exclusion criteria	Outcomes	Number of primary studies included	Results/findings	Comment
Olsen et al. (2004) Canada	To examine evidence on the effectiveness of current injury prevention strategies in soccer **Search dates** From the earliest records available	**Inclusion criteria** ● Studies addressed prevention of unintentional injuries ● Studies evaluated the effectiveness of: a) an educational injury prevention programme/strategy b) a policy/regulation/legislative change c) a community organisation effort d) environmental, equipment, or product modifications ● Studies contained as an outcome: a) injury incidence (excluding reinjury) b) injury severity c) uptake of risk reducing behaviours d) uptake or compliance with injury prevention measures ● Studies contained a control group in its methodological design or used other comparative measures. **Exclusion criteria** ● Studies that had biomechanical measures as an outcome related to injury (eg torque, resistance or absorption)	The four studies included in the review had a range of primary outcome measures: ● injury incidence and absence from games and practices ● incidence of anterior cruciate ligament injuries ● incidence of heat exhaustion ● incidence of injuries (team injury rates)	Forty-four studies were identified. Four included in this review. Two were conducted in the USA and the others in Sweden and Italy. One was an RCT, one a non-equivalent control group design and two were time series studies. All studies addressed organised competitive soccer, but they covered a range of intervention strategies and the strength of evidence provided varied	● A Swedish RCT found that a multicomponent prophylactic training programme targeted at male soccer players aged 17–36 which included education, information, correction and supervision of training, and provision of equipment such as leg guards and ankle taping, reduced injuries in the intervention teams by 75% at six month follow up compared with controls ($p < 0.001$). ● An Italian-based non-equivalent control group study found that a proprioceptive training programme aimed at teams of male professional and amateur soccer players (age not reported), which included a five phase pre-season training programme, reduced the incidence of anterior cruciate ligament injuries to 0.15 per team per season in the intervention teams compared with 1.15 per team per season in the control teams ($p < 0.001$) ● A USA time series study found that a strength training programme aimed at male college soccer team players (age not reported), which consisted of exercising upper and lower body muscles separately twice a week, reduced injuries for the two years that included the strength training (7.99 per 1000 exposures) compared with the previous two years that did not include the strength training (15.15 per 1000 exposures) ● A USA time series study aimed at male and female soccer tournament players aged 9 to 19, which consisted of preventive measures to reduce heat exhaustion, decreased the rate of heat exhaustion per 1000 player hours from 21 cases in the first 2 days of the tournament to 13 cases in the last 4 days of the tournament. Statistical significance was not provided The review authors conclude that as the four studies examine different intervention approaches definitive conclusions cannot be drawn	In the Swedish study it was not possible to assess the relative contribution of different components of the intervention The study authors of the Italian-based non-equivalent control group study note the potential confounding effect of the study design and conclude that the reduction in injuries cannot be attributed to the strength training programme with any certainty; the review authors concur The review authors remark that owing to major limitations in the USA time series study on preventive measures to reduce heat it is not possible to draw conclusions on the effectiveness of the measures
Specific mention of inequalities None identified						

Table 8: Characteristics of the studies in the included reviews (Roberts et al.)

Author, year, country	Objective, search dates	Inclusion/exclusion criteria	Outcomes	Number of primary studies included	Results/findings	Comment
Roberts et al. (2004) UK	To assess the effect of school-based driver education on licensing and road traffic crashes involving young people (aged 15–24 years) Search dates 1968–2000	Inclusion criteria ● RCTs ● Studies comparing school-based driver education with no driver education ● Studies targeting young people (15–24 years)	● Driver licensing (as either the proportion of students who have obtained a driving licence at the end of the trial period or time from randomisation to licensing) ● Road traffic crashes ● Road related injuries (fatal and non-fatal)	Three RCTs, from Australia, the USA and New Zealand	● The RCTs found no significant effect of school-based driver education programmes on road traffic crashes involving young adults compared with no driver education ● The Australian RCT found that 42% of students in both the intervention and control group had one or more crashes since being licensed (RR 1.01, 95% CI 0.83 to 1.23) ● The USA RCT found that 27.5% of the intervention group and 26.7% of the control group had been involved in one or more crashes as a driver (RR 1.03, 95% CI 0.98 to 1.09) ● The New Zealand RCT found that 16% of the intervention and 14.5% of the control group had experienced crashes (RR 1.10, 95% CI 0.76 to 1.59) ● Two RCTs from the USA and New Zealand found that driver education programmes encourage earlier licensing compared with no driver education ● In the USA RCT 87% of students in the driver education group obtained their driving licences, compared with 84.3% in the control group (RR 1.04, 95% CI 1.02 to 1.05) ● In the New Zealand RCT the time for trial enrolment to licensing was 111 days for males and 105 days for females who had received driver education, compared with 300 days for males and 415 days for females who had not received driver education	The review authors note that applying these findings to UK settings may be limited
Specific mention of inequalities None identified						

Results

This section summarises the findings of the Evidence Base papers under the following headings:

Prevention of accidental injury on roads

Five reviews were identified that address the prevention of accidental injury to young adults (aged 15–24) on roads – Coleman et al. 1996; Elkington et al. 2000; Evans et al. 2001; Roberts et al. 2001; Hartling et al. 2005. Prevention of accidental injury on roads is also addressed in the section titled, 'Community-based injury prevention', p43.

The effectiveness of interventions to prevent accidental injury to young persons aged 15–24 years: a review of the evidence (Coleman et al. 1996)

This systematic review sought to review the effectiveness of interventions aiming to prevent accidents or minimise injury among adolescents and young adults aged 15–24. The authors reviewed interventions in a variety of settings, including road, sport, work, home and community.

All studies assessing the effectiveness of an intervention for the prevention of accidental injury either specifically in the 15–24 age group or in a population that may have relevance to this age group were graded by the review authors as follows:

- evidence from at least one well designed randomised controlled trial (RCT) – grade I
- well designed, non-randomised controlled trials – grade II-1
- well-designed cohort or case controlled analytic studies – grade II-2
- multiple timed series with or without the intervention or uncontrolled experiments – grade II-3
- opinion of respected authorities, descriptive studies or reports of expert committees – grade III
- studies with significant methodological problems (eg poor sample size, inadequate follow-up etc) – grade IV.

Where a number of studies of the same intervention were identified, the evidence received a single overall grade equal to that of the highest graded study included.

Based on the quality of evidence identified for each topic, Coleman et al. made recommendations for practice depending on whether the evidence to support the intervention was good (grade A), fair (grade B) or poor (grade C). A further two grades recommended rejection of use of the intervention: fair evidence to reject was graded D and good evidence to reject graded E. Consistent with this strategy, this evidence briefing restricts review-level evidence statements of effectiveness to those arising from the higher quality grade A and B studies. Interventions with recommendations of grade C and below are graded as 'insufficient' evidence.

The review authors note that as few papers were identified that specifically related to accidental injury prevention on the roads for the target age group (15–24), papers of 'general relevance' to this topic were also included.

CYCLISTS AND MOTORCYCLISTS

Cycle helmets

Ten papers from the UK, USA and Australia (individual study designs not specified; overall quality grade II-2; recommendation grade B) related to injury prevention with cycle helmet use. Coleman et al. conclude that helmet use is associated with a reduced risk of head and upper facial injury in cycle accidents, whether or not a motor vehicle is involved. One additional study from Australia (quality grade II-2; recommendation grade B) found that decreased head injury severity is associated with increased helmet robustness.

The review authors note that there is roadside survey evidence from Australia and the USA (citation not reported) that indicates that cycle helmet use is particularly low among adolescents, and barriers to wearing cycle helmets include peer pressure, discomfort and the perceived unattractiveness of the helmet.

The authors identified a number of studies that sought to assess the effectiveness of different approaches to promote cycle helmet use. The first of these is a study from Australia (grade II-3; recommendation grade C) that found that a coordinated multi-agency campaign to promote cycle helmet use can increase the prevalence of helmet use in the year following the campaign, although the effect was greater in younger schoolchildren than in adolescents. Conflicting evidence was found from two studies from the USA (quality grade I; target group not specified) that assessed physician or telephone communication to promote cycle helmet use for the effect on the likelihood of buying or wearing a helmet.

Motorcycle helmets

Coleman et al. identified five studies from the USA (overall grade II-3; recommendation grade E) that indicate that repealing laws for motorcycle helmet use is followed by an increase in motorcycle fatalities of 25–40%. Two further studies from the UK and Australia (overall grade III; recommendation grade B) have shown that full-face helmets reduce the risk of facial injury in motorcycle accidents compared with 'traditional' helmets.

Cyclist/motorcyclist conspicuity

The review authors identified two field trials conducted in the UK (grade I; recommendation grade C), that assessed the effectiveness of measures to increase cyclist conspicuity. The first study found that reflective rods or flags, particularly longer ones (0.5m), fixed to the rear offside of bicycles were effective in reducing the proportion of close overtaking by other vehicles. Likewise, reflective jackets were found to improve conspicuity in the second trial, although armbands and 'Sam Browne' belts did not significantly improve conspicuity.

The review authors conclude that although interventions are effective in increasing cyclist conspicuity, the effectiveness of such interventions in reducing the risk of accidents remains unknown.

Similar findings were observed in trials with motorcyclists. Although two trials from the UK (grade I; recommendation grade C) found that the use of daytime headlights, running lights and fluorescent jackets increased motorcycle conspicuity, comparative studies from the USA (grade II-3; recommendation grade D) failed to show any effect of daytime headlight use on accident rates in states where such use is mandatory.

Motorcycle design

Coleman et al. note that research on motorcycle design features for the reduction of accidents or rider injury was still in the developmental stage and that it is too early to conclude whether or not interventions will be effective. Some promising interventions identified include provision of airbags (grade II-3; recommendation grade C), anti-locking or coupled braking systems (grade I; recommendation grade C) and vehicle-mounted leg protection (grade I; recommendation grade C).

Motorcycle rider training

The review authors identified five studies conducted in the UK, Canada, Australia and the USA (overall grade II-2; recommendation grade B/C) that assessed the effectiveness of a motorcycle training scheme for new riders in reducing accident rates. The majority of studies found no effect of motorcycle training schemes on accident rates, although one found an increase in accident risk and another found an initial reduction in risk, but this effect diminished after 2 years. A number of studies found that trained riders make greater use of protective clothing, although the review authors note that any differences between riders who seek training and those who do not may also be a result of selection bias rather than any direct effect of the intervention.

Motorcycle legislation

The review authors identified one study (grade II-3; recommendation grade B) that evaluated the effect of the introduction of the 1981 UK Transport Act, which imposed an extended riding test, and limited provisional licences to 2 years and engine size to 125cc for learner riders. They note that although the number of accidents among learner riders fell following the legislation, it is not entirely clear whether this reduction is attributable to the Act's training or engine size provisions, or the reduction in the number of learner motorcyclists on the road.

ALL ROAD USERS

Driver education and training

Coleman et al. identified a number of reviews and primary studies assessing the effect of educational and training interventions on accident rates. The majority of these studies assumed a direct link between information, attitudes, intention and behaviour and suggested that changes in behaviour will arise if adolescents are given information about the risks and consequences of risky behaviour.

Five studies from the UK and USA (grade II-1/II-2; recommendation grade C/D) found that pre-licence driver education and training courses had little or no effect on accident rates. Likewise, one study (grade II-1; recommendation grade D) of a driver improvement programme designed principally for 'high-risk' problem drivers, and comprising education, threats and inducements, found no positive effect and reported that an increase in crash rates sometimes occurred.

Six studies from the UK and USA (grade II-1/11-2; recommendation grade C/D) were identified that assessed the effectiveness of providing information in changing risky behaviour such as preventing drink-driving and promoting seat belt use. The review authors found that, overall, such programmes have not been demonstrated to be successful, suggesting that information provision alone is not sufficient to promote behaviour change.

Legislative or regulatory measures

The review authors identified few primary studies assessing the effectiveness of legislative interventions, or methods of enforcing existing legislation, in reducing accidents among 15–24 year olds. Four studies conducted in Canada and the USA (overall grade II-3; recommendation grade B) found that raising the minimum driving age would have a substantial positive impact on driver accident rates.

Likewise, seven studies from the USA (overall grade II-1; recommendation grade A) found that raising the legal drinking age above 18 years resulted in a decrease in young driver and passenger fatalities. Conversely, the review authors conclude from three studies from the UK, Finland and Canada (overall grade II-3/III; recommendation grade B/C) that the evidence for the effectiveness of stricter enforcement of drinking and driving laws or random breath testing is less clear cut and it is difficult to assess the degree of benefit such measures could provide for preventing accidents involving young drivers.

