



**Report on available evidence about preventing injury
to young people including a systematic review of the evidence
of preventing work and sports related injury to young people
aged 15 to 24 years.**

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Table of Contents

Preamble	3
Executive Summary	4
Review objectives	4
Methodology	5
Findings	6
Conclusions	8
Introduction	10
Background	10
Objectives of the review	11
Clarification of objectives	11
Research questions	11
How to use this report	12
Road safety – recent reviews	13
Systematic review of the evidence of preventing work and sports related injury to young people aged 15-24 years	16
Methodology	16
Criteria for considering studies for this review	16
Types of studies	16
Types of participants	16
Types of interventions	16
Types of outcome	16
Search methods for identification of studies	17
Completion of search	19
Systematic approach	19
Selecting articles for review	19
Quality of evidence	20
Articles retrieved	20
Workplace safety – results of systematic review	21
Sports safety – results of systematic review	24
Joint / limb	24

General sporting activities	28
Baseball / Softball	29
Football (AFL, League, American)	29
Gymnastics	30
Handball	30
Ice Hockey	31
Rugby	32
Skiing / snowboarding	33
Soccer	34
Results of review – by strategy	35
Original studies	35
Balancing	35
Education	36
Orthotics	37
Personal protective equipment	38
Stretching / static balancing	41
Training / multi-strategic	42
Reviews	44
Discussion	48
Limitations of the review	48
Limiting study participants to 15-24years of age	48
Locating articles	48
Quality and quantity of articles	48
Heterogeneity of the studies	49
Responses to the research questions	49
Conclusions	55
Appendices:	
Appendix A Work related reviewed articles overviews listed alphabetically by author	
Appendix B Sports related reviewed articles overviews listed alphabetically by author	
Appendix C Armed forces related reviewed articles overviews listed alphabetically by author	
Appendix D Young people and road safety references	
Appendix E Work and sports related references for articles included in the review	
Appendix F Work and sports related references identified but not included in review	

Preamble

This report was developed as an update of the Youthsafe report, published in 2000 on a systematic review of the evidence on preventing injuries to young people aged 15-24 years (Elkington et al 2000). A significant review of the literature specifically addressing youth injury prevention has not been undertaken since that time. This review was commissioned to inform Youthsafe of the current state of the evidence, regarding the prevention of injuries to young people aged 15-24 years with a focus on road, work, sport and recreational injuries and to assist in informing others, based on published and unpublished studies of acceptable quality.

Executive Summary

Youthsafe is committed to maintaining an up-to-date evidence base to inform its activities and assist others seeking information about effective injury prevention for young people. This review seeks to contribute to the injury prevention knowledge base to assist those working in research, planning and policy development for the prevention of injuries to young people.

Review Objectives

The objectives of this review represent an expansion, as well as an update, to the previous 2000 review undertaken by Jane Elkington and Associates on behalf of Youthsafe.

The current review objectives were to:

1. Inform Youthsafe of the scope of the literature documenting all approaches including educational, environmental, legislative and media focused strategies in promoting safety and reducing unintentional injuries to young people for the period 1999 -2006.
2. Identify the proven and promising approaches reported on in the Australian and overseas literature and their potential to create change regarding the safety of young people.
3. Identify those approaches for which there is evidence to suggest that they are ineffective or harmful to the health and safety of young people.
4. Provide evidence to facilitate decision making about the need to expand, modify or supplement the current Youthsafe Program.
5. Assist Youthsafe and its partners to plan future collaborative efforts to address the safety of young people – with an emphasis on transport-related injuries (including road and rail), workplace injuries, sports/water related injuries and other recreational related injuries.

To focus the review, research questions were developed as follows:

1. What is the scope of unintentional injury prevention strategies and interventions implemented for or directly impacting on young people?
2. What evidence is there to show that these strategies and interventions have been effective in the reduction of injury among young people?
3. What evidence is there to show that these strategies and interventions have been harmful to the health of young people or shown to have failed to contribute to the reduction of injury among young people?

4. What are the major gaps in the research and/or activities that could be undertaken by Youthsafe to support unintentional injury prevention among young people?

Youthsafe's main areas of interest are in injury prevention related to transport, particularly road transport, work and sport/recreational activities.

Soon after the review commenced it was identified that a number of excellent road safety reviews had been undertaken in recent years. Rather than replicating this good work it was decided that this report would include information about these road safety reviews and focus the systematic review of evidence on preventing work and sports related injury in 15 to 24 year olds.

Methodology

The search strategy for evidence on preventing work and sports related injury covered any evaluation study, either original article or review, published in English from 1999 to November 2006 that met inclusion criteria as follows:

- All, or the majority, of study participants were stated as being aged 15 to 24 years; or it could be inferred that they were e.g. 'high school' students; or the study results addressed young people within that age group.
- Studies/reviews measured injury outcomes in association with the intervention being measured and not just lower level outcomes such as knowledge or awareness of risk.

Seven databases were searched for relevant publications, as well as websites of various national and international organisations. Key organisations were also emailed requesting any relevant unpublished work not posted on their websites.

The search was undertaken in a systematic way which involved:

- Applying search terms and limitations systematically to database searches.
- Searching through reference lists of promising articles.
- Searching for 'related articles' of promising articles.
- Checking reference lists of all included original studies and reviews.

The reviewers read over 600 abstracts to determine if inclusion criteria were met and full articles were read if abstracts did not provide adequate information to determine if inclusion criteria were met.

Articles considered to have met inclusion criteria were read in full and a quality rating of "weak", "moderate" or "strong" was applied.

For work and sport/recreation areas, the focus of the systematic review, a total of 55 articles met the inclusion criteria and these were reviewed. Summaries of these articles were then prepared for inclusion in the report.

Many of the studies not meeting inclusion criteria contained pieces of information that some researchers could find of value, so these were identified for inclusion in a reference list in the appendices to the report.

Findings

In undertaking this review it was clear that there was substantially more literature available than when the 2000 review was undertaken.

Numerous systematic reviews and reports undertaken over the past ten years provide quite a strong body of evidence on countermeasures for road related trauma to young people. Young drivers have been a particular focal point.

However it was also evident that, despite the increase in available literature, there are still very few high quality evaluation studies from which conclusions can be drawn about the effectiveness of intervention strategies for the age group of interest with regard to work and sport/recreation activities.

Factors detracting from the quality of work and sport/recreation reviews included the following:

- No consideration of or adjustment for possible confounders.
- Lack of random assignment of subjects to interventions.
- Participants opting for involvement in interventions.
- Assessors not blinded to interventions.
- Compliance or assessment reliant on self-reporting.
- Pooling of injuries rather than analysing individual types of injuries because of low numbers.
- Analyses not appropriate for study design used e.g. cluster randomised trials without adjusting for the cluster design.

Lack of consistency between work and sport/recreation studies, for instance in study parameters and study populations, also made it difficult to summarise the review findings.

The area with the least number of articles and reports on the controlled evaluation of prevention strategies for young people was work related injury. The studies that were identified covered five different occupations and addressed the following:

- Education – both school based and job-specific occupational health and safety.
- Supervision of young people living in occupational settings e.g. farms.

Although the sports related studies reviewed covered a large array of countermeasures for injuries associated with over twelve different sports, there remained a paucity of good information about effective prevention strategies in this area. The studies that were identified addressed the following:

- Use of protective equipment for head and face, upper and lower limbs and feet.
- Use of different training/conditioning techniques e.g. stretching, balance board, plyometrics.
- Education of players and coaches.
- Mixed strategies.

Strategies with the strongest evidence to support implementation included:

- Full-face/head protection plus mouthguards to reduce risk of eye, dental and other facial injuries – two moderately strong studies in ice hockey.
- Ankle disc (wobble board / balance board) training to reduce risk of ankle injuries in players across different sports.
- Ankle bracing (semi-rigid) to reduce the risk of ankle injuries among players with a previous ankle injury.
- Plyometric conditioning in conjunction with balance training to reduce risk of knee injuries – across different sports.

There were mixed findings for knee bracing and footwear modifications.

A range of other strategies were identified with moderate to weak evidence that they may be of value, but they required further research before they could be considered proven strategies.

Results suggested that:

- Education alone had no impact on injury rates.
- Warm-up stretching alone could not be linked to injury reduction, though as part of pre-conditioning over a period of time it was shown to reduce injuries e.g. hamstring injuries.

There was no significant evidence to demonstrate that any specific countermeasures were harmful.

Conclusions

While there is quite a strong body of evidence on countermeasures for road related trauma to young people, this is not the case for work and sport/recreation related trauma to young people. The review highlights the fact that there are many gaps in our understanding of best practice in preventing work and sport/recreation related injuries to young people and that there is a clear need for formal, controlled trials of interventions where current evidence is weak or lacking.

One of the lessons to be learned from the road safety area is that young people are fundamentally different to other age groups. In looking for prevention strategies in work and sport/recreation areas that are effective for young people, there needs to be consideration of issues such as developmental and physiological differences, inexperience, risk perception, risk aversion, motivation to comply with recommended practices, attentiveness to safety messages and instruction and the interactions between all these factors.

The review provides some insights into specific areas for further research and robust evaluation.

Recommended areas of investigation for work related injury among young and inexperienced workers, especially in high risk industries, include the following:

- Examination of the contribution of orientation training in addressing major risks.
- Evaluation of the impact of gradual introduction to independent work on hazardous tasks.
- Evaluation of enforced compliance with safety procedures, including examination of incentives and disincentives.
- Investigation of enablers and barriers to the use of safety equipment.
- Investigation of the best mix of safety strategies to build worker resilience.

Recommended areas of investigation for sport/recreation related injury among young participants include the following:

- Evaluation of current preferred practices and use of protective equipment in high risk sports, including football, gymnastics, skiing and snowboarding.
- Evaluation of pre-season conditioning for sports and the most effective elements of training programs.

- Examination of the most effective protective devices to reduce risk of knee and ankle injury in high impact sports for players, irrespective of previous injuries.
- Investigation of acceptability of protective equipment among players to address compliance issues.
- Investigation of acceptability of various interventions among coaches.
- Investigation into gender specific high incidence injuries and the need for gender specific interventions.
- Investigation of the role of different playing surfaces on injury incidence.

The review overall is an important stepping stone in clarifying the extent of road safety evidence available with respect to young people and in developing our understanding of progress to date in identifying preventive strategies in work and sport/recreation arenas and further research needs.

Further, more focused, topic specific reviews may be an appropriate progression from this report.

Introduction

Background

Unintentional injury continues to be the single biggest cause of death and hospitalisation in young people 15 to 24 years of age.

The environments in which young people most frequently sustain injuries are on the roads but also in the workplace and during sport or recreational activities

Young people commonly sustain minor injuries, such as sports related soft tissue sprains and strains. However they are also significantly over represented in serious injury statistics, such as brain injury and spinal cord injury. These injuries are more likely to be related to road trauma and often lead to lifelong disability and death.

Fifteen to 19 year old males are at twice the risk of suffering traumatic brain injury than the community as a whole. The rate of injury for this group is 399 per 100,000 population compared to a rate of 189 per 100,000 for all ages.

Fifteen to 24 year olds have the highest age-specific rate of spinal cord injury with young men more likely to be injured than young women. The ratio of male to female injury in this age group is 9 to 1.

Other serious injuries include limb amputations, serious fractures and internal injuries.

Many factors contribute to the increased risk of injury in young people including:

- A still maturing adolescent brain – areas of the brain particularly associated with hazard perception and decision making do not mature until the mid twenties.
- New levels of independence and responsibility.
- Inexperience with new situations which may require developing new skills – for instance driving or starting work.
- Inexperience with alcohol and experimentation with alcohol and other drugs.
- Peer influence – at no other time during life are the perceptions of peers more important than during adolescence.
- Overconfidence in own ability and sense of invulnerability.
- Tendency towards risk taking or thrill seeking behaviours.

With clearly identifiable factors contributing to high risk of injury in young people and data demonstrating the high incidence of injury in this population, it is critical to establish what evidence is available to assist in effective injury prevention in young people and to identify gaps in the evidence to assist in setting a research agenda.

Objectives of the review

The objectives of this review were to:

1. Inform Youthsafe of the scope of the literature documenting all approaches including educational, environmental, legislative and media focused strategies in promoting safety and reducing unintentional injuries to young people for the period 1999 -2006.
2. Identify the proven and promising approaches reported on in the Australian and overseas literature and their potential to create change regarding the safety of young people.
3. Identify those approaches for which there is evidence to suggest that they are ineffective or harmful to the health and safety of young people.
4. Provide evidence to facilitate decision making about the need to expand, modify or supplement the current Youthsafe Program.
5. Assist Youthsafe and its partners to plan future collaborative efforts to address the safety of young people – with an emphasis on transport-related injuries (including road and rail), workplace injuries, sports/water related injuries and other recreation related injuries.

Clarification of objectives

Following preliminary searches of databases and websites of organisations that included terms related to road safety and motor vehicle safety, numerous quality reviews were found on young people and road safety interventions. Rather than redo the good work of others, it was decided to direct readers to these key reviews in this area and focus the literature review on workplace injuries, sports/water related injuries and other recreation related injuries.

Research questions

The project brief, adapted once the scope of the review was clarified, indicated that the review was to help answer the following research questions:

1. What is the scope of unintentional injury prevention strategies and interventions implemented for or directly impacting on young people?
2. What evidence is there to show that these strategies and interventions have been effective in the reduction of injury among young people?

3. What evidence is there to show that these strategies and interventions have been harmful to the health of young people or shown to have failed to contribute to the reduction of injury among young people?
4. What are the major gaps in the research and/or activities that could be undertaken by Youthsafe to support unintentional injury prevention among young people?

How to use this report

Due to the broad scope of the types of interventions and types of risk activities included in this review, this report is intended to provide an overview of the evidence, while directing readers to the articles included for further details.

This report includes summary information about recent road safety reviews then goes on to describe the methodology and present results of the systematic review of injury prevention evidence for work and sport/recreation in a summary table format, including identification of the references employed.

The reader may elect to examine the more detailed review of any article/report that is referenced by turning to *Appendices A, B and C*.

Appendix A provides an overview of reviewed articles relating to workplace issues and *Appendix B* provides an overview of reviewed articles relating to sports/water issues. *Appendix C* provides an overview of reviewed articles about studies involving armed forces personnel. This separate categorisation was created as the studies generally have potential application to both workplace and sports related areas. The overviews of articles are presented alphabetically by author for each group.

The overview of each of the articles /reports included in the review covers:

- Study design and target population
- Intervention
- Outcomes
- Results
- Study quality and conclusions.

Appendix D includes a list of references identified in the transport related reviews undertaken by others.

Appendix E includes a list of references included in this review of workplace and sports/water related areas.

Appendix F includes a list of references for workplace and sports/water related areas identified but not included in this review.

Road safety – recent reviews

In its strategic framework, Youthsafe identified “preventing serious injury among young people on the roads, in the workplace and in sport and recreation settings” as its focus areas.

The preliminary stages of this review included investigation of injury prevention in young people on the roads. However the road injury area has become a key topic area for researchers in the last decade, with numerous systematic reviews and reports being written in an attempt to draw together the lessons learnt.

Rather than replicating recent very good reviews relating to prevention of road trauma, information about these reviews is included in this report.

Table 1 presents examples of such reviews and reports. A reference list of some papers published from 1999-2006 (inclusive) that may be useful for people working in the road safety area can be found at Appendix D.

Table 1 Summary of major systematic reviews (1999-2006) that specifically address young people and evidence on injury countermeasures.

Topic area/ Year	Title & Source	What it covers
Novice drivers (2005)	<p>Motor vehicle crashes among young drivers: systematic review and recommendations for British Columbia (BC).</p> <p>Turcotte et al., (2005) Motor Vehicle Crashes Among Young Drivers: Systematic Review & Recommendations for British Columbia (BC)</p> <p>BC Injury Research and Prevention Unit</p> <p>http://www.injuryresearch.bc.ca/Publications/Reports/</p>	<p>A systematic review of strategies to prevent motor vehicle crashes and crash-related injuries among young drivers identified strategies to keep young people safe on the roads. Strategies presented included: minimum blood alcohol concentration, minimum drinking age, night-time driving curfew, driver education, school-based driver education, passenger restrictions, vehicle crash worthiness, parental involvement, maximum speed laws, driver fatigue and in-vehicle distractions. Recommendations for BC regarding each of these prevention and intervention strategies were formulated based on the collective evidence.</p>
School-based programs and drink driving (2005)	<p>Effectiveness of school based programs for reducing drinking and driving and riding with drinking drivers: a systematic review.</p> <p>Elder RW, Shults RA, Sleet DA, Compton R, Nichols JL; Task Force on Community Preventive Services. (2005) Effectiveness of designated driver programs for reducing alcohol-impaired driving: a systematic review. <i>Am J Prev Med.</i> Jun;28(5 Suppl): 280-7</p>	<p>Thirteen paper/reports met the selection criteria. Three types of programs were examined: school-based instructional, peer-based program and social norming campaigns. The latter two did not have sufficient studies to make conclusions. The evidence suggests that school based instructional programs can impact passenger choice not to ride with driver who is DUI – but no evidence is provided of this strategy impacting young drivers.</p>

Topic area/ Year	Title & Source	What it covers
GLS (2004)	<p>Graduated driver licensing for reducing motor vehicle crashes among young drivers. Cochrane Database of Systematic Reviews.</p> <p>Hartling L, Wiebe N, Russell K, Petruk J, Spinola C, Klassen TP. (2004) Graduated driver licensing for reducing motor vehicle crashes among young drivers. Cochrane Database of Systematic Reviews Issue 2. Art. No.: CD003300. DOI: 0.1002/14651858.CD003300.pub2.</p>	<p>Systematic review: 13 studies covering 12 programs from 1979-1998 examined: night curfews (8); limitations of extra passengers (2); and roadway restrictions (1). GLS was found to be effective in reducing the crash rates of young drivers, although the magnitude of the effect is unclear; conclusions are based on consistent direction of the findings and the temporal relationship and plausibility of the association.</p>
Novice drivers (2003)	<p>Report on Review of Novice Driver Road Safety Programs.</p> <p>NRMA website http://www.mynrma.com.au/cps/rde/xbcr/SID-3F5768EC-9661725A/mynrma/Novice_drivers.pdf</p>	<p>A review of the published evidence on 13 different approaches to increasing the safety of novice drivers, including various restrictions under GLS (hours of practice, time of day, number of passengers, BAC limits), age of licensing, strategies to involve parents, enhanced enforcement, increasing the salience of education strategies, social marketing about alternative transport, designated driver schemes.</p> <p>Does not cover: review of educational approaches, working with licensed venues, working with the community to provide alternative transport/entertainment.</p>
Driver education (2001)	<p>School-based driver education for the prevention of traffic crashes. Cochrane Database of Systematic Reviews.</p> <p>Roberts, I., Kwan, I. and the Cochrane Injuries Group Driver Education Reviewers. (2001) School-based driver education for the prevention of traffic crashes. Cochrane Database of Systematic Reviews Issue 3. Art. No.: CD003201. DOI: 10.1002/14651858.CD003201.</p>	<p>Systematic review to quantify the effect of school based driver education on licensing and road traffic crashes (among 17-21 year olds). Only 3 trials conducted between 1982 and 1984, met the inclusion criteria (n=17,965) - examining the effect of driver education on road traffic crashes. The results show that driver education leads to early licensing. They provide no evidence that driver education reduces road crash involvement and suggest that it may lead to a modest but potentially important increase in the proportion of teenagers involved in traffic crashes.</p>

Systematic review of the evidence of preventing work and sports related injury to young people aged 15 – 24 years

In light of the recent road safety reviews identified, the 2006/07 review ultimately focussed on prevention of injuries to young people in the workplace, in sport and in recreation settings. The following methodology and results specifically relate to these areas.

Methodology

Criteria for considering studies for this review

Types of studies

Any evaluation study (either original article or review) that was published (in English) and available from 1999 up to and including November 2006 that met the inclusion criteria described below.

Types of participants

Any study which:

- Stated age range of participants was within the range 15 to 24 years (inclusive), or
- The majority of participants from both the intervention and the control groups were aged 15 to 24 years, or
- The results were presented for people aged within that age range.

In some cases, where the age of participants was not stated, the article was included if it could be reasonably assumed to include predominantly the age group of interest e.g. it concerned “college students” or “high school students” or was a sport that is dominated by 15 to 24 year olds e.g. snow-boarding.

Types of interventions

Studies were included where the focus was on the prevention of injuries to young people while they were at work or participating in sport or other recreational activities.

Types of outcome

Studies/reviews were only included if they measured injury outcomes in association with the intervention being evaluated. It was not sufficient for evaluation studies to only evaluate knowledge or awareness of risk, for instance, to be included in this review.

Search methods for identification of studies

Using the terms “injury prevention, accident prevention, evaluation, risk management, drowning, sport injury, safety, aquatic sport, young people, workplace, occupational, work, recreation, public transport, rail”, the following databases were searched:

- CINAHL
- EMBASE
- Endnote
- ERIC
- OSHROM
- PUBMED
- PSYCHINFO.

The websites of various national (Table 1) and international organisations (Table 2) were searched for relevant publications and emails were sent to people in key organisations requesting any relevant unpublished work that may not have been posted on their websites.

Following the retrieval of promising studies identified in the search from the databases and organisations, the reference lists of those studies were searched and potential articles sought. Similarly, when key articles were identified in the PubMed search ‘related articles’ were sought. Using this approach the authors found that many articles were identified that, surprisingly, were not otherwise revealed in the original searches of the databases. This was an experience also shared by Canadian researchers (Mackay and Scanlan et al., 2001).

Table 1	List of National Organisations
	Australian Institute for Family Studies
	Australian Centre for Agricultural Health & Safety
	Australian Government Department of Employment, Workplace Relations and Small Business - Office of Australian Safety and Compensation Council
	Australian Government Department of Health and Ageing
	Australian Government Sports Commission
	Australian Indigenous Health InfoNet
	Australian Transport Safety Bureau
	Injury Prevention & Control (Australia) Ltd
	Injury Risk Management and Research Centre (NSW)
	Motor Accident Authority of Australia
	MUARC
	National Injury Surveillance Unit
	NOHSC
	NRMA
	NSW Centre for Overweight and Obesity
	NSW Centre for the Advancement of Adolescent Health
	NSW Commission for Children and Young People
	NSW Department of Employment and Training
	NSW Health
	NSW Institute of Trauma and Injury Management
	NSW Office of Industrial Relations
	Office of Children and Young People - youth.nsw
	ReachOUT
	Roads and Transport Authority
	The George Institute
	WorkCover NSW
	YouthSafe

Table 2	List of International Organisations
	Board on Children, Youth, and Families website British Columbia Injury Risk and Prevention Unit Child Accident Prevention Trust Harborview Injury Prevention Research Centre Injury Control Resource Information Network Injury Prevention Organisation National Center for Disease Control National Institute for Health and Clinical Excellence NIOSH SWOV The Cochrane Collaboration The New Zealand Injury Prevention Research Unit (IPRU) Otago United Kingdom Government Transport

Completion of search

The search of databases and websites was completed by November 2006 and an email sent to relevant organisations requesting all unpublished studies to be provided by December 2006.

Systematic approach

The authors applied a systematic approach used in previous systematic reviews to search the databases. This included the steps of: firstly, examining the databases applying terms and limitations systematically; secondly, searching through reference lists of promising articles; thirdly, searching for 'related articles' of promising articles; and finally, checking the reference lists of all included original studies and review articles.

Selecting articles for review

From these searches, abstracts of over six hundred articles were read by the authors. When the authors were unable to determine by reading the abstracts if the articles met the inclusion criteria, then the full article was sought. The authors then read the full articles to determine their eligibility for inclusion. Each author identified all articles to include and those to exclude. Where there were discrepancies between the authors' viewpoints, the critical elements of the articles were discussed and both authors then reached an agreement to either include or exclude the article. Articles that fell consistently into the 'grey' category were those review articles where not all the original articles presented the ages of the participants. Where it could be reasonably assumed that the majority of participants were aged between 15 to 24 years and the other inclusion criteria

(injury prevention and evaluation in the sport, recreation or workplace setting) were met, then the review was included.

Quality of evidence

Given the large number of articles included in the review, the articles that met the inclusion criteria were divided between the authors who then read, summarised and applied a quality rating of 'strong', 'moderate' or 'weak' to each article. This was an adaptation of the NHMRC quality rating the authors had adapted in the earlier review (Elkington, et al 2000). A 'strong' study was a systematic review of good quality, or mixed quality studies, or a randomised controlled trial; 'moderate' quality level studies were those where either the randomisation was by cluster, or a good cohort study was conducted with analyses taking into consideration potential confounders; and a 'weak' study was either a non-systematic study, or a review based on weak studies, or an observational or ecological original study.

Articles retrieved

Following the database search and reading the abstracts of promising studies, a total of 55 articles met the inclusion criteria and were reviewed. Overviews of the reviewed articles are included in Appendices A, B and C. The authors read many studies that failed to meet the inclusion criteria yet could provide useful information to other researchers. These articles excluded from the review have been included in the 'Reference list' in Appendix F.

Workplace safety – results of systematic review

The following tables provide a summary of findings for evaluations of interventions aimed at injury prevention amongst young people in the workplace.