Finally, two studies from the USA (overall grade II-2; recommendation grade B) found that curfew laws that prohibit young people from driving during late evening or early morning hours are effective in reducing young driver accident rates, and may also delay the age at which drivers obtain or seek to obtain driving licences.

Environmental engineering measures

Coleman et al. note that although there have been numerous environmental engineering developments that have affected accident rates, most are relevant to the improved safety of all road users and are already widely implemented. For this reason they only considered the effectiveness of two comparatively recent developments: speed control humps and area-wide low cost urban safety schemes, as these are particularly relevant to cyclists and pedestrians and are likely to be applicable to young people.

One study from the UK (grade II-1; recommendation grade C) found that introducing speed humps resulted in a small reduction in total casualties, principally in pedestrians. Two studies from the Netherlands and the UK (overall grade II-1; recommendation grade B) found conflicting results for area-wide measures in urban safety projects. The study from the Netherlands reported an average reduction in casualties of 13% and a particularly marked reduction among child cyclists and motorcyclists. Conversely, the UK study found no evidence that the number of fatal or seriously injured casualties fell with urban safety projects.

Vehicle engineering measures

The review authors note that there have been numerous engineering developments to improve the safety of vehicles for occupants. However, they only considered the effectiveness of two comparatively recent developments: vehicle safety inspections and random roadside testing; and fitting air bags.

One RCT from Norway (grade I; recommendation grade E) found that when random roadside testing was present, the addition of periodic vehicle testing had no effect on

accident rates. Two cross-sectional studies from the USA (grade II-2; recommendation grade B) found that fitting air bags can reduce the number of driver fatalities in frontal impacts by about 15% even when the drivers are wearing seat belts.

Inducements

The review authors note that there is limited evidence for the effectiveness of economic or other inducements to alter behaviour to reduce accidents in adolescent populations. Two studies from the UK (grade II-2; recommendation grade B) looked at the impact of changes in bus fare pricing on the mode of travel. The first study found that subsidising bus fares resulted in an increase in bus travel rather than an alteration in the method of travel, whereas the second study found that sudden changes in the relative cost of bus travel brought about a change in the mode of travel. Coleman et al. report that there was some evidence of a reduction in casualties per kilometre travelled (not further described).

Finally, the review authors identified one study from the USA (grade II-2; recommendation grade C) that assessed the effectiveness of providing rewards for seat belt use. The authors report that there were positive effects on children (not further described), although there was also an indication that the targeted behaviour may return to baseline after the withdrawal of reinforcements.

Multi-factorial approaches

The review authors identified five studies from the USA (four grade II-2, one IV; all recommendation grade C) that employed several methods in an attempt to change driving behaviour. The authors conclude that interventions that target a variety of behavioural aspects are more likely to be effective than programmes that target only one or two aspects. All interventions reviewed used surrogate measures of accident frequency, eg self-reported behaviour, reduction in violation rate, so the effect on reduction of accident rates is yet to be determined.

A systematic review of the evidence on preventing injuries to young people (15–24 years) (Elkington et al. 2000)

This systematic review sought to review the evidence of effectiveness of educational and other injury prevention strategies for young people (aged 15–24). The review authors also aimed to identify those elements of school-based injury prevention programmes that are required for maximum effectiveness (knowledge and behaviour change for injury reduction) and how educational approaches best fit within a comprehensive injury-prevention model for young adults

To be included in the review, studies had to evaluate interventions for the prevention of injury aimed primarily at young people (15–24 years) and be published primary studies (from 1996 to 1999), existing literature reviews (from 1986 to 1999) or unpublished reports from pertinent Australian organisations (such as government, non-government and academic institutions, published from 1996 to 1999). Only those studies and reviews that had received a quality rating of 'weak' to 'very good' were included.

Elkington et al. identified 17 published articles and nine reports or papers available through conference proceedings, government or university publications and unpublished or draft reports from key organisations. Although the review authors included the review by Coleman et al. (1996) the findings of this review have been discussed in detail above and will not be presented here.

The review authors present their findings by intervention type (eg school-based programmes, peer mediation, media-based programmes etc) and also according to the evidence of what works to prevent injuries for each injury setting (eg road, sports, workplace etc). The latter approach is consistent with that adopted in this evidence briefing so the discussion will not include findings relating to intervention type.

A total of 11 primary studies (design not specified; two rated 'good' quality, seven 'reasonable' and two 'fair') and five reviews (two rated 'good' quality, one 'reasonable' and two 'fair') were identified that addressed prevention of injuries to young people on roads.

Legislative or regulatory measures

Elkington et al. conclude that legislation and enforcement for road safety is the most successful intervention for the prevention of injuries to young people (aged 15–25). They note that significant reductions in road trauma were observed with:

- random breath testing
- speed cameras
- seat-belt legislation
- compulsory wearing of helmets for motorcyclists and cyclists
- graduated drivers' licensing schemes
- raising the legal age for alcohol consumption
- raising the legal driving age.

The review authors further note that there is evidence to suggest that the impact of legislative or regulatory measures is likely to be further enhanced through enforcement measures, multimedia campaigns and other supportive strategies such as increasing access to bicycle helmets.

Engineering measures

The review authors conclude that there is reasonable quality evidence to support the promotion of full-face helmets for motorcyclists and fitting airbags (for use in conjunction with seat belts) as measures to provide 'passive' or automatic protection for injury risk reduction for young people.

Driver education programmes

Elkington et al. conclude that the evidence concerning educational approaches for the promotion of road safety in young people is less clear cut, with comparably fewer good quality studies identified.

One primary study reported a significant decrease in some behavioural outcomes 3 years after a school-based programme that promoted skills development for avoiding drink-driving situations. One review found no 'convincing' evidence that driver education reduces motor vehicle crashes among young drivers.

The review authors note that few other school-based programmes were able to demonstrate impacts beyond short-term knowledge or attitude change regarding road safety issues.

Community-based approaches

The review authors identified one poor quality study that addressed road trauma prevention through community-based approaches (not further described). Although this study reported a reduction in school-age pedestrian injuries it failed to present any process or impact evaluation that would attribute change in injury rates to the intervention.

Motor-vehicle occupant injury: strategies for the increasing use of child safety seats, increasing use of safety belts and reducing alcohol-impaired driving (Evans et al. 2001)

This systematic review sought to review interventions designed to encourage the use of child safety seats and seat belts, and deter alcohol-impaired driving.

To be included in the review, studies had to be controlled investigations of intervention effectiveness (ie not review-level or secondary studies) that had been carried out in a developed country and published in English between 1966 and June 2000. Outcomes considered include the use of child safety seats or safety belts, decreases in alcohol-impaired driving and decreases in motor-vehicle crashes or crash-related injuries.

The review authors graded the strength of the body of evidence of effectiveness as 'strong', 'sufficient' or 'insufficient' on the basis of the number of available studies, the suitability of study designs for evaluating effectiveness, the quality of the study design, the consistency of results and the effect size.

A total of 175 studies (countries not stated), in which 12 interventions were evaluated, were included in the review. Based on the strength of the evidence of effectiveness, the authors either 'strongly recommend' or 'recommend' 11 interventions that encouraged the use of child safety seats, seat belts or deterred alcohol-impaired driving.

Prevention of accidental injuries to children aged below 15 is outside the remit of this evidence briefing so findings relating to the use of child safety seats are not reported here.

Safety belt use

The review authors strongly recommend three interventions that encourage the use of safety belts. These include laws requiring use, primary enforcement laws and enhanced enforcement programmes.

The authors identified 34 primary studies from the USA assessing the introduction of laws requiring the use of safety belts by motor-vehicle occupants not covered by the child safety seat laws. Introduction of safety belts laws resulted in:

- increased observed safety belt use (nine studies: median increase 32%, range 19.6% to 36.3%)
- increased self-reported safety belt use (four studies: median increase 15.8%, range 13% to 18.7%)
- increased police-reported safety belt use (two studies: range in increase 20.4% to 26%).

Consistent with these findings, introduction of safety belt laws also resulted in overall reductions in:

- non-fatal injuries (six studies: median reduction 3.5%, range 14.5% to increase of 10.6%)
- fatal injuries (seven studies: median reduction 8.4%, range 9% to 5%)
- fatal and non-fatal injuries (nine studies: median reduction 8.3%, range 19.7% to 2.6%).

A total of 13 studies were identified that assessed the introduction of either primary enforcement laws for safety belt use (such as allowing a police officer to stop a vehicle solely for an observed belt law violation) or secondary enforcement laws (where a police officer is allowed to issue a belt law citation only if the vehicle has been stopped for another reason). Compared with secondary enforcement laws, primary laws resulted in:

- an increase in observed safety belt use (five studies: median increase 14.1%, range 12% to 22.6%)
- an increase in self-reported safety belt use (two studies: range 22% to 1%)
- an overall reduction in the proportion of fatal injuries (three studies: median reduction 7.7%, range 13.9% to 3.1%).

Finally, 16 studies were identified that assessed the introduction of enhanced enforcement of safety belt laws. Interventions comprised increased enforcement (as compared with routine enforcement) to target violations of safety belt laws at specific locations and times. The authors note that media campaigns to publicise the enforcement activity were also important components. Enhanced enforcement of safety belt laws resulted in:

- an overall increase of observed safety belt use (16 studies: median increase 17%, range 8.3% to 24%)
- a reduction in fatal and non-fatal injuries (two studies: range of reduction 6.7% to 15.3%).

Interventions to deter alcohol-impaired driving

Evans et al. recommend four interventions to reduce alcohol-impaired driving. These include strong recommendations for laws imposing a limit of 0.08% blood-alcohol concentration (BAC), laws requiring a minimum drinking age of 21 and sobriety checkpoint programmes, and recommendations for introducing lower BAC limits for young people and inexperienced drivers.

The authors identified nine primary studies assessing the introduction of laws lowering BAC levels from 0.1% to 0.08% at which it is illegal to drive a motor vehicle. Introduction of such laws resulted in a reduction in alcohol-related fatal motor vehicle accidents (25 measures [not further defined]: median reduction 7%, range 15% to 4%).

A total of 33 studies were identified that assessed the impact of introducing laws governing a minimum legal drinking age (MLDA) of 21, below which the purchase or consumption of alcoholic beverages is not permitted. Studies found that increasing the MLDA resulted in an overall reduction in:

- fatal vehicle accidents (nine studies: median reduction 17%, range 30% to 7%)
- injurious accidents (four studies: median reduction 15%, range 33% to 6%)
- other accidents (two studies: range 21% to 18%).

Conversely, studies reported that lowering the MLDA resulted in an increase in the number of:

- fatal accidents (three studies: median increase 8%, range 2% to 38%)
- injurious accidents (four studies: median increase 5%, range from a reduction of 2% to an increase in 22%)
- other accidents (two studies: range in increase from 2% to 38%).

The review authors note, however, that there is insufficient evidence about the impact of raising the MLDA on alcohol-related accidents among adolescent drivers not directly affected by the change in law.

Six studies were identified from Australia and the USA that assessed the impact of introducing separate lower BAC levels for young and inexperienced drivers. The review authors note that in the USA the laws apply to all drivers under the MLDA whereas in other countries the laws typically apply to either newly licensed drivers or newly licensed drivers under a specified age. Overall, studies reported a reduction in alcohol-related fatal accidents (three studies: median reduction 17%, range 24% to 9%), and in injurious accidents (two studies: range in reduction from 17% to 4%).

Finally, the authors identified 23 studies that assessed the introduction of either random breath testing checkpoints (where all drivers stopped are given breath tests for BAC) or selective breath testing checkpoints (where police must have reason to suspect the driver has been drinking before using breath tests). Introduction of random breath testing resulted in a reduction in:

- fatal accidents (six studies: median reduction 22%, range 36% to 13%)
- injurious accident outcomes (11 studies: median reduction 18%, range 21% to 12%)
- other accidents (two studies: range in reduction 26% to 15%).

Likewise, selective breath testing also resulted in a reduction in:

- fatal accidents (two studies: range in reduction 26% to 20%)
- injurious accidents outcomes (six studies: median reduction 21%, range 24% to 5%)
- other accidents (five studies: median reduction 21%, range 35% to 13%).

The review authors conclude that there was no discernible difference in effectiveness between random and selective breath testing, with a similar magnitude of effects being observed at both long- and short-term follow-up. The authors also suggest that media campaigns that publicise the enforcement activity are an important component of the intervention.

Graduated driver licensing for reducing motor vehicle crashes among young drivers (Hartling et al. 2005)

This Cochrane review examined the effectiveness of graduated driver licensing (GDL) systems in reducing the crash rates of young drivers. GDL schemes have been proposed as a means of reducing crash rates among novice drivers by gradually introducing them to higher risk driver situations. In an ideal GDL programme the first stage requires that an adult with a valid licence be present with the new driver at all times; the second intermediate stage allows the new driver to drive alone but with certain restrictions, such as night-time driving and/or limitations on extra passengers, and the final stage permits the driver to drive independently under the usual laws and regulations.

Studies were included if they:

- compared outcomes pre- and post-implementation of a GDL programme within the same jurisdiction
- made comparisons between jurisdictions with and without GDL, and reported at least one objective and quantified outcome.

The primary outcome of interest was overall crash rates of teenage drivers (ie crashes involving fatalities, injuries and property damage only). Secondary outcome measures included rates of injury crashes, hospitalisations, fatality crashes, night-time crashes, drink-driving crashes, traffic violations and the amount of property damage.

This review identified 13 studies evaluating 12 GDL programmes that were implemented between 1979 and 1988 in the USA (n = 7), Canada (n = 3), New Zealand (n = 1) and Australia (n = 1). Two were identified in peer-reviewed medical journals and 11 were identified through grey literature (two of these 11 were subsequently published in peer-reviewed journals). All studies obtained data from routinely collected sources such as police reports, hospital records and census data.

Four studies used both internal and external control groups (eg from different age groups or different jurisdictions) to control for factors beyond the GDL programme that may have affected outcome; eight studies used internal control groups only (eg a different age group from the same jurisdiction), and only one study had no control group. Results from component studies were not pooled owing to statistical heterogeneity and a range of other study and

programme differences (for example, study and programme quality and design, and definition of outcomes).

The authors over-riding premise was that ecological studies* are among the methodologically weaker study designs, a specific concern being the inability to fully control for other explanatory factors. They assessed threats to the validity of ecological studies according to work by Hingson et al. (2001), which focuses on, for example, measurement error, control groups and statistical methods.

The quality of the GDL programmes was rated as either 'good', 'acceptable', 'marginal' or 'poor', based on the USA's Insurance Institute for Highway Classification (IIHC) scheme. A good programme includes:

- a mandatory learner's permit holding period of at least 6 months
- optimal restriction on the initial licence: either an optimal night driving restriction (curfew begins before midnight) or an optimal passenger restriction (no extra passengers unless supervised) lasting until age 17.

A poor programme includes:

- no mandatory learner's holding period
- no night driving or passenger restrictions during the intermediate stage or mandatory learner's holding period less than 6 months and no other significant elements of graduated licensing.

Of the 12 programmes identified none were graded good, six were acceptable, five were marginal and one was poor. Percentage change was selected as the summary measure and calculated for each year after the intervention year. Rates were adjusted to take account of internal controls (owing to lack of data, rates adjusted for external controls were not calculated). The authors recognise that unadjusted values may overestimate the impact of a programme. They present unadjusted percentage change and adjusted percentage change to compare changes between the first year after programme implementation with the last year prior to the year of implementation, and to reflect changes between the last year evaluated post-implementation and the last year prior to implementation.

Results were calculated for the different crash types (overall, injury, night-time, alcohol, and those resulting in hospitalisation) and were presented for teenagers and 16 year olds only. 'Teenagers' are not defined in this review, but descriptions of GDL schemes report a minimum initial stage age of between 14 years, 9 months and 16.

The GDL programmes varied substantially in terms of the minimum age, minimum holding periods, and restrictions and requirements at each stage. The authors were unable to find any consistent patterns when examining the results by the quality of the programmes, possibly because of the limited number of studies and/or the wide variation in programmes.

For overall crashes (including driver-involved fatal, injury, and property-damage only crashes) among 16 year olds, the reductions in per-population crash rates for the first year post-GDL ranged from 26% to 41% (four studies). For injury crashes (fatal and non-fatal injury), per-population reductions for 16 year olds ranged from 4% to 43% (seven studies). In general, adjusted rates were more conservative than the unadjusted rates.

All of the studies reported positive findings, with reductions for all types of crashes among all teenage drivers, although the size of the reductions varied. Overall, the evidence indicates that GDL is effective in reducing the crash rates of teenage drivers, although the magnitude of the reduction is unclear. Reductions were seen for all types of crashes among 16 year olds and all teenage drivers, although the impact varied across jurisdictions and the evidence did not allow the authors to report which aspects of GDL are most effective.

School based driver education for the prevention of traffic crashes (Roberts et al. 2001)

The review authors note that in the UK drivers aged 17–21 make up just 7% of licence holders but 13% of drivers involved in injurious road traffic crashes. The British government sought to tackle the problem of young adult road deaths and injuries with a driver education programme offered to students aged 16–18 in school and college. The education package was developed by the Driving Standards Agency (DSA) and the executive agency of the Department of Environment, Transport and the Regions (the then DETR, responsible for driving tests in Britain, now the Department for

* Ecological studies – studies carried out over a period of time in one area and often used to study the effect of legislation – see Stevenson M, McClure R (2005) Use of ecological study designs for injury prevention. *Injury Prevention* 11: 2–4.

Transport) and funded from driving test fees. The DSA school programme comprises presentations by driving examiners about selecting a driving instructor, theory and practical tests, and a range of road safety issues.

Although driver education has long been used as a road safety strategy, there is considerable concern that it may also encourage teenagers to obtain a driving licence and start driving sooner than they would in the absence of driver education. As teenagers have a higher risk of road death and serious injury than any other age group, the review authors note that earlier licensing could offset any beneficial effect of driver education by increasing the number of road traffic crashes involving teenagers. This Cochrane systematic review therefore sought to assess the effect of school-based driver education on licensing and road traffic crashes in young people (aged 15–24).

To be included in this review, randomised controlled trials (RCTs) had to compare school-based driver education with no driver education in young people (aged 15–24) who had not yet obtained a driving licence. Outcomes assessed included driver licensing (either as the proportion of students who had obtained a driving licence at the end of the trial or time from randomisation to licensing), road traffic crashes and road-related injuries (both fatal and non-fatal).

Three RCTs were included within the review. The first trial was a cluster RCT (n = 779 male learner drivers aged 17–19) from Australia in which schools (number not specified) were randomly assigned to a control group (no training) or one of three driver education courses:

- A: 11 hours of theoretical instruction, 5 hours of on-road and off-road driving and 6 hours in-car observation
- B: 11 hours of theoretical instruction, 5 hours of off-road driving and 6 hours in-car observation;
- C: 2 hours of theoretical instruction, 5 hours of off-road driving).

The trial found no significant difference between those students who had received school-based driver education and those who received no formal training in the proportion who had at least one traffic accident since being licensed (230/549 [42%] with driver education vs 80/193 [42%] with no formal training; RR 1.01, 95% CI 0.83 to 1.23).

The second RCT was from the USA and randomised high school students (n = 16,338) either to a control group (no formal driver education) or to one of two driver education programmes:

- the 'safe performance' curriculum (SPC), which comprised 72 hours of formal instruction and testing
- the 'pre-driver licensing' curriculum (PDL), which comprised the minimum training required to pass the driving test and involved 24 hours of formal instruction and testing.

The trial found that significantly more students in the driver education groups had been licensed since course completion compared with those in the control group (9510/10,894 [87%] with driver education vs 4588/5444 [84.3%] with no driver education; RR 1.04, 95% CI 1.02 to 1.05). There was no significant difference between groups in the number of students who had been involved in one or more crashes as a driver (3000/10,894 [27.5%] with driver education vs 1456/5444 [26.7%] with no driver education; RR 1.03, 95% CI 0.98 to 1.09).

The final RCT was from New Zealand. Secondary school students aged 15–18 (n = 848) were randomly assigned to receive either a driver training programme (comprising 8 hours behind-the-wheel instruction, 8 hours as a passenger while another student is instructed, eight lectures on road traffic law and correct attitudes and two lectures on motor mechanics), or no formal driver training. It found that the mean time taken from trial enrolment to obtaining a driving licence was significantly shorter for those students (both boys and girls) in the driver education group than those in the control group (number of days to licensing for boys: 111 days with driver education vs 300 days with no driver education; $t = 7.19$; $p < 0.001$; number of days to licensing for girls: 105 days with driver education vs 415 days with no driver education; $t = 9.88$; $p < 0.001$). There was no significant difference in the number of students involved in road traffic crashes between those that had received driver education training and those that had not (90/561 [16%] with driver education vs 33/227 [14.5%] with no driver education; RR 1.10, 95% CI 0.76 to 1.59).

The review authors note that the applicability of these findings to the UK may be limited.The British DSA programme is less extensive than the programmes described above – the entire presentation lasts only 50 minutes, there is no behind-the-wheel driver training and a greater emphasis is placed on taking the driving test.

Evidence statements

MOTORCYCLISTS AND CYCLISTS

Motorcycle rider training

Currently, there is insufficient evidence from the UK, Canada, Australia and the USA that motorcycle rider training initiatives are effective in reducing accident rates (Coleman et al. 1996).

Cycle/motorcycle helmet use

There is review-level evidence from the UK, USA and Australia that helmet use is associated with a reduced risk of head and upper facial injury in cycle accidents whether or not a motor vehicle is involved. This effect increases with the robustness of the helmet design (Coleman et al. 1996).

There is review-level evidence from the UK and Australia that full-face helmets can reduce the risk of facial injury in motorcycle accidents compared with 'traditional' helmets (Coleman et al. 1996; Elkington et al. 2000).

There is review-level evidence from the UK, Australia and the USA that legislation making cycle helmet use mandatory is effective in increasing the proportion of cyclists who wear a helmet, in decreasing numbers of head injuries among cyclists and in decreasing the number of bicycle accidents of any kind (Coleman et al. 1996; Elkington et al. 2000).

There is review-level evidence that the impact of legislative or regulatory measures is likely to be further enhanced through enforcement measures, multimedia campaigns, and other supportive strategies such as increasing access to bicycle helmets (Elkington et al. 2000).

Currently, there is insufficient review-level evidence from the USA that repealing laws for motorcycle helmet use is followed by an increase in motorcycle fatalities (Coleman et al. 1996).

Currently, there is insufficient evidence from Australia and the USA that multi-agency campaigns or physician or telephone communication to promote cycle helmet use are effective (Coleman et al. 1996).

Currently, there is insufficient review-level evidence to suggest that legislation making cycle helmet use mandatory may have an overall net health cost by decreasing the overall amount of bicycle use (Coleman et al. 1996).

Cyclist/motorcyclist conspicuity

Currently, there is insufficient review-level evidence from the UK and USA that initiatives such as flags or jackets, daytime headlights and running lights are effective in increasing cyclist or motorcyclist conspicuity and reducing the proportion of close overtaking by other vehicles (Coleman et al. 1996).

Motorcycle design

Currently, there is insufficient review-level evidence from the UK and the USA that improving motorcycle design (such as provision of airbags, anti-locking or coupled braking systems and vehicle-mounted leg protection) for the reduction of accidents or rider injury are effective (Coleman et al. 1996).

Motorcycle legislation

Currently, there is insufficient review-level evidence from the UK that legislation imposing an extended riding test, and limiting provisional licences to 2 years and engine sizes to 125cc for learner riders, is effective in decreasing the number of accidents among learner riders (Coleman et al. 1996).

ALL ROAD USERS

Driver education programmes

There is review-level evidence derived from RCTs in the USA and New Zealand that driver education programmes encourage earlier licensing for young drivers (Coleman et al. 1996; Roberts et al. 2001).

There is review-level evidence derived from RCTs in Australia, New Zealand and the USA that driver education programmes for young adults are ineffective in reducing the number of road traffic accidents involving young drivers (Coleman et al. 1996; Elkington et al. 2000, Roberts et al. 2001).

Currently, there is insufficient evidence from the UK and USA that provision of information alone is effective in changing behaviour such as preventing drink-driving or promoting seat belt use (Coleman et al. 1996; Elkington et al. 2000).

Legislative or regulatory measures

There is review-level evidence from Canada and the USA that increasing the legal driving age would have a substantial positive impact on driver accident rates (Coleman et al. 1996; Elkington et al. 2000).

There is review-level evidence from the USA that raising the legal drinking age above 18 results in a decrease in young driver and passenger fatalities (Coleman et al. 1996; Elkington et al. 2000; Evans et al. 2001).

There is review-level evidence from the USA that curfew laws that prohibit young people from driving during late evening or early morning hours are effective in reducing young driver accident rates (Coleman et al. 1996).

There is review-level evidence that laws requiring the use of safety belts, or primary enforcement laws and enhanced enforcement programmes for safety belt use, are effective in increasing the use of safety belts and reducing the frequency of fatal and non-fatal injuries (Elkington et al. 2000; Evans et al. 2001).