Strategy	Proven/Promising strategies	Level of evidence	Reference
Supervision	Supervision of children on farms within the home may be associated with fewer injuries (9%) than those who are with parents doing farm work (27.5%, $p=0.007$). Of those in the study sample, 55% of the children were 13-18 years of age.	Weak – cross-sectional survey-based study with correlations drawn between injuries and reported types of supervision. Has not controlled for anything.	Pryor et al., 2002
Variety of strategies	A review of the literature suggested that effective strategies to reduce work related injuries in young people MAY include enforcement of safety regulations and education approaches tailored to the young/inexperienced worker that include a role for employers, parents, health professionals and schools.	Weak – not a systematic review, no evidence presented to back up recommendations from this review. Only one evaluation study.	Runyan et al., 2000
Physical conditioning	<i>(See joint/limb findings in sports safety section)</i> The most promising strategy to reduce injuries during training was to modify the basic training by gradually increasing the duration and intensity over time. Minimal effect was found for pre and post-exercise stretching. Further research needed on types of shock absorbent boot insoles and footwear.	Moderate to strong – systematic review.	Sherrard et al., 2004
Physical conditioning	<i>(See joint/limb findings in sports safety section)</i> A significant decrease in the incidence of pelvic stress fractures, with 0.6% in intervention group versus 11.2% in historical group ($p<0.001$) following a reduction of route march speed; change of running surface; and implementation of interval running rather than middle-distance runs in male Australian Army recruits.	Weak – observational study did consider some potential confounders; attempted to provide control (measured male pelvic stress fracture incidence for corresponding period).	Pope et al., 1999

Strategy	Proven/Promising strategies	Level of evidence	Reference
Physical conditioning	<p><i>(See joint/limb findings in sports safety section)</i></p> <p>A reduction in the running distance (by 26.5 km), the introduction of interval training on grassed surfaces and a reduction in the final test distance from 5km to 2.4km, introduction of uniform and controlled march speeds and graduated load increments were associated with a significant reduction in stress fractures in male army recruits and a non-significant reduction among females (lower numbers). Some promise that attention to the intensity of training programs needs to be examined to minimise the risk of stress fractures associated with excessive training regimens.</p>	Moderate – baseline, partial change in program and full change in program but no indication of random allocation or medical assessors being blind to treatment group.	Rudzki et al., 1999
Education – safety training	<p>Safety training (anywhere from 1-40 hours and covering a variety of topics) was found to significantly reduce the incidence of workers compensation claims particularly for young construction workers (16-24 years). Young workers with safety training were 42% less likely than those with no training to file a workers compensation claim. Further research into the type of effective safety instruction is required.</p>	Weak – cohort study with no random allocation into groups; factors other than training were not controlled. Study was not able to look at different types of training offered – no quality control or indication of what type of training is most effective.	Dong et al., 2004
Education	<p>A school-based agricultural safety education program delivered to 9th & 10th grade students in 10 rural states was not associated with a change in self-reported injury rates. Program consisted of teachers’ resource kit, DVD, printed resources and covered aspects of personal growth, leadership and safety. Control group (no program) was not significantly different from the basic program group and an enhanced group receiving the program plus weekly contact by facilitators and free safety gear (like earplugs and sunscreen).</p>	Moderate – cluster randomised controlled trial over 10 states in the USA. Authors noted that there was limited control by the researchers over the intervention and thus the program was implemented somewhat inconsistently.	Lee et al., 2004

Strategy	Proven/Promising strategies	Level of evidence	Reference
Education	Training in the use of nail guns by apprentice carpenters was associated with reduced risk of injury. Apprentices with more experience in nail gun use were also at reduced risk. The type of training was not identified.	Weak – surveillance study looking at correlations to make causal inferences. No control over the intervention, no random allocation to groups.	Lipscomb et al., 2006

Sports safety - results of systematic review

The following tables present summaries of results of studies that focus on injury prevention in young people as they participate in sport.

Review results with potential relevance to a number of sports under the heading of “Joint/limb” and for “General sporting activities” are presented first. These tables are followed by sport specific findings presented by sport in alphabetical order.

Joint/limb injury prevention across multiple sports

Strategy	Outcomes	Level of evidence	References
Ankle disc training & orthoses	<p>(Also see orthosis) A significant reduction in ankle injuries was observed with:</p> <ul style="list-style-type: none"> - Use of ankle orthosis and ankle disc training. - Warm-up exercise and ankle disc training and multiple component prophylactic program. - Direct external support to ankle/semi-rigid orthosis or ankle braces. - Particularly benefits those with a previous sprain. - Co-ordination training. 	Moderate – systematic review of fourteen studies of weak to moderate quality.	Handoll et al., 2001.
Ankle bracing versus taping; mixed intervention	Ankle bracing was found to be effective in reducing ankle sprains, particularly among those with a previous ankle sprain. Mixed intervention (education about injury prevention, treatment and rehabilitation, technical and proprioceptive training, use of balance board and ankle taping was encouraged). Bracing was found more effective than taping.	Strong – systematic review, three studies.	Olmsted et al., 2004.
Ankle bracing, ankle disc and training	Players (college football, basketball, volleyball) with previous ankle injuries were more likely to experience a protective effect of ankle bracing, ankle disc and training program. Mixed results for high-top shoes, pre-season training/conditioning and ankle disc training.	Strong – systematic review, 7 RCTs, 3 cohort.	Thacker et al., 1999

Joint / limb contd

Strategy	Outcomes	Level of evidence	References
Taping versus laced ankle stabilisers	Taping versus laced ankle stabilizers in college football players (retrospective study) found laced ankle stabilizers twice as effective in preventing ankle injuries than taping (2.56 sprains per 1000 injury exposures versus 4.91 per 1000 injury exposures) – no control group in this study.	Strong – systematic review with original articles of varying quality.	Verhagen et al., 2000.
Knee braces & conditioning programs	Review showed mixed results regarding the effect of knee braces from no impact to some increase with single hinge brace. Conditioning programs generally found to be effective in decreasing injury risk but studies were of variable quality.	Weak to moderate – as found a lack of strong studies, particularly RCTs.	Thacker et al., 2003.
Knee and ankle bracing	Athletes, females grades 9 – 12, who use knee-pads (self selection) had a 50% lower knee injury rate and a 59% reduction among those with a previous injury. Knee and ankle braces were associated with an increased rate of injury to those with no history of a knee and ankle injury, respectively.	Moderate – as no random allocation, but 3 year prospective study with large sample size (over 11,000 males and 8,000 females).	Yang et al., 2005.
Insoles / orthotics	A systematic review of RCTs and quasi-RCTs found that there were significantly fewer people with lower limb injuries (including overuse injuries/stress fractures) in the groups wearing insoles compared to those with none. Conclusions could not be drawn about the effectiveness of different types of insoles. Analysis of orthotics found that there was no difference in stress fracture rates in participants wearing custom made semi-rigid orthoses versus soft biomechanical orthoses; semi-rigid orthoses were significantly more intolerable than soft biomechanical orthoses. Comparison of custom-made with prefabricated soft foot orthoses found no significant differences in stress fracture rates; however, significantly fewer participants gave up wearing orthosis in the custom-made group. Comparisons of custom-made mechanical semi-rigid with prefabricated semi-rigid orthoses found no significant difference in stress fracture rates.	Strong – systematic review of RCTs and quasi-RCTs.	Rome et al., 2005.

Joint / limb contd

Strategy	Outcomes	Level of evidence	References
Mix of shoe modification, insoles; leg muscle stretching and braces	Results from a review that examined footwear modification in combination with pre-exercise leg muscle stretching and bracing were described as inconclusive due to the quality of the studies reviewed and a lack of consistent findings.	Strong – systematic review of RCTs and quasi-RCTs.	Rome et al., 2005
Basketball shoes versus military boots	Inconclusive results for stress fractures and overall overuse injuries; training in basketball shoes significantly associated with significant reduction in incidence of other overuse foot injuries.	Strong - systematic review of generally weak studies	Rome et al., 2005.
Footwear (boots)	No significant difference in the development of shin splints between groups of male and female army basic training recruits, particularly those who were assigned different boots. Some evidence to suggest that neoprene insoles may protect against shin splints but the changes in the training program could also account for the difference.	Moderate – RCT but flaws in design.	Thacker et al., 2002.
Footwear	Mixed results for studies investigating types of shoe (high-top versus low-top) in incidence of ankle sprain. Some suggestion that newness of shoe may have a protective effect.	Strong – systematic review with original articles of varying quality.	Verhagen et al., 2000.
Plyometric training	Promising evidence that plyometric training (which trains the muscles, connective tissue and nervous system to effectively carry out the stretch-shortening cycle) combined with biomechanical analysis and feedback can significantly reduce the risk of anterior cruciate ligament injury among female athletes (in soccer, handball, volleyball).	Moderate – review with only two RCTs and some studies with small sample size.	Hewett et al., 2006
Training and preconditioning program	A decrease in serious knee injuries among female soccer/volleyball/ basketball players following a six week training/preconditioning program in jumping and landing techniques (60 – 90 minutes three times per week including stretching and weight training).	Weak to moderate – not an RCT and not double blind.	Hewett et al., 1999.

Joint / limb contd

Strategy	Outcomes	Level of evidence	References
<p>Training modification, bracing and footwear</p> <ul style="list-style-type: none"> • Stretching • Cushioned insoles • Education 	<p>Training modification, stretching, use of external support or modified footwear, (8 – 20 weeks) found a reduction in the frequency and duration of injury. Only one of 5 studies showed stretching to be effective in injury reduction. Some effect of footwear modification and use of knee brace.</p> <p>No significant difference in ankle injuries observed between groups for any of the three interventions (stretching, cushioned insoles and health education).</p>	<p>Strong – systematic review (12 studies including RCTs).</p> <p>Moderate. Systematic review of fourteen studies of weak - moderate quality.</p>	<p>Yeung et al., 2001</p> <p>Handoll et al., 2001.</p>
Mixed intervention	<p>Injury awareness, treatment and rehabilitation, proprioceptive training, and technical training, use of balance board training and taping and bracing were encouraged – found a 47% reduction in ankle sprain incidence. Balance board training specifically – found significantly lower incidence of ankle sprains in intervention group (5% compared with 17%).</p>	<p>Strong – systematic review with original articles of varying quality.</p>	<p>Verhagen et al., 2000.</p>
<p>Stretching - stretching ranged from stretching of the heel, calf, wrist and triceps, hamstring, 6 major leg muscle groups as well as static stretching</p>	<p>Pooled analyses of studies included in a systematic review of studies to examine the effect of stretching on injury found no significant reduction in total injuries.</p>	<p>Strong – systematic review based on studies of varying quality</p>	<p>Thacker et al., 2004</p>

General sporting activities

Strategy	Outcomes	Level of evidence	References
Balance training	A six week home-based balance training program using a wobble board resulted in a significant reduction of injury (RR.2 - .88) among 14 – 19 year olds in general sporting activities.	Strong	Emery et al., 2005a.

Baseball / Softball

Strategy	Outcomes	Level of evidence	References
Use of faceguards	The introduction of a policy for the use of faceguards was associated with 28% fewer self-reported facial injuries among youth baseball league players.	Moderate – non-randomisation prospective cohort study.	Danis et al., 2000.

Football (AFL, League, American)

Strategy	Outcomes	Level of evidence	References
Static stretching of lower extremities	Static stretching for the lower extremities was added to a general conditioning program for university football players. There was a significant reduction in injuries (including musculotendinous strain) to lower extremities compared to the previous year without the program. There was an increase in shoulder and elbow injuries but this finding was not explained in the article.	Weak to Moderate – pre-post retrospective study (no control for confounders such as weather, fitness, field condition).	Cross & Worrell, 1999.
Hardshell helmets, facemasks and mouthguards	<i>(Also see Rugby)</i> American football players had 1/3 the rate of injuries of rugby players. The authors attributed hardshell helmets, facemasks, mouthguards, shoulder/hip/thigh/knee pads to this difference, however the evaluation did not use strategies to control other differences between the games/players.	Weak – ecological study not controlling for other differences between the games and their environments.	Marshall et al., 2002.

Gymnastics

Strategy	Outcomes	Level of evidence	References
Education, equipment modification and use of safety equipment	No formal evidence of effectiveness of education of coaches and gymnasts. The review reported that evidence on countermeasures for injuries in gymnastics currently rests with informal opinion or anecdotal evidence, uncontrolled data based studies and a few prospective epidemiological studies. No formal controlled evaluation has been reported. RCTs are needed for injury prevention and injury prevention among previously injured gymnasts, particularly concerning equipment design, landing techniques, coaching on physical preparation spotting, screening and rehabilitation.	Weak to Moderate – critical review of literature but no RCTs available.	Daley et al., 2001.

Handball

Strategy	Outcomes	Level of evidence	References
Structured warm-up program	Significantly fewer acute knee and ankle injuries among a group with structured warm-up program (designed to improve running, cutting and landing techniques and neuromuscular control and balance and strength) versus usual training. The program was run for 15 training sessions, then weekly for the rest of the season. Structured warm up can effectively reduce the injury risk in young people, particularly women.	Moderate to Strong – cluster RCT. Applied intention to treat analysis.	Olsen et al., 2005.
Ankle disc training	Ankle disc and training for 14 – 16 year old female group had fewer traumatic injuries than training alone. There was no difference in the number of overuse injuries.	Moderate to Strong – cluster RCT. Analysis controlled for possible confounding associated with clusters.	Wedderkopp et al., 2003.

Ice Hockey

Strategy	Outcomes	Level of evidence	References
Facial protection: <ul style="list-style-type: none"> • Face helmets: full versus half-face mask • Mouthguards and full face helmet 	Compared to full faced helmets, players with half face masks had 2.3 times more head and facial injuries and were 9 times more likely to incur dental injuries (while there was no difference between groups when examining for concussion, neck and all injuries). Mouthguards and full face helmets together provide the lowest risk of concussion compared to either worn alone.	Moderate – prospective cohort.	Benson et al., 1999/2002.
Educational incentive program	Fair Play Program (educational/incentive) which earns team points (thus standing in the competition) for reduced transgressions, resulting in no difference in the number of transgressions and no difference in the injury rates.	Weak – no evidence of random allocation and possibility of selection bias (54% response rate).	Brunelle et al., 2005.
Facial protection	Rate of eye injury was higher for players (16 – 21 years) wearing no facial/head protection than for those wearing partial or full protection. No eye injuries were reported among those wearing full protection. Rate of concussion was 4 times higher in players with no protection than full protection, but not significant.	Moderate – cohort. N = 282.	Stuart et al., 2002

Rugby

Strategy	Outcomes	Level of evidence	References
Use of headgear	No evidence of superficial head and facial injury reduction linked with use of headgear in rugby.	Weak – Moderate. Case-control, interpretation of findings limited by weak design.	Jones et al., 2004.
Mandatory use of mouthguards	Introduction of mandatory use of mouthguards for U19 rugby players resulted in a 43% reduction in rugby related dental claims to ACC (New Zealand).	Weak – ecological study tracing claims data from 1993 – 2003 with compulsory use of mouthguards introduced in 1997.	Quarrie et al., 2005. Quarrie et al., erratum 2006.
Comparison of two mouthguards	No significant difference in incidence of concussion and dental trauma between the two types of mouthguards (a 2-layered boil and bite mouthguard versus use of mouthguard of choice) for football and rugby intervarsity players.	Moderate – cluster randomised controlled trial.	Barbic et al., 2005.
Use of protective equipment	Cohort study of rugby players found some protective effect (not statistically significant) of wearing: padded headgear against damage to the scalp and ear; mouthguards for protection against damage to the teeth, mouth or jaw and support sleeves against sprain or strain to the limbs. Authors also found that wearing shinguards, taping the head and body joints and applying grease were associated with an increased incidence of damage to the area designed to be protecting. None of these results were statistically significant.	Strong – cohort study with consideration of covariates	Marshall et al., 2005

Skiing/ snowboarding

Strategy	Outcomes	Level of evidence	References
Helmets	The effect of helmet use among skiers and snowboarders on neck injuries is unclear (as there were only 8 cases) but the authors could not rule out the possibility that helmet use may increase the risk of neck injury. However a significant reduction (from 29% for all cases and 56% of the more severe cases) in the risk of head injuries was observed among 15 – 25 year olds using a helmet.	Moderate – large data set; subjects matched for age, gender and time.	Hagel et al 2005a.
Wrist guards	Use of wrist guards reduced hand/forearm injuries by around 85%. Type of wrist guard was not analysed.	Moderate – large data set; subjects matched for age, ski area, gender and times.	Hagel et al 2005b.

Soccer

Strategy	Outcomes	Level of evidence	References
Education	A video awareness training program (education), two hour workshop of video discussion and injury risks was not associated with injury risk reduction among elite male soccer players.	Strong – RCT.	Amason et al., 2005.
Pre-season training (sport-specific training, plyometric, sportcord drills and strength and flexibility training)	Young (14 -18 years) female soccer players with sport-specific cardiovascular training, plyometric work, sportcord drills, strength and flexibility training had significantly fewer injuries (14%) than those not in pre-season training (33%). They also found a reduction in the average injury severity score among those who were injured. Good evidence of directed pre-season training to reducing injuries among young soccer players.	Strong – RCT.	Heidt et al., 2000.
Mixed training - sport specific neuromuscular and proprioceptive training	Young female soccer players with training that included education, stretching, strengthening, plyometrics and sport-specific agility drills had significantly less (82% p<0.0001) anterior cruciate ligament injuries when compared to controls. Good evidence of directed pre-season training to reducing injuries among young soccer players.	Moderate – non randomised controlled trial	Mandelbaum et al., 2005
Tailored program: Warm-up & cool-down exercises & taping	Compared to the control group, a 21% reduction in injuries (after controlling for different training amounts) was observed for Swiss soccer teams (14-19 years of age) involved in a tailored program run by sports physicians, which included improvement of warm-up exercises, regular cool down, taping of unstable ankles, promotion of fair play as well as exercises to improve the strength and stability of ankle and knee joints, large muscle groups and to improve coordination, reaction time, and endurance.	Moderate – controlled trial without randomisation. Researchers did not have tight control of the intervention, however they statistically controlled for different amounts of training.	Junge et al 2002
Balance board training	Balance board training for 30 days, then continue three times a week for the season among female Swedish soccer players, found no significant difference in injury rates compared to the control group, except among those who had a recent (3 month) history of injury – there was a significant effect of the intervention on this group.	Moderate – RCT, however half of the intervention group dropped out.	Soderman et al., 2000.

Results of systematic review - by strategy

The workplace safety and sports safety review results are also collated by strategy in alphabetical order in the following tables under two main headings:

1. Original studies.
2. Reviews.

1. Original studies

Balancing

Strategy	Strength for	Level of evidence	Reference
Balance training program	<i>(See also soccer and basketball)</i> Lower rate of ankle sprains in high school soccer and basketball players, who received a balance training program, including single leg stances, squats and raised leg exercises than standard conditioning exercises. Balance training protected players from spraining or re-spraining an ankle.	Strong – RCT.	McGuire et al., 2006.
Balancing	Significantly lower self-reported injury for high school students in general sport. Balance board training for 30 days, then continued three times a week for the season among female Swedish soccer players, found no significant difference in injury rates compared to the control group, except among those who had a recent (3 month) history of injury. There was a significant effect of the intervention on those who had recent injuries. Ankle disc and training for the 14 – 16 year old female group had fewer traumatic injuries than training alone. There was no difference in the number of overuse injuries.	Strong Moderate – RCT, however half of the intervention group dropped out. Moderate to Strong – cluster RCT. Analysis controlled for possible confounding associated with clusters.	Emery et al 2005 Soderman et al 2000. Wedderkopp et al., 2003.

Education

Strategy	Strength for	Level of evidence	Reference
Education	No difference in fair play program for ice hockey which focused on education and points for the team for complying with the rules	Weak	Brunelle et al 2005
	Safety training was reported effective in reducing injury claims among construction workers. Need further examination of type of instruction; little consideration of potential confounders and there was no random allocation to groups.	Weak – cohort study. No random allocation.	Dong et al 2004
	No significant difference in self-reported injury among students in Years 9 and 10 following either the standard Future Farmers of America program; an enhanced program or a control group.	Moderate – cluster randomised controlled trial over 10 states in the USA.	Lee et al 2004
	Training in the use of nail guns by apprentice carpenters was associated with reduced risk of injury. Apprentices with more experience in nail gun use were also at reduced risk.	Weak – surveillance study looking at correlations to make causal inferences	Lipscomb et al 2006
A video awareness training program (education), two hour workshop of video discussion and injury risks was not associated with injury risk reduction among elite male soccer players.	Strong – RCT.	Arnason et al 2005.	

Orthotics

Strategy	Outcomes	Level of evidence	References
Bio-mechanical orthotics	Bio mechanical orthotics were found effective in reducing the incidence of stress fractures in infantry recruits.	Strong – RCT.	Finestone et al., 1999.
Comparison of four types of orthotics	The study did not find a significant difference in stress fractures, ankle sprains and foot problems between four groups of infantry recruits using different orthosis types (fitted for: soft comfort; pre-fabricated; semi-rigid biomechanical orthosis; pre-fabricated semi-rigid orthosis) but compliance was an issue, as comfort was an important factor.	Strong – RCT.	Finestone et al., 2004.
Custom-made biomechanical shoe orthosis	Intervention group had significantly more self-reported back or lower extremity injuries (56%) than control group (36%) in Danish military recruits.	Moderate – prospective RCT but with issue of compliance.	Larson et al., 2002

Personal protective equipment

Strategy	Strength for	Level of evidence	Reference
Mouthguards	No difference was observed between boil & bite and standard guard in the incidence of dental trauma and concussion.	Moderate	Barbic et al., 2005.
	Review stated that an overwhelming number of studies cited the positive effect of mouth-guards. This review failed to give any data or description of evaluation studies other than one study of injury rates to the face and mouth being cut from 50% of all injuries to representing $\geq 0.5\%$ once the introduction of mandatory use of mouthguards in high-school football and college football.	Weak – not systematic review.	Newsome et al., 2001.
	Introduction of mandatory use of mouthguards for U19 rugby players resulted in a 43% reduction in rugby related dental claims to ACC (New Zealand injury insurer).	Weak – ecological study tracing claims data from 1993 to 2003 with compulsory use of mouthguards introduced in 1997.	Quarrie et al., 2005. Quarrie et al., erratum 2006
Wrist guards	The wearing of mouthguards was found to have some protective effect against the incidence of damage to the teeth, mouth or jaw (not significant) in a cohort of rugby players.	Strong – cohort study with consideration of covariates.	Marshall et al., 2005
	Effective in showing significantly fewer hand/wrist injuries amongst snowboarders who wore wrist guards.	Moderate.	Hagel et al 2005b

Personal protective equipment contd

Strategy	Strength for	Level of evidence	Reference
Helmets / face guards	Full face masks appear to provide protective effective against injuries to the head, facial & dental injuries; best protection for dental injuries was full face mask plus mouthguards – for ice hockey.	Moderate.	Benson et al 1999 / 2002
	Fewer self-reported facial injuries for baseball players using full-face masks.	Moderate.	Danis et al., 2000
	Non-significant reduction in skiers and snowboarders for head and neck injuries – some promise.	Moderate.	Hagel et al 2005a
	Non-significant reduction in superficial head and facial injuries for rugby players.	Weak to moderate.	Jones et al, 2004
	Full and partial face protection protects junior ice hockey players from injury (dental, eye, head injuries and concussion) versus no protection. American football players had 1/3 the rate of injuries of rugby players– authors attribute hardshell helmets, facemasks, mouthguards, shoulder/hip/thigh/knee pads to this difference.	Moderate – cohort. Weak – ecological study.	Stuart et al, 2002 Marshall et al 2002.
Padded headgear	The of wearing padded headgear was found to have some protective effect against the incidence of damage to the scalp and ear (not significant) in a cohort of rugby players.	Strong cohort study with consideration of covariates	Marshall et al, 2005
Knee and ankle bracing	Athletes, females, who use knee-pads (self-selection) had a 50% lower knee injury rate and a 59% reduction among those with a previous injury. Knee and ankle braces were associated with an increased rate of injury to those with no history of a knee and ankle injury, respectively.	Moderate – as no random allocation, but 3 year prospective study with large sample size (over 11 000 males and 8 000 females).	Yang et al., 2005

Personal protective equipment contd

Strategy	Strength for	Level of evidence	Reference
Support sleeves	The use of support sleeves was found to have some protective effect against the incidence of sprains and strains to the limbs (not significant) in a cohort of rugby players.	Strong cohort study with consideration of covariates	Marshall et al., 2005
Taping the head and body joints; grease	The application of tape to the head and the use of grease to the body was found to be associated with an increased incidence of damage to the body part they were designed to protect (not significant) in a cohort of rugby players.	Strong cohort study with consideration of covariates	Marshall et al., 2005

Stretching/ static balancing

Strategy	Outcomes	Level of evidence	References
Extended static muscle stretching versus short duration of stretching	Static muscle stretching (18 exercises for up to 3 hours per day) lead to a significant reduction in muscle injuries and lower back pain, compared to 5 – 10 minutes of stretching by the control group (among military recruits in Japan). No significant difference was measured in the overall injury rate. For specific injuries, the intervention group had significantly lower reporting of muscle injuries and spinal injuries.	Moderate – large sample size but not randomly assigned.	Amako et al., 2003.
Exercise technique	Conditioning to optimise hamstring torque – eccentric exercise technique - was not associated with a reduction in hamstring injury rates but compliance was very poor due to the onset of soreness.	Moderate – RCT with limitations.	Gabbe et al., 2006.
Hamstring stretching	(See also to work/military). Enhanced (three additional) hamstring stretching sessions as part of basic military training, for thirteen weeks, resulted in significantly fewer lower extremity overuse injuries (17% of subjects) than regular basic training (29%). There was also evidence of increased lower extremity flexibility which helps explain the findings.	Weak – Moderate – prospective cohort study, assessor not blind to group patients were in.	Hartig 1999.
Stretching	Significantly fewer lower extremity injuries (also found an unexplained increase in shoulder & elbow injuries) were observed. (See also to work/military) Nineteen platoons were assigned to perform stretches of 20 seconds per muscle group in each leg. Twenty platoons were assigned to be control groups. Both intervention and control groups did a four minute warm-up. No significant effect of stretching was observed on all injury risks and on bone injuries. Authors concluded that pre-exercise muscle stretching does not produce a clinically worthwhile reduction in the risk of lower limb injuries.	Weak-moderate no control for confounders Strong – RCT.	Cross et al 1999 Pope et al., 2000.