There is review-level evidence that laws imposing a limit of 0.08% blood-alcohol concentration (BAC) or lower BAC limits for young people and inexperienced drivers are effective in reducing alcohol-related fatal motor vehicle accidents (Evans et al. 2001).

There is review-level evidence that random or selective breath testing checkpoints can result in significant reductions in road trauma (Elkington et al. 2000; Evans et al. 2001). However, Coleman et al. (1996) caution that it is difficult to assess the benefit of random breath testing for preventing casualty accidents involving young drivers.

There is review-level evidence based on controlled trials from the USA, Canada, New Zealand and Australia that graduated driver licensing (GDL) is effective in reducing the crash rates of young drivers, but the magnitude of effect and the relative contribution of different provisions within a GDL programme are unclear (Elkington et al. 2000; Hartling et al. 2005).

Currently, there is insufficient evidence from the UK, Finland and Canada that stricter enforcement of drinking and driving laws is effective in reducing accident rates involving young drivers (Coleman et al. 1996).

Environmental engineering measures

There is review-level evidence that speed cameras are associated with significant reductions in road trauma (Elkington et al. 2000).

Currently, there is insufficient evidence from the UK that speed humps are effective in reducing accident rates involving young people (Coleman et al. 1996).

There is conflicting review-level evidence from the UK and the Netherlands that area-wide measures in urban safety projects are effective in reducing the number of fatal or seriously injured casualties (Coleman et al. 1996).

Vehicle engineering measures

There is review-level evidence from the USA that air bags are effective in reducing the number of driver fatalities in frontal impacts by about 15% (Coleman et al. 1996; Elkington et al. 2000).

There is insufficient evidence that safety inspections as well as random roadside testing are effective in reducing accident rates involving young people (Coleman et al. 1996).

Inducements

There is review-level evidence from the UK that changes in bus fare pricing can be effective in reducing the number of casualties per kilometre travelled (Coleman et al. 1996).

Currently, there is insufficient evidence from the USA that provision of rewards for seat belt use is effective in changing behaviour in the long term (Coleman et al. 1996).

Multi-factorial approaches

Currently, there is insufficient evidence from the USA that multi-factorial approaches that target a variety of behavioural aspects are effective in reducing accident rates in young adults (Coleman et al. 1996).

Community-based approaches

Currently, there is insufficient evidence that community-based approaches for the prevention of road trauma in young adults are effective (Elkington et al. 2000).

Prevention of accidental injury in the workplace

Two reviews were identified that address the prevention of accidental injury to young adults (aged 15–24) in the workplace – Coleman et al. 1996; Elkington et al. 2000.

The effectiveness of interventions to prevent accidental injury to young persons aged 15–24 years: a review of the evidence (Coleman et al. 1996).

For background information on Coleman et al., (1996) refer to p21.

The review authors identified two intervention studies that were aimed specifically at young people in the workplace.

The first, an educational safety campaign to promote safety among young farmers from the USA (grade IV; recommendation grade C) was not fully evaluated although it did find that supervisors and farm employers were made more aware of the need to improve safety for young people.

The second study was from Australia (grade IV; recommendation grade C) and examined the effects of driver training for mail despatch riders and failed to find an effect on reduction of accidents in the study population. The review authors note, however, that this finding may have been the result of the study's methodological limitations.

A systematic review of the evidence on preventing injuries to young people (15–24 years) (Elkington et al. 2000)

For background information on Elkington et al. (2000) refer to p24.

The review authors identified one primary study (rated 'reasonable' quality) that addressed the prevention of injuries to young people in the workplace.

The study found a significant impact on knowledge and awareness of workplace safety of a 3 month programme comprising 12 separate components (not further described) delivered to 11th grade students in advance of

their entering the workforce, compared with a control. It should be noted, however, that outcomes relating to behaviour and workplace injuries were not assessed.

Evidence statements

Currently, there is insufficient review-level evidence from the USA that educational safety campaigns to promote safety among young farmers are effective in reducing accidents (Coleman et al. 1996; Elkington et al. 2000).

Currently, there is insufficient review-level evidence from Australia that driver training for mail despatch riders is effective in reducing accidents (Coleman et al.1996).

Prevention of accidental injury in the home

One review was identified that addresses the prevention of accidental injury to young adults (15–24 years) in the home – Coleman et al. 1996.

The effectiveness of interventions to prevent accidental injury to young persons aged 15-24 years: a review of the evidence (Coleman et al. 1996).

For background information on Coleman et al. (1996) refer to p21.

The review authors note that young adults (aged 15–24) have not been the target of home accident prevention programmes in the UK, possibly due to the comparatively low number of home accident fatalities in this age group. The only studies identified that address prevention of accidental injury in the home setting for 15–24 year olds were those relating to environmental engineering measures to prevent burn-related injuries, and community-based projects involving combined measures.

Fire-detector/alarm programmes

One study from the USA (grade II-2; recommendation grade B) found that smoke detectors reduced the risk of fires in some residential settings. Two further studies from the USA (overall quality grade II-3; recommendation grade C) assessing the effectiveness of community-based smoke detector give-away programmes reported a reduction in fire-related deaths and injury even among high-risk populations (not further described).

The review authors note that in light of the rarity of fire-related accidents in the home, very large studies would be required to give reliable estimates of the effect of interventions seeking to reduce fire-related accidents.

Community-based approaches

Four studies were identified that assessed community-based multi-factorial interventions (comprising elements such as hazard identification, home modification, education, inspection and environmental engineering modifications) for the prevention of home accidents across all age groups (and not specifically 15–24 year olds).

The first study was a prospective cohort study (quality grade II-2; recommendation grade C) from the USA that targeted a poor urban minority population in Philadelphia (the 'Safe Block' project) and comprised home modification, inspection and education. Coleman et al. report that the intervention group was significantly more likely to institute preventive measures and had greater knowledge compared with the control (values not reported).

The second study was a prospective cohort study (quality grade II-3; recommendation grade B) of a community programme based in a rural municipality in Sweden and involved the cooperation of local authorities, agencies and individual citizens. The intervention comprised changes to the physical environment, information, education and supervision, and outcomes included accident incidence and changes in the pattern of accidents compared with a control area. The review authors note that although there were some methodological difficulties in comparing accident rates between the two areas (not further described), the study was unique in reporting outcomes specifically for the 15–24 age group. The study reported a fall in the accident rate in both the home and work settings following the intervention period.

Finally, two studies from Sweden and Norway (quality grade II-2; recommendation grade C) assessed hazard identification educational and environmental engineering measures and reported an increase in local accident prevention initiatives and elimination of hazards.

Evidence statements

Fire-detector/alarm programmes

Currently, there is insufficient review-level evidence from the USA that smoke detectors are effective in reducing the risk of fires in some residential settings (Coleman et al. 1996).

Currently, there is insufficient review-level evidence that community-based smoke detector give-away programmes alone reduce fire-related deaths and injury even among high-risk populations (Coleman et al. 1996).

Community interventions

There is review-level evidence from a rural municipality in Sweden, that a community programme involving the cooperation of local authorities, agencies and individual citizens and comprising changes to the physical environment, information, education and supervision is effective in reducing accident rates in both the home and work settings (Coleman et al. 1996).

Currently, there is insufficient review-level evidence that a multi-component intervention comprising home modification, inspection and education targeting a poor urban minority population is effective in reducing accident rates among young adults (Coleman et al. 1996).

Prevention of accidental injury in sport/leisure settings

Four reviews were identified that addressed the prevention of accidental injury to young adults (aged 15–24) in the sport/leisure setting – Coleman et al. 1996; Elkington et al. 2000; Emery 2003; Olsen et al. 2004).

The effectiveness of interventions to prevent accidental injury to young persons aged 15-24 years: a review of the evidence (Coleman et al. 1996).

For background information on Coleman et al. (1996) refer to p21.

In the assessment of interventions for the prevention of accidental injury while taking part in sporting and leisure activities, the review authors included population studies. They excluded studies in which skills, coaching and training schemes relating to specific safety issues and advice about standard protective devices and clothing were an integral part. The authors also included environmental engineering measures such as the erection of warning signs and fences by operators of open water, although no studies examining the effectiveness of such interventions for 15–24 year olds were identified.

Changes in sporting rules/regulations

Based on studies from the USA and Canada (quality grade II-3/III; recommendation grade A/C) the review authors conclude that changes to the rules of some sports have significantly reduced certain types of injury. For example, facial and oral injuries in American football and ice hockey were significantly reduced following the introduction of rules mandating compulsory face protectors and mouth guards. Likewise, studies from the UK, USA and New Zealand (overall quality grade II-3; recommendation grade A) reported significant reductions in the incidence of permanent cervical quadriplegia after the introduction of rules governing tackling and spearing in American football and rugby union.

Helmets

The review authors identified two studies from the UK and Canada (quality grade I; recommendation grade C) that assessed the impact of helmets on the risk of injury. The first study compared three types of helmets for American football and found that helmets with suspension liners performed comparatively less well under standard impact conditions than the other two types of helmet. The second study found that the protection provided by horse-riding helmets may be less than that provided by cycle and motorcycle helmets.

Mouthguards

Eight studies from the UK, Australia, the USA, South Africa and New Zealand (overall grade III; recommendation grade B) were identified that looked at the impact of mouthguards on the risk of injury in sports such as soccer, rugby, American football and Australian rules football. The review authors conclude that most studies showed fewer dental and oral injuries in wearers of mouthguards – particularly those using custom-made guards – compared with non-wearers.

Knee braces

Five studies from the USA (overall grade I; recommendation grade C) assessed the efficacy of knee braces in protecting against knee injuries in American football. The review authors report only modest effects, with conflicting results in some studies being associated with player position. The authors also note that the applicability of the findings outside the USA is likely to be limited as they may be confounded by the additional protective clothing worn in American football.

Belts

From one UK study (grade II-3; recommendation grade B), the review authors conclude that stabilising belts are effective in preventing injuries to the back during weightlifting.

Ankle taping

Three studies from the USA, Japan and South Africa (grade II-3; recommendation grade B) found that taping, particularly when used in combination with high-top shoes, can be effective in the primary prevention of ankle injuries.

Eye protectors

From one study in Canada (grade II-3; recommendation grade A) the review authors conclude that there is good evidence that eye protectors meeting certain standards

(not further described) are effective in preventing sports-related eye injuries.

Modification to the sports environment

From four studies in the USA and Germany (grade I/II-1; recommendation grade A/C) the review authors conclude that environmental engineering measures such as modifications to the 'furniture' of the area of play (such as gymnastic landing mats or bases used in baseball or softball) present reasonable scope for reducing injuries in organised sports.

Educational measures

Two studies from the Netherlands (grade I/II-3; recommendation grade C) found that a health promotion campaign targeted at young people or a sports injury prevention programme delivered in schools resulted in an increased knowledge and awareness of sports injuries but no direct effect on reducing injuries. Likewise, evidence from one study from the Netherlands (grade I; recommendation grade C) found that a programme providing information and performance of a standardised package of warm-up and cool-down exercises improved knowledge and attitudes but did not affect the incidence or severity of injuries.

Multifactorial measures

Three studies were identified that used a combination of approaches in an attempt to reduce the incidence of severity of sporting-related injuries.

The first study (grade II-3; recommendation grade B) was a multi-agency collaboration between manufacturers and horse-riding clubs in the USA. It found that although the intervention increased awareness of the dangers, there was no report of an effect on injuries.

The second study (grade II-1; recommendation grade B) comprised the installation of warning signs about the consequences of not wearing eye protection in racquetball in addition to free safety equipment to borrow on-site. The study found an increase in compliance when eye protection was made available to borrow compared with display of the warning alone.

Finally, the review authors report on a well-designed Swedish study (grade I; recommendation grade A) that found that a programme including standardised warm-up, ankle taping and particular design of shoe, leg guards and controlled rehabilitation, reduced soccer injuries in elite players when delivered by medical personnel (by 75%) or coaches (by 50%).

A systematic review of the evidence on preventing injuries to young people (15–24 years) (Elkington et al. 2000)

For background information on Elkington et al. (2000) refer to p24.

The review authors identified three reviews (two rated 'good' quality, and one 'fair') that addressed the prevention of sports injuries in young people. They conclude that the following interventions are effective in reducing sports injuries:

- use of face and mouth guards
- ankle taping and protective padding for inline skaters
- changes in sporting rules/regulations (particularly in American football and rugby union)
- eye protectors in squash and racquet sports
- multi-factorial measures for elite soccer players
- equipment modification (eg breakaway bases in softball).