Stretching / static balancing contd

Strategy	Outcomes	Level of evidence	References
Stretching - stretching ranged from stretching of the heel, calf, wrist and triceps, hamstring, 6 major leg muscle groups as well as static stretching.	Pooled analyses of studies included in a systematic review of studies to examine the effect of stretching on injury found no significant reduction in total injuries.	Strong systematic review based on studies of varying quality	Thacker et al., 2004

Training / multi-strategic

Strategy	Outcomes	Level of evidence	References
Training routine	Significant decrease in incidence of pelvic stress fractures (0.6% in intervention group versus 11.2% in historical group) following a reduction of route march speed; change of running surface; and implementation of interval running rather than middle-distance runs in male Australian Army recruits.	Weak – Observational study did consider some potential confounders;	Pope, 1999
Training routine: Structured warm-up program	Significantly fewer acute knee and ankle injuries among handball players with structured warm-up program (designed to improve running, cutting and landing techniques and neuromuscular control and balance and strength) versus usual training.	Moderate – Strong (cluster RCT);	Olsen et al 2005.
Training routine: Pre-season training (sport-specific training, plyometric, sportcord drills and strength and flexibility training).	Significantly fewer injuries among the intervention group than among those female soccer players not involved in pre-season training.	Strong - RCT	Heidt et al, 2000

Training / multi-strategic contd

Strategy	Outcomes	Level of evidence	References
Training routine: tailored program- Warm-up & cool-down exercises & taping	Compared to the control group, a 21% reduction in injuries (after controlling for different training amounts) was observed for Swiss soccer teams (14-19 years of age)	Moderate. Controlled trial without randomisation.	Junge et al 2002
Training routine: Reduction in running distance	A reduction in the running distance (by 26.5 km), the introduction of interval training on grassed surfaces, and a reduction in the final test distance from 5km to 2.4km, introduction of uniform and controlled march speeds and graduated load increments were associated with a significant reduction in stress fractures in male army recruits and a non-significant reduction among females (lower numbers of participants). Study offers some promise that attention to the intensity of training programs needs to be examined to minimise the risk of stress fractures associated with excessive training regimens.	Moderate – baseline, partial change in program, and full change in program – but no indication of random allocation or medical assessors being blind to treatment group.	Rudzki et al 1999
Mixed training - sport specific neuromuscular and proprioceptive training.	Young female soccer players with training that included education, stretching, strengthening, plyometrics and sport-specific agility drills had significantly less (82% p<0.0001) anterior cruciate ligament injuries when compared to controls. Good evidence of directed pre-season training to reducing injuries among young soccer players.	Moderate – non randomized controlled trial	Mandelbaum et al., 2005

2. Reviews

Strategy	Findings	Level of evidence	Reference
Pre-season training	Some evidence is provided that pre-conditioning is associated with reduction in back injuries to female gymnasts.	Weak – Moderate. Critical review of literature but no RCTs available.	Daley et al 2001
	Significantly fewer injuries in the pre-season trained versus untrained female group	Moderate	Hewett et al 1999
	Some positive effect when pre-season training was initiated but reported study failed to consider confounders e.g. change of rules; Other studies also supported findings that conditioning programs area associated with lower injury rates (mixed results on knee injuries specifically)	Weak – moderate, as found a lack of strong studies, particularly RCTs.	Thacker et al., 2003
In-season training	Appears to be effective in reducing risk of anterior cruciate ligament injury.	Moderate	Hewett et al., 2006
Knee braces	Review uncovered mixed results – some showing protective effect while others showing negative effects. Negative effects included: muscle fatigue, decreased quadriceps and hamstring activity. Double-hinged single upright prophylactic knee braces significantly protected against knee injuries. Other studies showed single hinged braces may increase the rate of injury.	Weak – moderate, as found a lack of strong studies, particularly RCTs.	Thacker et al., 2003.
Ankle supports	Taping and rigid bracing reported to be associated with decreased injury	Strong systematic review of moderate original articles	Sherrard et al., 2004.
Semi-rigid orthotics	Mixed results – most often protective effect with players with a history of ankle sprains.	Strong – systematic review, 7 RCTs, 3 cohort	Thacker et al., 1999

Strategy	Findings	Level of evidence	Reference
Ankle discs	<p>Effective with training in reduction of ankle injuries.</p> <p>Ankle disc and training program was found to be effective compared to no intervention among players with a previous injury (soccer). Training was aimed at the prevention of ankle sprains (identifying risk factors, treatment, ankle disc training, and a 2 hour session on the ankle disc and safe side-to-side and take-off techniques) was found effective in people with history of ankle sprains</p>	<p>Moderate. Systematic review of fourteen studies of weak - moderate quality.</p> <p>Strong – systematic review, 7 RCTs, 3 cohort.</p>	<p>Handoll et al, 2001</p> <p>Thacker et al., 1999</p>
Cushioned insoles	No significant difference between intervention group and controls in incidence of ankle injury.	Moderate. Systematic review of fourteen studies of weak - moderate quality.	Handoll et al, 2001
Insoles	<p>Mixed results from a review investigating shin splints prevention. No significant change was observed between foam inserts and standard inserts.</p> <p>Insoles/orthotics versus controls: significantly fewer people with lower limb injuries (including overuse injuries) were in the insoles group;</p>	<p>Moderate review with original articles with study flaws.</p> <p>Strong systematic review of generally weak studies</p>	<p>Thacker et al, 2002.</p> <p>Rome et al., 2005.</p>
Ankle taping versus ankle stabilisers	Study involving intramural basketball players found taping reduced the incidence and severity of ankle sprains; taping versus laced ankle stabilisers in college football players (retrospective study) found laced ankle stabilisers were twice as effective in preventing ankle injuries than taping.	Strong systematic review with original articles of varying quality.	Verhagen et al., 2000.
Mixed intervention: Ankle orthosis with training and multi component prophylactic programme	Observed reduction in ankle injuries; particularly with participants with a history of ankle injury.	Moderate. Systematic review of fourteen studies of weak - moderate quality.	Handoll et al., 2001

Strategy	Findings	Level of evidence	Reference
Mixed intervention Ankle bracing versus taping;	Ankle bracing was found to be effective in reducing ankle sprains, particularly among those with a previous ankle sprain. Mixed intervention (education about injury prevention, treatment and rehabilitation, technical and proprioceptive training, use of balance board and ankle taping) was encouraged. Bracing was found more effective than taping.	Strong – systematic review, three studies.	Olmsted et al 2004.
Mixed intervention: injury awareness, treatment and rehabilitation, proprioceptive training, and technical training, use of balance board training and taping and bracing were encouraged	Mixed intervention found a 47% reduction in ankle sprain incidence. Balance board training specifically – found significantly lower incidence of ankle sprains in intervention group (5% compared with 17%).	Strong systematic review with original articles of varying quality.	Verhagen et al., 2000.
Education	No significant difference between intervention group and controls in incidence of ankle injury.	Moderate. Systematic review of fourteen studies of weak - moderate quality.	Handoll et al, 2001
	Education of coaches and gymnasts has not been evaluated by formal controlled studies.	Weak – Moderate. Critical review of literature but no RCTs available.	Daley,et al 2001

Strategy	Findings	Level of evidence	Reference
Stretching	No significant difference in incidence of ankle injury following regime of calf stretching or the six leg muscle stretching trial.	Moderate. Systematic review of fourteen studies of weak - moderate quality.	Handoll et al, 2001
	Five studies provided clear evidence of nominally moderate quality that muscle stretching before or after exercise has no effect on delayed onset of muscle soreness. Other studies (with army recruits) suggest there is no injury risk reduction.	Strong – systematic review, 8 RCTs.	Herbert et al 2002.
Balance training	Balance training alone does not appear to be as effective as when combined with other types of training	Moderate – review with only two RCTs and some studies with small sample size.	Hewett et al 2006.
Balance board and plyometrics	Most promising were programs designed to increase neuromuscular control (e.g. balance board, plyometrics conducted by skilled trainer) to reduce knee injuries; ankle supports (taping and semi-rigid bracing) to reduce ankle injuries. Further research is needed on the usefulness of shoulder pads and coaching for landing techniques.	Moderate-strong; systematic review	Sherrard et al 2004
Footwear: Basketball shoes versus military boots	Inconclusive results for stress fractures and overall overuse injuries; training in basketball shoes significantly associated with significant reduction in incidence of other overuse foot injuries.	Strong systematic review of generally weak studies	Rome et al., 2005.
High-top shoes	Mixed results – when a protective effect was observed, this was enhanced when used with taping for players with and without a history of ankle sprains.	Strong – systematic review, 7 RCTs, 3 cohort.	Thacker et al., 1999
	High-top shoes were found to be more protective than low top, particularly among athletes with taped ankles; while another study found low-top shoes more effective than high-top shoes when worn with laced ankle stabilizers. A further RCT of intramural basketball players found no significant difference between high- and low-top shoes	Strong systematic review with original articles of varying quality.	Verhagen et al., 2000.

Limitations of the review

The findings and conclusions stemming from the current review need to be considered alongside the limitations of the review. The authors note four major areas of limitations. These are discussed below.

Limiting study participants to 15-24 years of age

The current review covered the evidence (for the period 1999-2006) on the prevention of injuries to young people associated with work, sports and recreational activities. While this scope was very large for conducting a systematic review, it was narrowed through specifying the age range of interest, 15 to 24 years. This latter criterion posed some difficulties in the selection of studies to include in the review, as there were many articles where the age group was not specified, or only touched on the age range of interest e.g. children 5 to 17 years, or all sports players with the average age being 23 years. This raises the concern of whether all (and only) the qualifying articles were included, as deciding which to include was often far from clear-cut. In addition, by limiting the age range of study participants, the literature providing lessons learned from other, or non-specified, age ranges has not been included in this study.

Locating articles

Despite attempts to conduct a comprehensive database search of published articles, the hand search of reference lists of articles once retrieved, indicated that there were many other articles missed by the database search alone. This raises the concern of how many more were out there that were not identified by either search method. Only the expenditure of many more searching hours (such as reviewing the reference lists of articles rejected at the abstract stage) may have overcome this limitation. The broad scope of the review limited the researchers' confidence that all possible reports and articles have been captured.

Quality and quantity of articles

There were few areas of research found to have a reasonable number of high quality evaluation studies to draw conclusions about the effectiveness of intervention strategies for the age group of interest in relation to work and sport/recreation. Examples of how some studies lost quality included: failure to consider or adjust for possible confounders; lack of random assignment of the intervention; assessors not being blinded to the intervention; participants opting to be involved in the intervention; reliance on self-reporting for compliance with intervention or assessment of injury; too few injuries making it difficult to analyse by individual injury area and having to pool injuries (e.g. instead of analysing by dental injuries,

injuries were pooled to include additional injuries); failure to conduct analyses appropriate for the study design (e.g. cluster randomisation trials). On the whole, work and sports related areas have too few robust studies to make conclusions about the proven effectiveness of interventions. As was the case for even the high quality review articles included in this review, the conclusions that can be drawn about what works in preventing work, sports and recreational related injuries to young people is limited by the paucity of high quality evaluation studies.

Heterogeneity of the studies

One of the major difficulties in being able to summarise the findings from the current review is that every study employed different parameters for not only the study population (and in some cases this meant different sports, or a different set of sports from which participants were drawn), but most notably the parameters of the interventions. Conditioning programs, for example, were generally not of the same intensity, duration per session and number of weeks. Similarly, footwear modifications were varied or rarely described at a level of detail that permitted comparisons between studies. The measurement of outcomes also varied greatly – where one study measured injury by medical examination, another measured injury by self-report. The heterogeneity of the studies limits the conclusions that can be drawn about the elements of an effective injury countermeasure.

Responses to the Research Questions

This section responds to the four research questions included in the project brief according to findings of the review.

1. *What is the scope of unintentional injury prevention strategies implemented for or directly impacting on young people?*

There were very few published articles and reports on the controlled evaluation of strategies to prevent *work related injuries* to young people. Those that were located could be classified as follows:

- Education:
 - i. School based education.
 - ii. Job-specific OHS training.
- Supervision (of young people living in occupational settings e.g. farms).
- Physical conditioning (for physically demanding occupations such as the military).
- Mixed strategies (enforcement, education, modification of the environment).

The strategies implemented for *sport related injury* prevention included:

- Use of protective equipment:
 - i. To the head and face (helmets, mouthguards, face guards).
 - ii. To the Upper and lower extremities (wrist guards, knee and ankle bracing and taping).
 - iii. To the feet (footwear and insoles).
- Use of different training/conditioning techniques:
 - i. Stretching.
 - ii. Balance board (ankle disc).
 - iii. Plyometric.
- Education:
 - i. Of players regarding injuries and rules.
 - ii. Of coaches regarding injury prevention and coaching technique.
- Mixed strategies (training/conditioning routine, training surfaces, education, balance, shoes, orthoses etc).

2. *What evidence is there to show that these strategies and interventions have been effective in the reduction of injury among young people?*

The current review of the literature has revealed that there have been relatively few randomly controlled evaluations of countermeasures to work and sports related injuries among young people.

Proven or promising strategies

From the literature reviewed, the findings suggested (based on the quality of research and consistency between different studies) that the following strategies (some are occupation or sports specific and some are of more general application) have reasonably strong evidence to support their implementation.

- Full-face/head protection plus mouthguards could be considered at least promising in reducing eye, dental and other facial injuries based on significant risk reduction among ice-hockey players in two moderately strong studies (Stuart, 2002; Benson, 1999, 2002).
- Ankle disc (wobble board / balance board) has been consistently (although from studies of varying levels of quality) shown across a number of different sports to reduce the risk of ankle injuries among players (Emery, et al., 2005; Wedderkopp et al., 2003; Handoll et al., 2001; McGuine and Keene, 2006).
- Ankle bracing (semi-rigid) has been shown to reduce the risk of ankle injuries particularly among players with a previous ankle injury (Thacker et al., 1999; Olmsted et al., 2004)
- The types of bracing varies or is not well described, although some studies indicate that bracing is more effective than taping (Verhagen et al., 2000.) and

in some studies other strategies such as warm-up exercises were included (Olmsted et al., 2004). Results concerning all players (including those without previous injury) are more mixed.

- Plyometric conditioning (conditioning of muscles, connective tissues and nervous system) and pre-conditioning in conjunction with balance training has been shown in a number of studies to reduce the risk of knee injuries (Hewett et al., 1999, Heidt et al., 2000, Mandelbaum et al., 2005, Sherrard et al 2004). In some studies this countermeasure has been combined with biomechanical analysis and feedback (Hewett et al., 2006).

Limited/weak supportive evidence

There were a large number of studies or reviews that showed findings to support an injury countermeasure – but either the methodology was weak to moderate, and/or there was only one or two studies on a particular countermeasure. These are considered to be areas of limited supportive evidence where further research is recommended before investment in implementation is undertaken.

- Faceguards in softball/baseball (Danis et al., 2000).
- Adding static stretching to conditioning programs for football players (Cross and Worrell, 1999).
- Multiple protective gear (helmets, facemask, shoulder pads, mouth guards) for football players (Marshall et al 2002.).
- Strategies including landing techniques, equipment design and the use of safety equipment for injuries to gymnasts (Daley et al. 2001).
- A mix of interventions including education about injury awareness, treatment and rehabilitation, proprioceptive training and technical training, use of balance board training and taping and bracing has been found to reduce injuries by up to 47% in one study (Verhagen et al., 2000).
- Helmets were found in one study (only) to reduce the incidence of head injuries, particularly severe head injuries, among skiers and snow-boarders (their impact on neck injuries is unclear) (Hagel et al., 2000a).
- Pre-season training using a mix of strategies including cardiovascular training, plyometric work, sportcord drills, strength and flexibility training has been linked with a significant reduction in injuries among female soccer players in a study of moderate quality (Heidt et al, 2000).
- A reduction in injuries has been observed for participants in a tailored program for soccer players run by sports physicians, which included improvement of warm-up and cool-down exercises, taping of unstable ankles, promotion of fair play as well as exercises to improve the strength and stability, coordination, reaction time and endurance (Mandelbaum et al., 2005; Junge et al., 2002).
- A few studies, with weak to moderate designs, found support for modifying physical conditioning programs for military recruits. The reduction of

running distances and/or gradually increasing the intensity, a shift to running on grass and modifying the type of shoe/sole being used, has been linked with a reduction in stress fractures (Rudzki et al., 1999; Pope, 1999).

Mixed findings

Some countermeasures were associated with evaluation findings from different studies or reviews that supported their association with a reduction in injuries and then other studies showed either no reduction or in fact an increase in injuries or their severity.

- Knee bracing has shown mixed outcomes in terms of their impact on knee injuries from a reduction, to no impact, to an increase with some kinds of braces (Thacker et al., 2003, Yeung et al., 2001, Yang et al., 2005).
- Footwear modifications have been evaluated with mixed results from no significant effect on shin split injuries among military recruits (Thacker et al., 2002, Larsen et al., 2002) to mixed findings regarding ankle injuries for high-top versus non high-top boots (Verhagen et al., 2000. Thacker et al., 1999). In fact one study suggested it was the newness of the shoes that may have a protective effect on ankle injury (Verhagen et al., 2000).

3. *What evidence is there to show that these strategies and interventions have been ineffective in achieving their stated aims, harmful to the health of young people or shown to have failed to contribute to the reduction of injury among young people?*

The current review did not identify any strong evidence of countermeasures that were harmful to participants. While some individual studies found an increase in the incidence of some kinds of injuries, these were not strong studies, the findings often did not reach statistical significance and the findings were not backed up by similar findings in other studies. Across all articles reviewed, there was a tendency for results to show no significant effect for the following interventions:

- Education alone is shown in several studies (of moderate to strong quality) to have no impact on injury rates (Lee et al., 2004 Arnason et al., 2005. Brunelle et al., 2005, Yeung et al., 2001).
- Warm-up stretching exercises appear not to have been linked with a reduction in injuries (Pope et al., 2000, Herbert et al 2002). However, as part of pre-conditioning, conducted over many occasions/number of weeks, muscle stretching has been shown to reduce injuries such as hamstring injuries (Hartig 1999).

4. What are the gaps in the research and/or to activities that could be undertaken by Youthsafe to support unintentional injury prevention among young people?

While the body of evidence on countermeasures for road related trauma to young people is quite strong, the area of work-related injuries most particularly, but also sport-related injuries, has very little strong evidence about countermeasures targeting young people. It could therefore be said that research opportunities are almost boundless in this area – with a clear need for formal controlled trials of interventions where currently the evidence is weak or lacking. Some specific areas calling for greater research and/or activities (accompanied by robust evaluation) are:

- Work-related injuries among young and inexperienced workers particularly in high risk industries. Specific areas for further investigation raised by the current review include:
 - The contribution of orientation training, with the development of skills and knowledge specific to the major risks of specific industry groups.
 - The impact on new/young workers of gradual introduction to independent work on the most hazardous tasks (akin to graduated driver licensing schemes).
 - The role of enforcement of safety procedures with incentives and disincentives in motivating young people to change their behaviour.
 - The barriers and facilitating factors to young people utilising safety equipment.
 - The best mix of strategies to safely build the resilience of workers (endurance training programs) and attending to external protective factors (ground surface and shoes) among those occupations that require physical conditions of new recruits.

- Sports-related injuries among young participants. Specific areas for further investigation raised by the current review include:
 - High risk sports where evidence on current preferred practice is lacking: notably gymnastics; football (rugby league, union and AFL) and relevant protective equipment; skiing and snowboarding and the use of helmets and wrist guards.
 - Pre-season conditioning for sports generally and examination of the most effective elements of training programs.
 - The most effective kind of protective equipment/orthoses to guard against knee and ankle injuries in high impact sports for previously injured players and for not previously injured players.
 - The acceptability to players of various protective equipment, as compliance appears to be a significant barrier to their effectiveness.
 - The acceptability to coaches of various interventions.

- Gender-specific high incidence injuries (e.g. anterior cruciate ligament injury) may require gender specific interventions.
- The role different playing surfaces have in the incidence of injury.

Conclusions

The current review was broad in its scope. Its search strategy and selection criteria identified reviews or evaluation studies on a very large array of countermeasures for injuries associated with over 12 different sports and five different occupations. With the focus, however, on young people aged 15 to 24 years, this review has highlighted that this age group is poorly attended to in work and sport/recreation areas of research. This is in contrast to road safety, where young people are the focus of a considerable level of research and as a result, legislation, education and environmental measures are guided by relatively good evidence of what works for this age group.

The review highlights that there are many gaps in our understanding of best practice in targeting the prevention of injuries to young people in sport and recreational settings and in the workplace. What works in building resilience against injury among young sports players or young workers in physically demanding occupations is still poorly understood. The available research does not clearly identify the effectiveness of specific safety equipment, modifications to the environment and equipment being used with this age group.

While we have slightly more research available to us on all or other age groups from which we can hope to generalise the findings to young people, in doing so we are ignoring the lessons learned in road safety - that young people are fundamentally different from other age groups. Issues such as motivation to comply with recommended practices, developmental and physiological differences, attentiveness to safety messages and instruction and the interaction of these factors with each other and with factors such as youth, inexperience, risk perception and risk aversion, mean that we may well be making inappropriate decisions about injury countermeasures for this age group.

Evidence on interventions to reduce injuries among young workers is particularly scarce and what is available is generally weak. It is noteworthy that the current review provides some evidence that young and inexperienced workers are at higher risk of injury (Lipscomb et al 2006) and may benefit more than other age groups from safety training specifically related to their job (Dong et al 2004). Clearly, further research on strategies to reduce the risk of injury to young workers is overdue. We need to better understand the right mix of OHS educational, environmental and enforcement strategies with this age group. We also need to better understand the best timing to be trying to build awareness, skills and commitment to safety in the workplace: while still in school, upon orientation to a new job and/or ongoing training?

The prevention of sports related injuries is similarly faced with a lack of evidence to guide the planning of prevention strategies. The review suggests that there is little value in warm-up stretching exercises before intensive physical activity, but there may be value in long-term conditioning including muscle stretching – over many weeks. The type of stretching appears to differ for each sport. While one sport requires flexibility of joints and muscles another requires strength around those joints. The effectiveness of these practices, common to many sports, needs to be better understood.

Physical training for army recruits warrants attention with some evidence to suggest that reducing the intensity of training and attending to things such as the type of shoes, the softness of the training surface can reduce the incidence of stress fractures and injuries to the joints. More research is needed on injury countermeasures for young people engaged in high risk sports including rugby league, rugby union, AFL, gymnastics, skiing and snowboarding.

The review supports the use of mouthguards in reducing dental injuries; the use of full-face helmets over half-face helmets or no helmets in sports such as baseball and ice hockey; ankle disc/ankle bracing for sports with high impact levels on ankle joints, among players with a previous ankle injury (although the specifics of the most effective types of bracing is not clearly identified); and plyometric pre-conditioning in conjunction with balance training for a reduction of knee injuries in sports that stress the knee joint. These countermeasures need to be better promoted with appropriate sporting groups and further research opportunities taken to examine the additional benefits of adjunct strategies such as biomechanical analysis and feedback.

The review highlights, as noted above, some key areas for further research, but a more general issue it raises is an urgent need for quality studies in this field. Greater attention needs to be paid to the methodological flaws that are commonplace in evaluation, such as the absence of randomisation techniques that ensure factors external to the intervention are being controlled; non-blinded assessment of outcome; inadequately defined outcome criteria and inadequate reporting of study design, the study population, interventions and results (Moher 2001). Trials using cluster randomisation should perform appropriate analyses and include sufficient information in trial reports to aid interpretation by readers and users of such trials (Campbell 2004). These methodological constraints are generally more difficult and therefore more costly to implement, however, the greatest gains in expanding the currently weak knowledge base in this area can only be made from investing in quality research.

It is recommended that the current review be considered as a “stepping stone” in developing our understanding of the progress made and further research needs in

work and sports related injury prevention for young people. A next step might be to conduct a review more focused on a particular topic and include all ages and from there examine the applicability of interventions to young people. As noted in the section on limitations, the current review by covering all evaluation studies and reviews of work, sport and recreational related injury countermeasures was unable to compare the findings for this age group against other or all age groups. The amount of literature to review would have been unmanageable within the resources available. The most practical way to do this would be to very narrowly define the activity and/or the countermeasure of interest and seek out all available research while comparing the effectiveness of the intervention for 15 to 24 year olds.

Finally, it is recommended that readers use the tables provided in the findings section together with those in the Appendices to seek out details that are available on specific interventions or specific occupational or sports groups. This review primarily aims to alert readers to the evaluation findings that are available and will help in better understanding what works and where this is not known, what research needs remain.

Appendix A: Work related reviewed articles – overviews listed alphabetically by author

Author	Dong et al 2004
Study design and target population	Cohort study (8568 workers) – examining training and injury records (workers compensation) of workers in the construction industry in the US
Intervention	One to 40 hours of safety training – covering a wide variety of topics. It was recorded whether or not they had had union safety training and how many hours. No information was collected on the type of training.
Outcomes	Incidence of claims under workers compensation.
Results	<p>The association between training and a reduction in workers compensation claims was most pronounced among younger workers (16-24 years). While other age groups showed a reduced rate of claims by those who'd received training, only the 16-24 year age group was significant (nearly half, 17% with training versus 30% without of all workers making a claim).</p> <p>Workers aged 16 to 24 who completed at least one hour of safety and health training during the study period were 42% less likely than workers of the same age without training to file a workers compensation claim. Overall, after controlling for age and gender, cohort members who received training were 12% (not significant) less likely than non-trained workers to file a claim.</p> <p>The data provided no evidence of a dose response relationship.</p>
Study quality and conclusions	Weak. No random allocation into groups – so potential for some bias in those who receive training. It is feasible that worksites that provide training are more safety-conscious in other areas such as policies, environment etc – which may contribute to the reduced rate of claims. Conversely, there is a possibility that training alerted workers, particularly young workers to workers compensation – thus you may expect an increase in claims – so two issues could work against each other. Study was not able to look at different types of training and its effectiveness – so no recommendations can be generated in this area.

Author	Lee et al 2004
Study design and target population	Rural youth in 9 th and 10 th grades in 10 states in the USA. Cluster, randomised controlled trial design with 2 interventions: standard FFA (future farmers of America), an enhanced program and a control group. There were 3 measurement occasions – pre, immediate post and 1 year follow-up.
Intervention	School-based agricultural education program, which includes aspects of personal growth and leadership as well as safety. Teachers resources kit consists of video, DVD, printed resources. The standard group received the same as 4000 other chapters throughout the USA. The enhanced group received this program plus weekly contact with facilitators, free health and safety equipment like sunscreen and ear plugs, and promotional efforts and incentives to include community nurse involvement with the program.
Outcomes	Self reported injury over the previous 3 months alongside other information about attitudes, self-esteem, safety knowledge.
Results	There was no significant difference between the three groups in terms of the number of self-reported injuries. Although about 25% of respondents reported that they had been injured during the previous 12 months, there was no significant difference between the three groups. Injury risk was more closely aligned with safety consciousness and risk taking than whether they had attended either program or nothing. Similarly there was no significant impact on the knowledge, attitudes and practices.
Study quality and conclusions	Moderate – limited by the cluster design and evidence that the program was implemented somewhat inconsistently as there was limited control of the intervention by the researchers. Results showed no positive effect of the program on the indicators of interest. Further research into effective strategies is required.