The authors also identify a number of interventions that had little empirical evidence of effect on injury prevention in young adults. These include:

- knee braces
- physical conditioning
- educational interventions either alone or as part of a community-based approach
- interventions for the prevention of water-related injuries (such as pool fencing, swimming lessons, pool covers, adult supervision etc).

Risk factors for injury in child and adolescent sport: a systematic review of the literature (Emery 2003)

This review identified risk factors and potential prevention strategies that might modify risk factors for injury in child and adolescent sport. The objective was to identify risk factors for injury in child and adolescent sport as well as potential prevention strategies that may modify risk factors and reduce injury in this population.

Drawing on work by Caine et al. (1996) and Lysens et al. (1984) risk factors are presented as follows.

Potential risk factors for injury in child and adolescent sport

Extrinsic risk factors	Intrinsic risk factors
Non-modifiable	*Non-modifiable*
Sport played (contact/no contact)	Previous injury
Level of play (recreation/elite)	Age
Position played	Sex
Weather	
Time if season/time of day	*Potentially modifiable*
	Fitness level
Potentially modifiable	Preparticipation sport-specific training
Rules	Flexibility
Playing time	Strength
Playing surface (type/condition)	Joint stability
Equipment (protective/footwear)	Biomechanics
	Balance/proprioception
	Psychological/social factors

Studies that have examined an association between risk factor and injury or a prevention strategy and injury in child and adolescent sport were reviewed and assessed regarding their validity, generalisability, and strength of scientific evidence.

The review is based on epidemiological evidence in which data are original, an exposure and outcome are objectively measured and an attempt is made to create a comparison group. Seven electronic databases were searched. No limitations were put on articles searched. If 500 articles or fewer were identified by a given search strategy, the study title and abstract were reviewed to identify articles potentially relevant to the subject area. The methods section of potentially relevant articles were then reviewed to identify studies that met the selection criteria.

Inclusion criteria:

- epidemiological study that assessed the association between any potential injury risk factor or prevention strategy and injury in child and adolescent sport
- outcome included a measure of injury sustained in sport
- exposure measure included some objective measurement of risk factor or intervention
- study design included a comparison group (cross-sectional, case control, cohort, quasi-experimental, and RCT all considered)
- study contained original data.

Exclusion criteria:

- sport-related injury involving the following high speed sports: bicycling, scootering, skateboarding, inline skating, tobogganing, skiing, snow boarding, and boating
- study reported exclusive examination of head or dental injuries or medical emergencies
- prevention strategy involved protective equipment (ie helmets, knee braces) to modify risk of sport injury.

The quality of evidence was assessed based on criteria regarding internal validity, external validity, and Hill's criteria for causal association (Rothman and Greenland (1998).

A total of 46 studies were included in the review (not the same as those incorporated into the review by Olsen et al. 2004 – see p39). A summary of research design, subjects, exposure measures, outcome measures and results for all the studies are presented and results are summarised in two subsections:

- risk factors for injury in child and adolescent sport – i) non-modifiable risk factors; ii) potentially modifiable risk factors
- risk factors for injury in adult sport (age range of 'adult' is not defined).

Of these just four studies focused on participants younger than 15, and in four other studies the age of participants was not clear. Where a review finding is underpinned solely by one or a number of these eight studies, results are not reported here.

In addition, when presenting results, the review author appears to draw on further publications in addition to the 46 studies identified. It is not clear how these additional studies were identified and results relating to these are not reported here. Finally, as this evidence briefing is concerned with interventions to prevent injury, findings relating to some non-modifiable risk factors are not reported here (eg general rates of injury for males and females).

Risk factors for injury in child and adolescent sport – non-modifiable risk factors

Emery (2003) summarises that risk of injury increases with organised sport vs unorganised sport, amount of time

spent doing sporting activity, competition vs practice, tournament play vs regular season play, increased level of competition, indoor vs outdoor soccer, and large field size and reduced numbers of players in Australian rules football.

Risk factors for injury in child and adolescent sport – modifiable risk factors

Twenty of the 46 studies examined potentially modifiable physical intrinsic risk factors specifically for injury in child and adolescent sport. Most that examined biomechanical alignment, flexibility or strength demonstrated no association of these factors with injury in child and adolescent sport, except for in sport-specific studies. In gymnastics and figure skating the review suggests that there is some evidence of an association between poor flexibility and injury.

Other findings suggest that there is conflicting evidence that elbow injury in baseball players is related to pitching style. Fatigue also appears to play a role in hockey during the last 5 minutes of a period and the last period of a game. An increased risk of injury in young women with decreased endurance fitness is reported, as is a significantly decreased risk of knee injury in adolescent football players participating in a pre-season conditioning programme (values not reported).

Of the studies reviewed, just four intervention studies addressed prevention of injuries in adolescent sport. These targeted risk factors such as limitations in flexibility, strength, endurance and proprioception.*

One quasi-experimental non-randomised controlled trial in the USA that targeted high-school football players (age not reported; the usual age range of children in high school is 12–17/18) (five teams; three intervention and two control) showed no effect of an intervention consisting of half-time warm-up and stretching exercises, compared to no exercise in control groups. Injury was defined as requiring medical attention (no further details provided). Injury rates between groups were not statistically significant and there was insufficient data to calculate relative risks.

A Swiss quasi-experimental non-randomised controlled trial targeting 194 soccer players with a mean age of 16.5 included coach and player education, rehabilitation and a conditioning programme. Control group details were unclear. Injury was defined as resulting in physical complaint after 2 weeks or missed session(s) (unclear if one or more missed sessions). The results suggest a significant protective effect of the intervention in low-skilled adolescent soccer players (RR = 0.63 [0.42–0.94]).

Only two RCTs were reviewed. One Danish trial that targeted 237 female European team handball players aged 16–18 consisted of a practice session training programme including proprioceptive balance training using a wobble board. Injury was defined as requiring the player to miss the next session or being unable to participate without considerable discomfort (further details not provided). Results revealed a significant reduction of injury (RR = 0.17 [0.09–0.32]), compared with a non-specific practice training session in controls.

The second RCT, a study in the USA, targeted 300 female high-school soccer players (age not reported; the usual age range of children in high school is 12–17/18) and consisted of a 7 week pre-season acceleration training programme. Injury was defined as needing to miss at least one game or practice. Results demonstrated a protective effect of the intervention (RR = 0.42 [0.2–0.91]), compared with a control group with no pre-season training programme.

The review also suggests that psychosocial factors may be modifiable and reports one Canadian case-control study targeted at 35,380 children aged under 19 demonstrated evidence of a dose-response gradient between decreasing socio-economic status and increased risk of injury, and cohort evidence from the USA that demonstrated a high correlation between injury in sport and stressful life events, as well as outcomes on a mood profile.

Emery (2003) appears to draw on further publications in addition to the 46 studies identified. It is not clear how these additional data were identified and results relating to these are not reported here.

Review conclusions

The review author makes a number of comments. He concludes that the strength of the evidence for potentially modifiable risk factors for injury and children and adolescents is limited by research design and

* Proprioception: the unconscious perception of movement and spatial orientation arising from stimuli within the body itself.

concerns about validity. In case-control and cross-sectional study designs, the temporal associations between exposure and outcome is unclear. In many of the cohort studies and non-randomised intervention studies reviewed, various sources of bias in the selection of subjects, measurement of exposure and outcome variables, and lack of control for other potentially confounding variables threaten the studies' validity.

There is limited RCT evidence supporting preventive training programmes in specific sports to reduce the risk of injury in adolescents. There is more convincing evidence in adult epidemiological studies that decreased endurance, decreased strength, decreased proprioception, and decreased pre-season sport-specific training are associated with sports injury. The consistency of the findings between child and adolescent studies reviewed and the adult population studies is encouraging.

Strategies for prevention of soccer related injuries: a systematic review (Olsen et al. 2004)

This Canadian review examined evidence of the effectiveness of injury prevention strategies in soccer. The authors comment that between 1995 and 2000 participation rates reported by the Canadian Soccer Association increased by 10% a year. They also refer to the likelihood of a concurrent increase in the number of injuries. Figures from the Canadian Hospital Injury Reporting and Prevention Program, which records emergency department visits in 15 hospitals across the country, revealed an increase in cases of soccer injuries in 5–14 year old children (year parameters for this age cohort not provided).

A document was included if it:

- addressed unintentional injury prevention
- evaluated the effectiveness of
  - an educational injury prevention programme/strategy
  - a policy/regulation/legislative change
  - a community organisation effort
  - environmental, equipment, or product modifications
- contained as an outcome:
  - injury incidence (excluding reinjury)
  - injury severity
  - uptake of risk-reducing behaviours
  - uptake or compliance with injury prevention measures
- contained a control group in its methodological design or used other comparative measures.

A document was excluded if it focused on biomechanical measures as outcomes related to injury (eg torque, resistance or absorption).

Nine electronic databases were searched. Study relevance was assessed using six criteria: relevance of research topic, specific sport and recreation area, evaluation of injury prevention strategy, outcome measures related to injury or behavioural measures, and methods used (ie whether the study design included a control group or other comparative measure).

The quality of RCTs was evaluated using a validated quality assessment tool (Jadad et al. 1996). The review authors report that in the absence of validated tools to assess quality of reporting for other study designs, specific quality assessment forms were developed following a MEDLINE search, scrutiny of 18 other instruments and review by an international multidisciplinary panel of design and methodology experts. Forms for each study design were also piloted.

Of 44 potentially relevant soccer-related articles identified, five were included as relevant, but as one reported on the same research data, the most recent was selected for data extraction, leaving a total of four. The studies that were incorporated are not the same as those reviewed by Emery (2003) (see p36).

Of the four studies included in the review, two were conducted in the USA and the others in Sweden and Italy. One was an RCT, two were time series studies and the final study was a non-equivalent control group. All studies addressed organised competitive soccer, but covered a range of intervention strategies and varied in the strength of evidence they provided.

Two studies assessed the effectiveness of training programmes to reduce knee injuries.

The first, an RCT, assessed the effectiveness of a seven-part programme to reduce injury incidence in 17–36 year old male players in a Swedish community soccer league. The review authors rated the study quality as poor on Jadad et al.'s RCT quality assessment scale. Injuries were defined as minor (absent from practice for more than 1 week); moderate (absent from practice for more than

1 week but less than 1 month), or major (absent for more than 1 month). Coaches selected the 15 best players from each of 12 teams who were then randomly assigned to one of six intervention teams (n = 90 players) or one of six control teams (n = 90 players).

Intervention teams were enrolled in a seven-part programme delivered by doctors and physiotherapists consisting of:

- correction of training with a specific warm up and cool down programme
- equipment consisting of compulsory leg guards and training shoes
- prophylactic ankle taping for those with previous ankle sprains and/or instability
- controlled rehabilitation for lower extremity injuries
- exclusion of players with knee instability
- information to coaches and players on disciplined play and injury risks
- correction and supervision of prophylactic measures by doctors and nurses.

At 6 month follow up the intervention teams had 75% fewer injuries than the control teams (0.6 injuries per month vs 2.6 injuries per month respectively, $p < 0.001$). It is not clear whether these figures relate solely to knee injuries as tabular information defines the primary outcome measure as injury incidence and absence from games and practices. Reductions in the incidence of ankle injuries, sprains, strains, operations and absences from practices and games were also reported for the intervention teams.

In the second phase of the study the intervention was delivered by coaches; analysis did not adhere to the randomised controlled study design but compared injury rates before and after intervention for all teams combined. The second phase showed a smaller reduction in injuries (50%).

The review authors conclude that the study showed effectiveness of a multi-component programme and note that it is not possible to assess the relative contributions of the different programme components. They conclude that multi-component approaches to soccer injury prevention such as these may hold promise, but the evidence is based on a single study.

The second knee study, a non-equivalent control group design, tested the ability of a proprioceptive training programme to reduce the incidence of anterior cruciate ligament (ACL) injury in semi-professional and amateur male soccer players in Italy (age was not reported). The review authors rated the quality of this study as moderate. Forty teams participated – half followed a five-phase pre-season programme using wobble boards at least three times a week in season, while the other half received no special training. All teams were followed for three seasons.

Following the programme the incidence of ACL injuries in teams receiving the programme was 0.15 per team per season compared with 1.15 per team per season in the control teams ($p < 0.001$). The study authors concluded that the programme led to a seven-fold decrease in ACL injuries, but the review authors remark that as the evidence is from only one study further testing of the intervention is necessary.