Author	Lipscomb et al 2006
Study design and target population	Surveillance study of 772 apprentice carpenters (125 could not be used due to incomplete data) regarding hours of use of trigger nailguns. Age not specified – but as apprentices we can assume they are generally young.
Intervention	Training in use of nailguns
Outcomes	Self-reported injury
Results	Those with no training and those with the least amount of experience were at the greatest risk of injury.
Study quality and conclusions	Weak. Surveillance study looking at correlations to make inferences about causal relationships. Self report of training received and type of nailgun. No random allocation to groups. Type of training was not identified.

Author	Pryor et al., 2002
Study design and target population	Part of the cross-sectional Louisiana Farm Family Injury Prevention and Health Initiative study. Women over 18 years whose family were involved in agricultural production, incorporating a stratified random sample of a pool of 4808 farms. 657 completed the interviews of those 177 had children less than 18 living in their home.
Intervention	Level of supervision (derived from telephone interviews.) Levels were: no supervision, goes with caregiver engaged in farm work and supervised at home). Conduct of telephone interviews with the female most involved in agricultural activities & who had children less than 18 years in home.
Outcomes	Injuries reported (includes farm-related as well as off-farm jobs; recreational injuries, injuries sustained in the home and travelling in a vehicle) over previous 12 months.
Results	Of the 177 children, 40 (23%) reported an injury in the previous 12 months. Of those 40, 12 (30%) were aged 16-18 years and 10 (25%) were aged 13-15 years. Of the 40 injured children, 18 were left unsupervised.
Study quality and conclusions	Weak study with little consideration for potential confounders in analyses. Small numbers; great potential for recall bias. Children more likely to sustain farm-related injury when children were with the caregiver who was doing farm work (27.5%) rather than being cared for in the home (9.0%; p=0.007). More likely that children aged older than 14 years were unsupervised.

Author	Runyan and Zakocs, 2000
Study design and target population	Review of youth workers – epidemiology and identification of countermeasures. No presentation of level of search.
Intervention	The one study presented a mixed intervention of a new piece of equipment (case-cutter) combined with training.
Outcomes	Workers’ injuries from cuts sustained in grocery stores.
Results	Result of this one study found that there were reduced injuries from cuts (no other details were provided for this study). The review then presented numerous recommendations to address adolescent worker injury: Enforcement of current safety regulations; Educational approaches – directed at employers, young workers, parents, health professionals and school officials; Encourage employers to provide support that reflects their employees e.g. young workers require more guidance due to differences in their ability to judge their capabilities compared with adults; Young workers – educational health and safety programs (not evaluated); Parents – identification in age-appropriate tasks (e.g. agricultural settings) e.g reference to the <i>American Guidelines for Children’s Agricultural Tasks</i> ; Health professionals – provision of resource to young people in identifying workplace injuries and counselling young people about workplace safety. School-based – provision of information on workplace laws and regulations; recommend need to develop school based workplace safety education; Community-based – recommended by NIOSH authors unable to identify any published evaluations for this specifically.
Study quality and conclusions	Weak – not systematic review. Recognises very limited evaluations of interventions for prevention of adolescent worker injury.

Appendix B: Sports related reviewed articles – overviews listed alphabetically by author

Author	Arnason, et al., 2005
Study design and target population	RCT - 15 of 20 teams completed the study. Participants were elite male soccer players playing in the top 2 divisions in Iceland.
Intervention	Intervention (n=127 players, 7 teams); Control (n=144 players; 8 teams). 2 hour workshop at beginning of season. Workshop consisted of: 15 min. presentation on study; information on injury risks and typical injury mechanisms; video of 12 sequences involving injury; small group and then whole group discussion breaking down the injury sequence – how, why did it happen, how could it be avoided.
Outcomes	Acute injuries recorded all acute injuries and coaches recorded training exposure.
Results	No difference observed in total injury incidence per 1000 hours between intervention and control groups (z test, $p=1.0$); nor in any match or practice injuries ($p=0.8$ and 0.2 respectively). No significant difference in location of injury (chi sq. $p=0.50$) for all injuries, ($p=0.60$) for match injuries and ($p=0.8$) for training injuries; nor injury severity.
Study quality and conclusions	Strong. Video awareness training program at beginning of season had no effect on injury incidence for male elite soccer players.

Author	Barbic et al 2005
Study design and target population	Cluster randomised controlled trial - Players (over 16 years) in intervarsity football and rugby teams (12 clusters) in Canada. Matched pair randomisation to the intervention and control groups. Team health professional reported observed concussion and dental trauma.
Intervention	The WIPSS mouthguard (a 2 layered boil and bite mouthguard designed to separate the tempo-mandibular joint and thus minimise the acceleration forces entering the cranium) compared to the standard use mouthguard of choice for the prevention of concussion and dental trauma among university football and rugby players.
Outcomes	Incidence of diagnosed concussion, and dental trauma
Results	There were no significant difference observed in the number of concussions among the intervention group compared to the control group. No dental trauma events were recorded for either group.
Study quality and conclusions	Moderate. RCT but using 12 clusters (prospective design) and the limited number of injuries in total may have limited the ability to find a significant difference between the two groups. The study does not support the premise that the WIPPS design offers significant advantages over other mouthguard designs.

Author	Benson et al 1999/2002
Study design and target population	Prospective cohort study. Mean age 22 years, university ice hockey players. Use of face shields was pre-determined by the team/coach themselves (no random allocation). 22 teams, 11 wearing full face masks and 11 wearing half-face masks.
Intervention	Use of a full-face protective helmet, versus a half face helmet. The 2002 article also examined self-selected mouthguard use.
Outcomes	Injury requiring treatment by a team therapist resulting in missing at least one playing session and any mild brain injury or brachial plexus stretch (burner/stinger) or facial laceration, eye injury
Results	There was a significant difference between the groups in the rate of head and facial injuries (2.31 times more in the half face helmet group than the full face) however there was no difference for sustaining concussion, neck or for all injuries. The risk of incurring dental injuries was 9 times greater among the half face helmet group. The 2002 article went on to examine the role of mouthguards in the incidence of concussion and found that using a mouthguard in association with a full-face helmet possibly provides the lowest risk of concussion.
Study quality and conclusions	Moderate. Adequate sample size, thorough analysis. No random allocation – only based on existing team policy which may influence risk due to differences in training, philosophy, etc. However, this bias is considered in examining all injuries and finding no significant differences between groups.

Author	Brunelle et al 2005
Study design and target population	Cohort study -13 teams in a district in Quebec in a “fair play program”, 36 (control) schools not in program. Young (14 &15 yr olds) elite ice hockey players
Intervention	A “Fair-Play Program” (FPP) - where players earn points for good conduct during games based on (low) number of penalties called by the referee. Points assist teams standing in the competition.
Outcomes	Number of rules transgressions and number of self-reported injuries (requiring seeking medical advice and/or missing one game or practice)
Results	Overall, no difference observed in the number of transgressions observed for the intervention and control schools but number of penalties was lower (Refs penalised an average of 9% of all transgressions observed). 54% response rate from players re injury reports. No difference noted in the injury rates. Some indication of a reduced risk of severe injuries – but small sample size limits conclusions.
Study quality and conclusions	Weak. No evidence of random allocation of 13 teams to intervention group. Selection bias possible due to 54% response rate. Authors acknowledged that small sample size limited power. Practice and championship games excluded as FPP was not in place for these. Authors felt the intervention did not target the main cause of injuries – body checking – so limited impact expected anyway. Fair Play programs could be a tool as part of a multi-strategy approach – no evidence of impact on its own.

Author	Cross et al 1999
Study design and target population	Pre/post retrospective study of injuries to 195 college football players. Mean age 18.6 years
Intervention	In year 2, preventive static stretching program, immediately before strenuous activity, for the lower extremity was added to the conditioning program that was used for Year 1 of the study.
Outcomes	Injury (including musculotendinous strain) causing a minimum of the loss of one day of practice or play.
Results	There were significantly fewer (reduced by 48%) lower extremity injuries (to the knee, ankle, foot and musculotendinous strain) to the players in the year following the stretching program. There was an increase (around 4 fold) in shoulder and elbow injuries which are not explained.
Study quality and conclusions	Weak - Moderate. As a pre-post retrospective study there was no control over the potential confounding factors such as weather, fitness, field conditions etc. Unable to report cause/effect relationships and prospective research which control for confounders is needed.

Author	Daley et al 2001
Study design and target population	Critical review (1966-98) of the literature on countermeasures to injuries for gymnasts.
Intervention	A range of countermeasures were covered in the articles reviewed: coaching (physical preparation, education, spotting, and performance technique), equipment, and the health support system (medical screening, treatment, and rehabilitation).
Outcomes	Some evidence that general coaching, pre-conditioning (particularly following a break from gymnastics) with one study finding a reduction in back injuries to female gymnasts.
Results	<p>Education of coaches and gymnasts and coaching techniques and/or behaviours are considered crucial in the prevention of gymnastics injuries. However, there is no formal evidence for the effectiveness of these countermeasures for preventing injuries in gymnasts.</p> <p>No controlled trials investigating the influence of formal instruction on how to land or the influence of different landing techniques or strategies on injury rates were found.</p> <p>There is a lack of formal controlled evaluations of the effectiveness of preventive measures for reducing the occurrence of injuries and re-injury in gymnastics. Further studies are needed to understand the causes of gymnastics injuries so that randomised controlled or prospective cohort studies can be designed to evaluate the effectiveness of potential gymnastics counter measures. Recommendations for future research into the prevention of injuries and re-injury in gymnastics needs to examine:</p> <p>physical conditioning programs and the role of strength training; optimal duration and frequency of warm up, stretching, and cool-down as an injury prevention measure; load distribution characteristics of equipment and landing surfaces; design of dowel grips or hand guards for preventing wrist and hand injuries; biomechanical research into such as into the influence of different landing techniques; the role of education for both coaches and gymnasts to improve their knowledge about injury prevention strategies; the role of spotting; pre participation screening programs and the role of health care personnel and rehabilitation programs.</p>

Study quality and conclusions	<p>There were no RCTs. The highest level of proof for the effectiveness of a gymnastics counter measure is provided by prospective cohort studies. This is followed by data based (uncontrolled) studies, which includes case series, cross sectional, retrospective cohort designs, and information from routine surveillance systems. Most of the evidence to date is based on informed expert opinion, uncontrolled data based studies and prospective cohort studies.</p> <p>Thus research to date does not allow for firm conclusions about what is effective or the relative effectiveness of different approaches – although there are widespread practices based on the assumption of their effectiveness.</p>
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Author	Danis et al 2000
Study design and target population	238 baseball youth league teams in Indiana – a non-randomised prospective cohort study. One group of teams (138) agreed to have all batters wear a faceguard (and were supplied with them) the other group (control, 102) the wearing of faceguards was voluntary – by the individual. No age group is specified.
Intervention	Policy to have all batters wear a face-guard. Other teams, there was no policy – so up to the individual.
Outcomes	Self-reported facial injury
Results	There was a significant difference between the two groups in terms of reported injuries – with 28% fewer injuries among the intervention group. 10 players saw a doctor because of their injury – 8 of these were in the control group.
Study quality and conclusions	Not random allocation and some blurring of lines between intervention and comparison groups because not 100% compliance in the intervention group (95%) and some comparison group players (8%) wore a face-guard. This however would only mean that the results were conservative.

Author	Emery et al 2005a
Study design and target population	Cluster (10 schools in Calgary, Canada) RCT and then random allocation of students (2 males 2 females) within the schools to participate in program. All subjects were between 14 and 19 years of age.
Intervention	A regular physical education program using a simple 6-week home-based proprioceptive balance-training with a wobble board.
Outcomes	Measures by physiotherapists of static and dynamic balances and self-reported injuries associated with sport. The balance assessment helps to confirm a link between the intervention and the injury outcome.
Results	At 6 weeks, improvements in static and dynamic balance were observed in the intervention group but not in the control group. Twelve (5 female and 7 male) subjects reported athletic injuries over the 6-month observation period: 2 were in the intervention group, and 10 were in the control group. The relative risk of injury was significantly lower in the intervention group (RR 0.20, 95% CI 0.05 to 0.88) despite small numbers and is consistent with the finding in the only other randomized controlled trial examining a similar prevention program for adolescents. Improvements in static and dynamic balance were measured and a reduction in self-reported athletic injuries over 6 months among high school students. Improvement was noted to be greater with increased reported compliance.
Study quality and conclusions	Quite strong. RCT and physiotherapists doing assessment of movement were blind to whether schools were intervention or not. A cluster randomized controlled trial with random recruitment of schools and subjects, and comprehensive primary and secondary end points, reduces the biases associated with the results and increases the generalisability of the study results. The high rate of consent to participate and the low dropout rate limited potential selection bias. Numbers were fairly small and individual variation is a factors – however after controlling for before program differences significant results were obtained. Logistic regression to examine the effectiveness of the training program in reducing injury, while controlling for other baseline covariates.