The third study, a time series study from the USA, was conducted over 4 years to assess the effectiveness of a strength training programme on the incidence of injuries in male college soccer team players (age was not reported). The review authors rated the quality of this study as moderate. Monitoring took place over 4 years and the regimen, which consisted of exercising upper and lower body muscles separately twice a week, was incorporated into the non-season and pre-season during the third and fourth years. For the years without the strength training the injury rate was 15.15 per 1000 exposures, compared with 7.99 per 1000 exposures for the two years with the strength training. The study authors note the potential confounding effect of the study design and concluded that the reduction in injuries cannot be attributed to the strength training programme with any certainty. The review authors concur.

The final study, a time series study from the USA, assessed the effects of emergency preventive measures to prevent heat exhaustion during a 6 day youth soccer tournament that took place in July 1988 involving 4000 male and female players aged 9 to 19. The review authors rated the quality of this study as moderate. The intervention included provision of heat stroke prevention information to staff, coaches, officials and referees, as well as emergency game modifications (including shorter game times, longer breaks, unlimited substitutions) and hydration techniques (including spraying players with water). The educational strategies were implemented before the start of the tournament, and the game

modification and hydration techniques began on the third day of the tournament.

Following implementation of the emergency measures, the rate of heat exhaustion per 1000 player hours decreased from 21 cases in the first two days to 13 cases in the last four days. Olsen et al. (2004) note that results were presented graphically and numerical values, including statistical significance were not included. They remark that owing to major limitations of this study it is not possible to draw conclusions on the effectiveness of these measures.

Evidence statements

Changes in sporting rules/regulations

There is review-level evidence from the USA and Canada that changes to the rules of some sports – such as introduction of rules mandating compulsory face protectors and mouth guards in American football and ice-hockey, or introduction of rules governing tackling and spearing in American football and rugby union – have significantly reduced the incidence of injuries in the sporting setting (Coleman et al. 1996; Elkington et al. 2000).

Helmets

Currently, there is insufficient review-level evidence from the UK and Canada on the most effective type or design of helmet for preventing injury in sports such as American football or horse riding (Coleman et al. 1996).

Mouthguards

There is review-level evidence from the UK, Australia, the USA, South Africa and New Zealand that wearing mouthguards – particularly those that are custom-made – significantly reduces the incidence of dental and oral sports injuries (Coleman et al. 1996; Elkington et al. 2000).

Knee braces

Currently, there is insufficient review-level evidence from the USA on the effectiveness of knee braces for preventing sports injuries (Coleman et al. 1996; Elkington et al. 2000).

Belts

Currently, there is insufficient review-level evidence from the UK that wearing stabilising belts is effective in preventing injuries to the back during weightlifting (Coleman et al. 1996).

Ankle taping

There is review-level evidence from the USA, Japan and South Africa that taping, particularly when used in combination with high-top shoes, can be effective in the primary prevention of ankle injuries (Coleman et al. 1996; Elkington et al. 2000).

Eye protectors

There is review-level evidence from Canada that eye protectors are effective in preventing sports-related eye injuries (Coleman et al. 1996; Elkington et al. 2000).

Modification to the sports environment

There is review-level evidence from the USA and Germany that modifications to the 'furniture' of the area of play (such as gymnastic landing mats or bases used in baseball or softball) may be effective in reducing injuries in organised sports (Coleman et al. 1996; Elkington et al. 2000).

Educational measures

Currently, there is insufficient review-level evidence that educational measures aiming to increase knowledge and awareness of sports injuries are effective in reducing the incidence or severity of injuries (Coleman et al. 1996; Elkington et al. 2000).

Training measures

Currently, there is insufficient review-level evidence that physical conditioning can reduce the incidence of sports injuries (Elkington et al. 2000).

Currently, there is insufficient review-level evidence from Italy that a pre-season training programme using wobble boards at least three times a week targeted at semi-professional and amateur male soccer players in season can reduce the incidence of anterior cruciate ligament injury (Olsen et al. 2004).

Currently, there is insufficient review-level evidence from the USA that a strength training programme targeted at male college soccer players can reduce the incidence of injuries (Olsen et al. 2004).

Currently, there is insufficient evidence from Switzerland that a coach and player rehabilitation and conditioning programme, targeted at soccer players with a mean age of 16.5, can be effective in protecting players from injury resulting in a physical complaint (Emery 2003).

Currently, there is insufficient evidence from the USA that a programme consisting of half-time warm up and stretching exercises, targeted at high-school football players, may be effective in reducing injury requiring medical attention (Emery 2003).

Currently, there is insufficient evidence from Denmark that a practice session training programme including proprioceptive balance training using a wobble board, targeted at female European team handball players aged 16–18, can be effective in reducing injury that requires the player to miss the next session or be unable to participate without discomfort (Emery 2003).

Currently, there is insufficient evidence from the USA that a 7 week pre-season acceleration training programme targeted at female high-school soccer players can protect players from injury that results in missing at least one game or practice (Emery 2003).

Multi-factorial measures

There is review-level evidence from the USA and Sweden that interventions comprising a variety of approaches – such as installing warning signs combined with providing free safety equipment, or a package comprising standardised warm-up, ankle taping and particular design of shoe, leg guards and controlled rehabilitation – can be effective in reducing the incidence and severity of sports injuries (Coleman et al. 1996; Elkington et al. 2000).

Currently, there is insufficient review-level evidence from the USA that a programme of education, information, correction and supervision of training, and environmental equipment, targeted at 17–36 year olds, can reduce soccer-related injuries (Olsen et al. 2004).

Currently, there is insufficient review-level evidence from the USA that a package including information, game modifications, and hydration techniques targeted at male and female soccer players aged 9–19 can reduce rates of heat exhaustion (Olsen et al. 2004).

Community-based injury prevention

One review was identified that addressed community-based injury prevention – Klassen et al. 2000.

Community-based injury prevention interventions (Klassen et al. 2000)

This review identified studies that evaluated the impact of community-based injury prevention efforts on childhood injuries, safety behaviours and the adoption of safety devices. The authors define community-based interventions as those that target a group of individuals or a geographic community but are not aimed at an individual. This includes cities and municipalities, but interventions delivered in clinical settings and those targeting areas as large as states or countries are excluded. Community-based intervention strategies include education/behaviour change, engineering/ technology and legislation/enforcement.

Studies were included if they:

- included a control group that did not receive the intervention
- targeted a population between 0–19 years of age
- examined the effectiveness of a community-based intervention
- reported injury rates or change in an injury-reducing behaviour.

The authors report that non-randomised comparison group studies were included, as a previous review in this area found that most studies did not use a randomised design and because of the logistics of randomisation in community-based injury prevention programmes.

A total of 32 studies were identified, of which 28 targeted bicycle helmet use, automobile restraint use, pedestrian safety, general injury prevention, and adolescent alcohol use and vehicle safety. The remaining four trials aimed to reduce the frequency of play with guns, reduce football injuries, improve road safety behaviour of bicyclists, and improve burn prevention practices. However, these are not reported here as only one study addressed each of these outcomes and no intervention had a positive impact.

Of the 28 included studies six were RCTs and 22 were non-randomised controlled trials. Most examined safety behaviours; just four examined injury outcomes. The review authors summarise the included studies in tabular format and discussion is limited to studies that substantially contribute to the knowledge of effectiveness of community-based interventions in general or those that illustrate critical influential aspects of a particular programme.

Programmes targeting bicycle helmet use

The authors identified 11 community-based programmes that aimed to increase the use of bicycle helmets by children and adolescents. However only four of these bear some relevance to the 15–24 year old target age group covered by this evidence briefing. These are reported as being non-randomised controlled trials. All four studies are summarised in tabular format, but only two are discussed in further detail. The four studies are described below.

Following legislation in Howard County, Maryland, USA, that required children under 16 to wear helmets when riding bicycles on country roads and paths, one study compared the combined effect of the legislation and an educational campaign in Howard County that included school and community components with the effect of education alone in adjacent Montgomery County. A third community, Baltimore State, served as a control community where no formal educational or legislative effects were in place. Self-reported helmet use was the primary outcome measure of interest.

Klassen et al. report that 10 months after the legislation went into effect there was a significant increase in observed helmet use in the target population (4% pre-intervention vs 47% post-intervention), a non-significant increase in observed helmet use in Montgomery County (8% pre-intervention vs 19% post-intervention), whereas in Baltimore County, use decreased during the same period (19% pre-intervention vs 4% post-intervention) (increase in the education and legislation community, $p < 0.0001$). But it is not clear whether this relates to comparison between groups or within groups. A second evaluation targeting younger children asked about helmet use 1 year before and 1 year after the Howard County legislation and found that children in Howard County were 2.3 times more likely to report helmet use on the most recent ride than children in the other two counties. The review authors report that the combined effect of legislation and education increased helmet use more than education alone.

The Seattle Bike Helmet campaign targeted parents/caregivers and children aged 5–15. The campaign used multiple strategies to increase helmet use and had three main objectives:

- to increase parental awareness of the need to wear a helmet when bicycling
- to change peer pressure to make helmets 'cool'
- to reduce financial barriers to purchasing a helmet.

The campaign included discount coupons, sales at cost through a parent-teacher association and donations to low-income children.

After 16 months the campaign increased observed helmet use among the target population following the intervention (target group: pre-intervention 5.5% vs 16 month post-intervention 15.7%; control group: pre-intervention 1.0% vs 16 month post-intervention 2.9% (increase in target group, $p < 0.001$). However, it is not clear whether this relates to comparison between groups or within groups. The review authors report personal correspondence suggesting that since the 16 month follow-up the observed rate of helmet use increased even more and was accompanied by a two-thirds reduction in bicycle-related head injuries in the target population, but full details are not provided.

One Swedish study evaluated an intervention that targeted parents/caregivers and children from 0–15 years and consisted of school-based education, public/parent education and an economic incentive. The annual change in rates of bicycle injuries leading to hospital inpatient care was the primary outcome measure. Results revealed a 3.1% decrease in injuries in the target group and decreases of 2.9%, 2.2%, 3.4% and 1.1% in four control cities. The review authors report no statistical significance. The review does not discuss this study in further detail.

Finally, a Canadian trial evaluated an intervention targeting adolescents in grades 8, 9 and 10 (details of ages not provided; the usual age range of children in these grades is 13–15/16). It included school-based education by peers and school-based education by a health professional and focused on self-report of risk-taking behaviour as the primary outcome measure. Pre-intervention, post-intervention and follow-up data revealed no effect of the intervention using a control group of same-age teenagers from the same city ($p > 0.05$, but it is not clear whether this relates to comparison between groups or within groups). This review does not provide a detailed discussion of this study.

Programmes targeting motor vehicle restraint use

Klassen et al. (2000) identified five community-based studies aimed at increasing motor vehicle restraint use among children or adolescents. Of these, just one appears relevant to the 15–24 target age group covered by this evidence briefing. This study is reported as being a non-randomised controlled trial.

The Oregon Head and Spinal Cord Injury Prevention Program targeted high-school students (details of age not provided; the usual age range of junior and senior high-school students is 12–17/18). It aimed to increase shoulder and lap belt use among adolescents through an educational campaign, compared with a control group of high-school students in the same city. The programme relied on a single strategy of providing emotionally-charged information at a high-school assembly to change knowledge, attitudes, and behaviours regarding seat belt use. Effectiveness was measured by observed seat belt use and questionnaire measures of knowledge and attitudes 2 weeks before and 2 weeks after the intervention.

Pre- and post-intervention data revealed no effect on seat belt use ($p > 0.05$, but it is not clear whether this relates to comparison between groups or within groups). Only knowledge about the importance of seat belt use increased in the target group following the intervention ($p < 0.01$, but again it is not clear whether this relates to comparison between groups or within groups). The review authors report that another study of this curriculum implemented in Washington state also found no consistent change in knowledge, attitudes or seat belt use associated with the intervention (further details not provided). They suggest that consistent with other community-based programmes, single, one-time interventions to change behaviour are not successful.

Pedestrian safety interventions

The review identified four community-based studies aimed at reducing child pedestrian injuries, but all targeted the 3–6 age group and are therefore not relevant to the 15–24 age group covered by this evidence briefing.

General safety campaigns

Klassen et al. identified four community-based trials that used general safety campaigns to target multiple child-injury problems. Of these, just one appears relevant to the 15–24 age group. This study is reported as being a non-randomised controlled trial.

The Safe Kids/Healthy Neighborhoods Coalition implemented in Harlem, New York City, targeted parents/caregivers and children aged 5–16 with the aim of reducing a variety of childhood injuries resulting from outdoor activities. The review authors suggest that this project illustrates how a successful intervention grows and changes within a community. The initiative began when parents and educators in central Harlem requested a programme in playground safety from health professionals. Playgrounds were being used by drug dealers, were in poor repair and children had little supervision. The intervention comprised school-based education, engineering and environmental improvement, economic incentives, and community activities such as sports and arts. The project had the following goals:

- to renovate central Harlem playgrounds
- to involve children and adolescents in safe, supervised activities that teach useful skills
- to provide injury and violence prevention education
- to provide safety equipment at reasonable cost (eg bicycle helmets).

Injuries targeted by the campaign included all injuries related to vehicles, outdoor falls, assaults and guns. Non-targeted injuries included poisoning and burns (no others specified). Effectiveness was evaluated by examining changes in hospital presentation injury rates in the targeted age group for injuries targeted by the campaign over 9 years from 1983 to 1991. These rates were compared with changes in rates of non-targeted injuries and changes in injury rates in a comparison community (the suburb of Washington Heights) during the same time period.

The review authors state that targeted injuries were reduced by an estimated 44% during the intervention period, with no significant decrease for non-targeted injuries, and that this decrease was noted mainly in the targeted age group. Unexpectedly, a 30% decline in severe injuries among school-aged children was also observed in the control community, but this occurred in both targeted (motor vehicle injuries only) and non-targeted injuries. Tabular data reports a post-intervention decrease of 50% in the target group (decrease in target group for target injuries $p < 0.001$, but it is not clear whether this relates to comparison between groups or within the target group). The study authors conclude that the specific decrease in targeted injuries within the targeted age group in central Harlem demonstrated a positive effect of the intervention.

Programmes targeting adolescent alcohol use and vehicle safety

Klassen et al. identified three community-based programmes aimed at decreasing alcohol misuse and reckless driving among teenagers, but only two of these appear relevant to the 15–24 age group. One is reported as a RCT and one as a non-randomised controlled trial. The two studies are described below.

A school-based curriculum aimed to prevent alcohol use among 10th grade students (details of age not provided; the usual age of 10th grade students is 15/16) in nine Michigan high schools by preparing them to cope effectively with peer pressure to misuse alcohol. Classes were randomly assigned to intervention or control groups. The intervention was delivered by teachers during five sessions. A significant increase (value not reported) in knowledge about alcohol, its physiological effects, and resisting pressure to drink was observed in the intervention group following the intervention and again in the 12th grade (details of age not provided; the usual age of 12th grade students is 17/18).

The authors report no change among controls (higher knowledge scores with intervention, $p < 0.001$, but it is not clear whether this relates to comparison between groups or within groups). Despite gains in knowledge, self-reported alcohol misuse and driving a motor vehicle after drinking still increased over time among students in both groups (non-significant increase of driving after drinking with age, $p > 0.05$, but it is not clear whether this relates to comparison between groups or within groups).

Another programme targeting adolescents in grades 10, 11 and 12 (details of age not provided; the usual age range of children in these grades is 15–17/18) that aimed to improve vehicle safety included a week long module on injury control and crash safety information in a high-school physics course. The intervention covered forms of energy, injury prevention, car safety features, types of

vehicular collisions, seat belts, and g forces, as well as hands-on activities.

At baseline the groups were similar in terms of knowledge, self-reported seat belt use, speeding and driving under the influence of alcohol. However, two years following the intervention knowledge, reported seat belt use when riding as a passenger, and intention of always wearing a seat belt, were significantly higher (value not reported) in the intervention group, but it is not clear whether this relates to comparison between groups or within groups. A positive behavioural change was reflected in seat belt use, which increased from 70% to 80% in the intervention group, but only 67% to 70% among controls (increased use of seat belts with intervention, $p = 0.01$, but it is not clear whether this relates to comparison between groups or within the target group).

The review authors report that despite this positive behavioural change, the study suffered from notable limitations. These included differential drop-out of risk takers (that is, teenagers most likely to drive fast, drive after drinking one to two alcoholic beverages, and not wear a seat belt) between follow-up assessments, and scores on drinking and driving attitudinal questions that left little room for improvement.

Summarising the three studies, the authors conclude that community-based programmes aimed at reducing the likelihood that adolescents will drive or ride with a driver under the influence of alcohol have been unsuccessful.

Evidence statements

Programmes targeting bicycle helmet use

Currently, there is insufficient review-level evidence from the USA that multiple strategies, including school-based education, public/parent education and an economic incentive can increase observed helmet use in children aged 5–15 (Klassen et al. 2000).

Currently, there is insufficient review-level evidence from Sweden that school-based education, public/parent education and an economic incentive can decrease the annual rate of bicycle injury resulting in hospital care in children aged under 16 (Klassen et al. 2000).

Currently, there is insufficient review-level evidence from Canada that school-based education influences self-report of risk-taking behaviour in grade 8, 9 and 10 students (usually aged 13–15/16) (Klassen et al. 2000).

Programmes targeting motor vehicle restraint use

Currently, there is insufficient review-level evidence from the USA that emotionally-charged education (not defined) is effective in increasing seat belt use in high-school students (usually aged 12–17/18). Based on this review-level study there is also currently insufficient evidence that the intervention increases knowledge in this group (Klassen et al. 2000).

General safety campaigns

Currently, there is insufficient review-level evidence from the USA that school-based education, engineering and environmental improvements, economic incentives and community activities (eg sports, arts) are effective in reducing targeted injury rates presented to hospital (all injuries related to vehicles, outdoor falls, assaults and guns) in children aged 5–16 compared with rates of non-targeted injuries (poisoning, burns, etc – no others stated) in a control community (Klassen et al. 2000).

Programmes targeting adolescent alcohol use and vehicle safety

Currently, there is insufficient review-level evidence from the USA that a school-based curriculum can increase knowledge about alcohol, its physiological effects, and resisting pressure to drink in 10th grade students and again at 12th grade (usual age 15 and 17/18 years, respectively) (Klassen et al. 2000).

Currently, there is insufficient review-level evidence from the USA that a school-based educational curriculum targeted at grade 10, 11 and 12 adolescents (usual age 15–17/18 years) can increase knowledge, reported seat belt use when riding as a passenger, and intention of always wearing a seat belt, at 2 year follow-up (Klassen et al. 2000).

Cost effectiveness of accidental injury prevention

One review was identified that addressed the cost effectiveness of prevention of accidental injury to young adults (aged 15–24) – Coleman et al. 1996.

The effectiveness of interventions to prevent accidental injury to young persons aged 15–24 years: a review of the evidence (Coleman et al. 1996)

For background information on Coleman et al. (1996) refer to p21.

Prevention of sporting-related injuries

The authors identified three studies (grade II-3; recommendation grade A) from the USA that assessed the costs and benefits associated with modification of softball bases. The study reported that savings could be made with breakaway bases compared with traditional stationery bases, although the review authors note that there may have been a possible under-estimation of the costs involved as only those costs relating to the injury sustained were considered rather than indirect costs such as time lost from work or health status, etc.

Likewise, one study from Canada (grade II-3; recommendation grade A) reported significant healthcare savings with the introduction of regulations requiring the use of a full-face protector by recreational ice hockey players. However, the review authors note that the cost savings may have been under-estimated since indirect costs were not included in the analysis.

Prevention of injuries on roads

The review authors identified seven studies from the UK, Finland and USA that addressed the cost effectiveness of interventions for the prevention of injuries on roads. Interventions included conspicuity aids such as low beam daytime headlights and high visibility clothing, random breath testing, motorcycle helmet laws and environmental engineering measures. The review authors present brief details for only two of the studies identified. The first was from the UK (grade IV; recommendation grade C) and examined the cost effectiveness of the introduction of traffic islands. The review authors note that the study suggested that savings outweigh the costs of the intervention although the figures on which the estimation was based were not clear. Likewise, the second study, also from the UK (grade IV; recommendation grade C), failed to adequately explain how estimates of the cost effectiveness of surveillance cameras were derived.

Evidence statements

Prevention of sporting-related injuries

There is review-level evidence from the USA and Canada that interventions such as modification to the sporting environment or changes to sporting rules or regulations for the prevention of sports injuries can result in significant healthcare savings (Coleman et al. 1996).

Prevention of injuries on roads

Currently, there is insufficient review-level evidence that interventions for the prevention of injuries on roads are cost effective (Coleman et al. 1996).

Gaps in the knowledge base and recommendations for research

The following recommendations for research have been made in the systematic reviews studied in this briefing.

Research on prevention of accidental injury on roads

- Rigorous community-based studies focusing on motor vehicle restraint use among adolescents are needed (Klassen et al. 2000).
- With regard to pedestrian safety interventions, future investigations using rigorous methodological designs are necessary to quantify the benefits or shortcomings of environmental approaches, because they are gaining popularity over educational interventions (Klassen et al. 2000).
- The bulk of the research into the prevention of accidental injury to cyclists and motorcyclists has focused on individual behaviour and rider protection. Research is needed on interventions that physically separate cyclists from motor vehicles or increase motorist awareness of bicycles and motorcycles (Coleman et al. 1996).
- Further research is needed on area-wide schemes, cycle lanes and marking of safe routes; assessing impact on all road users within the area and adjoining areas; motorcycle safety devices and protective clothing; UK studies of daytime headlight use; and conspicuity aids in general use (Coleman et al.1996).
- UK research is needed on the effectiveness of restrictions on engine size or maximum speed in this age group (15–24 year olds) (Coleman et al. 1996).
- Further investigation of the effectiveness of incentives to encourage safer driver behaviour or safer modes of transport may prove rewarding, eg concessionary fares for 15–24 year olds on public transport, and increased insurance-related incentives for safer driving (Coleman et al. 1996).
- There should be investigation of measures to reduce the involvement of heavy goods vehicles in accidents in urban areas (Coleman et al. 1996).
- Primary research on graduated driver licensing should focus on analyses that account for potential confounders and trends over time, standardised reporting of outcomes and results, and long-term follow-up (Hartling et al. 2005).

Research on prevention of accidental injury in the workplace

- For occupational injuries there is a need to evaluate interventions that target high-risk age groups of young people (Elkington et al. 2000).
- Greater attention should be paid to the occupational safety of young people – and the use of sound evaluation is essential alongside innovations in this area (Elkington et al. 2000).
- Young people are over-represented in traumatic work-related injuries and counter-measures that specifically target this age group should be developed and evaluated (Elkington et al. 2000).
- The paucity of evaluative research into the effectiveness of various interventions in preventing accidents in those aged 15–24 indicates clearly that research is needed in the area of injury prevention to young people in the workplace (Coleman et al. 1996).

Research on prevention of accidental injury in the home

- The effectiveness of various interventions should be investigated, for example smoke alarms and increased regulation or low-cost environmental safety measures such as smoke seals fitted to doors in private rented

accommodation in which many young people now live (Coleman et al. 1996).

Research on prevention of accidental sports/leisure injury

- One of the challenges currently facing those interested in preventing soccer injuries is the lack of good surveillance data that allow the identification of risk factors and the use of that information in developing and evaluating prevention strategies and/or policies. A more complete assessment of the patterns of injury is needed and this could be accomplished through the establishment of targeted surveillance and data collection strategies involving both organised and non-organised settings. There is a serious lack of research that evaluates injury-prevention interventions aimed at young soccer players (Olsen et al. 2004).
- Studies examining prevention strategies such as pre-season conditioning and proprioceptive training are warranted. Clinical trials examining such prevention strategies should quantify and control for potential risk factors for injury in child/adolescent sport (Emery 2003).
- For water-related injuries there is a need to evaluate interventions that target high-risk age groups of young people (Elkington et al. 2000).
- There is a need for well-designed studies to assess the effect of interventions aimed at reducing sports injury. When conducting evaluations of interventions targeting sporting and recreational injuries some of the data that should be collected include player ability; type of playing surface; changes in coaching practice/or athletic ability; changes in sports regulations; assessment of injury sustained; whether or not treatment was sought; and whether or not the injury resulted in inability to participate in the sport/game (Elkington et al. 2000).
- Controlled trials of various measures to reduce injuries in high-risk popular participation sports, such as rugby and soccer, are required (Coleman et al. 1996).
- Further investigations are needed into the efficacy of horse-riding helmets and measures to increase their use (Coleman et al. 1996).
- Evaluation is needed of the effectiveness of various environmental engineering measures to prevent drowning and near-drownings in the population aged 15–24 (Coleman et al. 1996).

Research on prevention of accidental injury in community-based studies

- With regard to general safety campaigns, future campaigns should employ rigorous study designs to evaluate programme impact. As the success of broad-based programmes is likely to depend on an impetus for change that comes from community constituencies, randomly assigning a community to receive the intervention, whether or not the community expresses a desire for change, may diminish programme success (Klassen et al. 2000).
- Future implementation of community-based and multi-strategy approaches needs to be undertaken alongside rigorous evaluation that includes process, impact and outcome measures (Elkington et al. 2000).
- Although whole-community based interventions may turn out to hold the greatest promise for accident reduction, the evaluation of such approaches is not straight-forward in terms of traditional epidemiological study design. Where local community-based approaches to accident prevention are being planned, the opportunity to conduct some kind of qualitative evaluation should not be missed (Coleman et al. 1996).

General research issues

- With few 'proven' strategies in the area of injury prevention in young people, all innovations should include a budget for quality evaluation studies (Elkington et al. 2000).
- There is little information on the costs and benefits of injury-prevention programmes. Coleman et al.'s (1996) review was the only one that included information on cost effectiveness. This review identified nine studies in the road and sports settings that address cost effectiveness of various interventions. More research on the costs and benefits of different interventions is needed.
- There is a lack of information on inequalities and the relative effect of interventions between different groups of the population and research in this area should be addressed.

Overall findings

This briefing has focused on interventions in three settings, roads; work, school or further education; and leisure. Overall, the results have shown that legislation and enforcement have been effective in prevention of accidental injury to young people aged 15–24. Interventions that use environmental measures and protective equipment have also been shown to be effective. Stand-alone educational interventions have not been shown to be effective but, when combined with other approaches such as legislation and engineering, may be successful. However, with multi-factorial intervention programmes it is difficult to attribute the degree of success to any single element.

Interventions such as raising the legal drinking age from 18 to 21, random breath testing, seat belt legislation, compulsory protective helmets for motorcyclists and bicyclists, lowering the drink-driving limit (blood-alcohol concentration) and graduated driver licensing schemes have been shown to be successful on the roads.

Within the sports and leisure setting, legislative measures, such as the mandatory use of mouth guards and face protectors, and modifications to the rules of games, have been shown to be effective in reducing injuries. Other successful interventions within the sports environment include the use of protective equipment such as helmets and eye protectors, taping previously injured ankles, strength training and conditioning exercises.

There is scant review-level evidence of effective interventions to reduce accidental injuries among the 15–24 age group within the workplace. No reviews specifically addressed injuries in the school setting.

There is very little review-level evidence on the relative effect of interventions between different groups of the population such as disadvantaged or deprived groups of young people, or those living in different geographical areas. Insufficient detail is provided within the review-level material to tell whether interventions were delivered by professionals or non-professionals.

There is little review-level information on the cost effectiveness and benefits of injury-prevention programmes.

Issues arising

In the process of conducting this briefing, a number of relevant issues have been identified.

In the eight systematic reviews identified, there is a paucity of information on the prevention of injury among the target age group of young people aged 15–24. This age range includes part of that commonly defined as 'children', 0–18 years, but in some cases, only the lower range of the age group is covered, ie 15–16.

Evidence is not distributed evenly between the three settings. The majority of studies relate to roads. Within the sports and leisure setting, there is some evidence about the use of safety equipment, legislation and strength training. There is a lack of evidence relating to the workplace and school setting.

Some evidence exists on successful programmes and strategies within other target age groups, for example in children. Community childhood injury prevention programmes have used multiple interventions implemented over a period of time, which has allowed injury prevention messages to be repeated in different forms and contexts and which can begin to develop a 'culture of safety' within a community (Towner and Dowswell 2002). It must be remembered that current cross-government activities to increase walking and cycling and physical activity have the potential to increase the number of accidental injuries in young people. Some strategies such as reducing the need for vehicle travel have been excluded by the design of this review, but these issues are being considered in a forthcoming evidence briefing on transport and NICE's forthcoming programme of work on physical activity.

Much of the available evidence of effectiveness in the eight reviews is derived from the USA, Canada and Australia. Translating findings of research to the UK setting may not be straightforward as 'the culture of safety' in the different settings differs, eg the uptake of the use of seat belts in the UK and in different states in the USA.

Some issues relate to methodology. The variation in the methodologies used for primary research complicates the synthesis of the evidence. Of the eight reviews identified, all conducted a narrative synthesis of the evidence, as is appropriate in the light of the heterogeneous nature of study designs identified.

Within the reviews identified, there are relatively few randomised controlled trials and several studies lack a control population. Not all studies have undergone comprehensive evaluation and a number focus on injury outcomes. There is little mention of the impact or process measures necessary to determine the extent to which an intervention is likely to be successfully implemented and accepted. This means that the lack of information about barriers and facilitators of successful implementation impede translating the evidence to other settings. Within multi-factorial intervention programmes, it is difficult to identify the contribution made by each element without the reporting of good process measures.

APPENDIX 1

Search terms

1 Target group

Adolescen*
Young people
Young person
Youth*
Young adult*
Teenager*

2a Accidents and accident prevention

Accident*
Accident prevention
(Injury or Injuries or Injur*) Prevent*
(Home or domestic) near (Accident* or Injur*)
(Traffic or vehicle) or road near (Accident* or Injur*)
(Sport* or leisure) near (Accident* or Injur*)
(Gun* or shooting) near (Accident* or Injur*)
(Rural or agricultural) near (Accident* or Injur*)
Fall* near (prevent* or avoid* or reduc*)
Choke* near (prevent* or avoid*)
Electrocut* near (prevent* or avoid*)
Burn* or scald* or fire* near (prevent* or avoid*)
Accidental poisoning or unintentional poisoning
Accidental drowning or unintentional drowning
Road safety
Young driver* near (accident* or injur*)
Pedestrian near (accident* or injur*)
(Cycling or cyclist*) near (accident* or injur*)
Motorcyclist* or motorcycling

2b Safety measures

Safety device*
Safety measure*
Safety behavio*
Speed reduction
Traffic calming
Cycle lane*
Speed limit*
(Helmet* or head) near protection
Seat belt*

3 Public health/health promotion and settings

Health promotion
Health education
Evaluation studies or study*
Intervention studies or study*
Campaign*
Workplace
Universit*
School*

APPENDIX 2

Sources of data searched

The following databases were searched:

Bandolier
CINAHL
Cochrane Central Register of Controlled Trials
Cochrane Library 2004 Issue 3
Current Contents of Clinical Medicine
DARE July 2004
EMBASE
ERIC
MEDLINE
PsycINFO
Sociological Abstracts

(Limits: English language only; electronic searches January 1999 to September 2004; human; not developing countries)

To identify 'grey' literature the following were searched:

ISI Conference Proceedings
National Research Register
Transport

To identify policy guidelines, and other experimental research, the following web pages were searched:

Harborview
Health Evidence Bulletin Wales
ISCAIP net
Monash Accident Prevention Centre
National Guideline Clearing House
NCCHTA
NICE
REFER
SIGN
Transport Research Laboratory
TRIP
Wider Public Health Report

Hand-searching issues of the journals *Injury Prevention* and *Accident Analysis and Prevention* took place from January 2000 to September 2004.

Restrictions

We have not specifically incorporated the '15 to 24' age group into the search terms since this group straddles the 'adolescent' (13 to 18 years) and 'adult' (19 to 44 years) age groups, as defined by the National Library of Medicine: Medical Subject Headings.

APPENDIX 3

Critical appraisal tool

Authors: _____

Title: _____

Source: _____

Ref. Man ID: _____ Reviewer: _____

Topic area			
Does this paper address unintentional injury? (home/ road/ leisure environment)	Yes	No	Unsure
Study design			
Is it a systematic review of intervention studies?	Yes	No	Unsure
Is it an evaluation of an intervention?	Yes	No	Unsure
Target group			
Does the paper address the target group (15–24 years?)	Yes	No	Unsure
Specific age range given? _____			
Systematicity			
Do the reviewers try to identify all relevant studies?	Yes	No	Unsure
Consider whether the following details are given:			
Databases searched	Yes	No	Unsure
Search terms specified	Yes	No	Unsure
Years searched	Yes	No	Unsure
Non-English language included	Yes	No	Unsure
References followed up	Yes	No	Unsure
Experts consulted	Yes	No	Unsure
Grey literature searched	Yes	No	Unsure
Inclusion/exclusion criteria described	Yes	No	Unsure
Relevance to UK			
Can the results be generalised to UK population/setting?	Yes	No	Unsure
Is it worth continuing?	Yes	No	
Why / Why not?			
Accept paper for review?	Yes	No	Refer
Use as background literature?	Yes	No	Refer

APPENDIX 4

Data extraction tool– review of reviews

Ref. Man. _____ Publication date _____ Reviewer: _____

Authors: _____

Title: _____

Publication source: _____

Details of publication

Review type	Systematic review (inc. minimum 1 RCT)			Systematic review (non-RCTs)			Systematic review (observational studies)	
Method of data synthesis	Meta-analysis			Narrative synthesis			Other	
Publication type	Health	Ed/Soc Sci	Psych	Med	Eng/Tech	Conf Abs.	Unpubl.	Other (please specify)
Injury setting	Home	School	Work	Road	Leisure/sport		Other (please specify)	
Injury type	Driver	Passenger	Cyclist	M/cyclist	Pedestrian	Sports	Drowning	
	Fall	Burn/scald	Head	Laceration	Firearm	General	Other (please specify)	

Transparency

Review has a clearly focused aim/research question?	Yes	No	Unsure
How many primary studies were included? _____			
When were studies conducted? (dates) _____			
Review pre-specifies:			
Population studied	Yes	No	Unsure
Nature of interventions	Yes	No	Unsure
Output measures considered	Yes	No	Unsure
Quantitative data collected	Yes	No	Unsure
Qualitative data collected	Yes	No	Unsure
Inequalities considered	Yes	No	Unsure

Quality

Authors address quality/rigour of included studies?	Yes	No	Unsure
Review uses:			
A rating system	Yes	No	Unsure
More than one assessor	Yes	No	Unsure
Are results of studies clearly displayed?	Yes	No	Unsure
Have study results been combined in a meta-analysis?	Yes	No	Unsure
If yes, was it reasonable to do so?	Yes	No	Unsure
Consider the following:			
Studies address similar research questions	Yes	No	Unsure
Studies sufficiently similar in:			
– design	Yes	No	Unsure
– target population(s)	Yes	No	Unsure
– output measures considered	Yes	No	Unsure
Reasons for variations in results discussed	Yes	No	Unsure

Overall finding(s) of the review. Consider:

The outputs considered/how the results are expressed *(process, impact, outcome)*

Could the results be due to chance? *(p values and confidence intervals)*	Yes	No	Unsure
Is sufficient data included from individual studies to substantiate interpretation/conclusions?	Yes	No	Unsure

Comment: _____

Approaches covered:

Education	Yes	No	Unsure

Target group(s):
Small scale _____ Mass media _____

Comment: _____

Environmental change	Yes	No	Unsure

Area-wide _____ Small scale _____

Comment: _____

Legislation/enforcement	Yes	No	Unsure

National _____ Local _____

Comment: _____

Empowerment	Yes	No	Unsure

Comment: _____

Relevance to UK

Are results generalisable to UK setting?	Yes	No	Unsure
Are there cultural differences from the UK?	Yes	No	Unsure
(If yes, specify)			

_____

Other reasons why results may not be transferable?	Yes	No	Unsure
(If yes, specify)			

_____

Key findings

Results (overview)

Implications for future policy, practice

Specific mention of inequalities

Specific mention of cost effectiveness

Special features of publication

Evidence gaps/recommendations for research?

Accept for inclusion in the evidence briefing?	Yes	No	Refer to third party

Comment: _____

Quality of evidence (tick as appropriate)

1 – core material of high quality

2 – part of review of high quality

3 – background/contextual information

Additional comments

APPENDIX 5

References

Systematic reviews included in the briefing

Coleman P, Munro J, Nicholl J et al. (1996) *The effectiveness of interventions to prevent accidental injury to young persons aged 15–24 years: a review of the evidence.* University of Sheffield: Medical Research Unit, School of Health and Related Research.

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APPENDIX 6

Characteristics of excluded reviews

Author/date	Reason for exclusion	
	Not target age group (15–24)	Not systematic
Centre for Disease Control (2001)	X	
DeRoo and Rautiainen (2000)	X	
Duperrex et al. (2002)	X	
Handoll et al. (2004)	X	
Harborview Injury Prevention Research Centre (2004)		X
Kwan and Mapstone (2004)	X	
Lister-Sharp et al. (1999)	X	
Mackay et al. (2004)	X	
Mackenzie (2000)		X
Messonnier et al. (1999)	X	
Rivara et al. (2000)	Insufficient detail provided. Contact with author unproductive	
Rivara and Thompson (2002)		X
Towner et al. (2001)	X	
Yeung and Yeung (2001)	X	