Author	Emery, et al 2005b
Study design and target population	Review targeting effective strategies to prevent injuries in child and adolescent sport. Included articles reported participants from: high school; little league baseball and European handball.
Intervention	Various: rules; protective equipment; training regime (warm-ups and cool-downs);
Outcomes	Injuries - various
Results	Reported summaries from 9 studies. Equipment - Breakaway bases reduce sliding injuries significantly in baseball & softball; ankle bracing and ankle taping can reduce ankle injury sprains in basketball; full face shields associated with reduction in head and face injury in ice hockey. Rule modification - Elimination of spear tackles associated with reduction in number of head and neck injuries in football; fair play rules and making checking from behind illegal in ice hockey associated with reduction in overall injury as well as head/neck and back injury incidence. Training - For older players, some evidence that balance training with preseason training reduce incidence of specific injuries in some sports. Protective equipment identified as effective (e.g. full face masks and guards in hockey; face shields & safety balls in baseball; shin pads in soccer) but doesn't provide detail of level of effect.
Study quality and conclusions	Moderate - reasonable review; quality assignment not provided; good discussion of limitations of studies included in review. Few studies examine the effect of countermeasures to reduce injuries in sports for children and adolescents. Some promising countermeasures provided in results row above.

Author	Finch et al., 1999 (Cricket injuries)
Study design and target population	Review – not systematic
Intervention	Identifies frequency of providing rest to bowlers and batsmen; frequency of provision of water; use of protective equipment; quality of playing field; modified rules for children
Outcomes	No outcomes specifically addressed (did mention avoidance of dehydration; sun exposure; physical injuries sustained from direct contact with the ball).
Results	None provided
Study quality and conclusions	Weak – moderate - Identified dearth of evaluation of effective interventions. Recommends further research for: longitudinal studies for bowling action and reduction in back injuries; evaluation of pre-participation screening programs and interventions to prevent finger injuries in bowlers; evaluation of warm-up; warm-down; stretching and cool-down as an injury countermeasure; evaluation of appropriate footwear for bowlers and batsmen.

Author	Gabbe et al 2006
Study design and target population	RCT of eccentric exercise to prevent hamstring injuries in community-level Australian football. Median age of players (23 years) falls within the age range of interest.
Intervention	A specific type of conditioning that aims to optimise the hamstring torque generation and a change in muscle function in order to reduce hamstring injuries. Control group (randomly assigned within each club) received normal pre-conditioning. Intervention received the same pre-conditioning plus the eccentric exercise technique.
Outcomes	The occurrence of hamstring injuries.
Results	There was no significant difference in hamstring injury rates between the two groups – but when looking at only the data for those who participated fully in their group there were indications of a protective effect (but not significant).
Study quality and conclusions	Participation (compliance) in the intervention group was very poor (related to reported delayed onset of muscle soreness). Issue of contamination between groups as they were within the one club.

Author	Hagel et al 2005a
Study design and target population	Case-control and case cross-over study of head and neck injuries while skiing or snowboarding (in 19 ski areas in Quebec) – examining use of helmet. Results reported in age groups including 15-25 year olds.
Intervention	Helmets – but self directed use, included in some cases inadequate use – such as ill-fitting.
Outcomes	Head and neck injuries were assessed.
Results	The proportion of controls wearing helmets among the 15-25 year olds that was higher (but not significantly) than among the head injured cases – although only based on 8 cases. It is concluded that the effect of helmets on neck injuries is unclear. The effect on head injuries is from a 29% to 56% reduction in risk.
Study quality and conclusions	(Moderate) Large data set and subjects matched on age, gender and time of day/day of week. However, as a case-control study it is not an evaluation study per se. The intervention was self-selected by skiers and snowboarders. Some concerns over response rate – with around 30% of those approached to respond to the survey declining, and other opportunities for bias – but on the whole these were controlled for or assessed to be minimal.

Author	Hagel et al 2005b
Study design and target population	Subjects were drawn from a larger study (Hagel et al 2005a). Case-control study of upper extremity injuries while snowboarding (in 19 ski areas in Quebec) – examining use of wrist guards . Controls were snowboarders with an injury to another part of the body matched on age and ski area. Results reported in age groups including 15-25 year olds.
Intervention	Wrist guard use
Outcomes	Hand-forearm injuries and elbow-shoulder injuries
Results	Questionnaires were returned by 74% of cases and 70% of controls. Snowboarders (n=32) with hand/forearm injuries were less likely to be wearing a wrist guard (with wrist guard reducing the risk of hand/forearm injuries by around 85%) . However, for those with a shoulder or elbow injury a greater proportion of cases than controls were wearing a wrist guard.
Study quality and conclusions	(Moderate) Large data set and subjects matched on age, ski area, gender and time of day/day of week. However, as a case-control study it is not an evaluation study per se. The intervention was self-selected by snowboarders. Some concerns over response rate – with around 30% of those approached to respond to the survey declining, and other opportunities for bias – but on the whole these were controlled for or assessed to be minimal. Information was not collected on type of wrist guard. Provides evidence of the protective effect of wrist guards on hand/forearm injuries. Biomechanical data are needed to help explain why wrist guard use is associated with an increased risk of injury to the elbow or shoulder.

Author	Handoll et al 2001
Study design and target population	Systematic review of interventions (14 studies) for preventing ligament ankle injuries (generally in sport – also recreational). It was reported that largely the study populations had mean age form 19-24 years.
Intervention	Range of interventions – mostly orthosis and ankle disk training, one study examined health education.
Outcomes	Ankle injuries
Results	<p>Studies observed a significant reduction in ankle injuries (compare to the control groups) with:</p> <p>Use of ankle orthosis and ankle disk training groups</p> <p>Composite intervention of warm-up exercises and ankle disk training and a multi-component prophylactic programme.</p> <p>Providing direct external support to the ankle. A significant benefit for those with previous sprain (regardless of severity of sprain) using ankle orthoses or external support and not significant for those without a prior ankle injury</p> <p>Co-ordination training using ankle disks in those with a prior history of ankle sprain (cluster randomisation of groups made study less strong, however)</p> <p>There was no significant difference between groups for: stretching (either the calf stretching trial or the six leg muscle stretching trial) wearing cushioned insoles health education (although low injury numbers in both groups makes finding significant differences difficult)</p> <p>Conclusions: There seems to be good evidence to support the conclusion semi-rigid ankle orthoses or ankle braces provide protection for athletes involved in sporting activities considered to be at high risk for ankle injuries.</p> <p>Subgroup analyses show that this beneficial effect is most pronounced for those who have experienced previous ankle ligament injuries. Although a smaller benefit is likely for those who have no previous history of ankle injury, this remains to be proven. These devices also seem to prevent all grades of severity of ankle sprains. Impact on different age groups is not known.</p>
Study quality and conclusions	All studies were reported to be of weak to moderate quality – with high quality being difficult to attain in that keeping subjects blind to the intervention is difficult given the types of interventions. The quality of the review was high - systematic.

Author	Heidt et al 2000
Study design and target population	Randomised control trial with 42 players randomly selected from 300 female soccer players (14-18 years of age) to be in the intervention training program.
Intervention	A seven week pre-season training program (the Frappier Acceleration Training Program) – sports specific cardiovascular training, plyometric work, sport cord drills, strength and flexibility training
Outcomes	An injury defined as that which cause the player to miss a game or practice – information was assessed by the school’s athletics trainer.
Results	The intervention group had a significantly lower incidence of injuries (14%) compared with those not in the pre-season training (33%). Average injury severity score was 2.86 for the trained athletes and 3.23 for the untrained group.
Study quality and conclusions	Good. Randomisation and trainers who assessed injuries were blinded as to players group. Only 7 injuries in intervention group (would have been stronger if more athletes assigned to the intervention group). Concludes there is good evidence of the effectiveness of directed pre-season training in reducing the risk of injuries to young soccer players.

Author	Herbert & Gabriel 2002
Study design and target population	Systematic review of the effects of stretching before and after exercise - on soreness and injury. Only included randomised or quasi randomised studies. Excluded articles in languages other than English. Search period, depending upon the database, stretched back from 1949 through to February 2000. Of 8 studies included only 3 had target groups that stretched outside the age range of interest. Results of comparable studies were pooled into a meta-analysis.
Intervention	Total stretch time ranged from 5-10 minutes, except for one study where it was 180 seconds
Outcomes	5 studies examined muscle soreness up to 72 hours after exercise, 2 studies examined injuries that prevented a subject from returning to activity within 3 days, free of signs and symptoms.
Results	Five studies provided clear evidence of nominally moderate quality that stretching before or after exercising has no effect on delayed onset muscle soreness. Addition studies of the impact of stretching on injury rates of army recruits suggest that there is no injury risk reduction associated with muscle stretching before exercising.
Study quality and conclusions	High quality review – based on what it terms as nominal moderate quality studies. Authors note their systematic review process served to minimise bias. As the findings were of no effect – it is assumed the publication bias is not likely. Used the established PEDro scale to rate the quality of the studies reviewed.

Author	Hewett et al 2006
Study design and target population	Review of interventions to prevention cruciate ligament injuries in female athletes. 3 were on soccer, 2 handball, and one a mix of soccer/handball/volleyball. Systematic review - Meta-analysis including RCTs and prospective cohort studies.
Intervention	Neuromuscular training either pre-season and or during the playing season for a variable number of weeks and times per week – it seems the inclusion of balance training may be a critical factor
Outcomes	Anterior cruciate ligament injuries among women associated with sport
Results	All three studies with significant reduction in injuries among the intervention group – included plyometric training (which trains the muscles, connective tissue and nervous system, to effectively carry out the stretch-shortening cycle) combined with bio-mechanical analysis and feedback. Balance training on its own does not appear to be effective. In-season training appears to be effective and the authors suggest it would seem to be more cost-effective than pre-season training.
Study quality and conclusions	Moderate. Only 2 RCTs; some studies had small sample sizes. Authors acknowledge some possible biases (e.g. publication bias) and different study designs and follow-up periods making comparisons difficult. These findings are based on the shared components of the studies with significant findings and were missing from those with non-significant findings. So the evidence is promising rather than conclusive

Author	Hewett et al 1999
Study design and target population	High school female athletes in soccer, volleyball and basketball – in all 43 sports teams in an intervention and control group, plus a male control group
Intervention	Six week training/pre-conditioning program in jumping and landing techniques – 60-90 minutes, 3 times per week – included stretching and weight training.
Outcomes	Serious knee injuries – weekly injury reporting forms. An injury risk exposure was defined as one athlete participating in one practice or match. A serious knee injury was defined as a knee ligament sprain or rupture that caused the player to seek care by an athletic trainer and that led to at least 5 consecutive days of lost time from practice and games.
Results	Significantly fewer injuries in the trained group compared to the untrained female group. The untrained group demonstrated an injury rate 3.6 times higher than the trained group and 4.8 times higher than the male control group.
Study quality and conclusions	Neuromuscular training decreases injury risk in female athletes – this might be due to increased dynamic stability of the knee joint after training. They recommend pre-participation training of young female athletes in sports that involve jumping, twisting and turning, in jumping technique and strengthening exercise. Moderate – prospective study with adequate sample size, no randomised, not double-blind – and some difference between groups in terms of proportion of each of the three sports. Relatively small number of injuries (1 in 100 women players). Women are particularly susceptible to knee ligament injuries.

Author	Jones et al 2004
Study design and target population	Case-control study of head and facial injuries to rugby players presenting to Emergency Departments in Wales. Cases filled in a questionnaire including position played and a matched control found from that. Hospital staff supplied medical information about the cases. Video review of 41 World Cup games to assess injuries and use of headgear
Intervention	Use of headgear
Outcomes	Superficial head and facial injuries
Results	There was a non-significant reduction in superficial head and facial injuries among those wearing headgear. Video results for World Cup not included as not expected to be within the age-range of interest.
Study quality and conclusions	Weak-Moderate. No control over the intervention. People selected whether they wore a helmet. No information available on the type of helmet. Clubs use of medical staff may have biased attendance to ED. No firm evidence provided for use of head gear but design limitation of the study may have been implicated.

Author	Junge et al 2002
Study design and target population	Prospective cohort controlled intervention study. Two groups intervention and control (7 teams each from 2 different regions of Switzerland) Not randomised. Physician visited the male only soccer teams (players aged 14-19 years) and documented (weekly) all injuries to players for 1 year period.
Intervention	The prevention program was tailored for each team's situation – and included improvement of warm-up exercises, regular cool down, taping of unstable ankles, promotion of fair play as well as exercises to improve the strength and stability of ankle and knee joints, the trunk, hip, and leg muscles, as well as to improve coordination, reaction time, and endurance.
Outcomes	Injuries that lasted for more than 2 weeks or resulted in absence from a subsequent match or training session were reported weekly by physicians. All types of injuries were included and details on their location, type and the duration of limitation of performance.
Results	There were significantly fewer (by 20%) injured players in the intervention group than the control group, and a 36% reduction in the total number of injuries (i.e. incorporating multiple injuries per player). (This difference was reduced to 21% when the number of hours of training was controlled for). The differences in injury rates between the control and intervention group were statistically significant for mild injuries, overuse injuries, non-contact injuries, injuries incurred during training, and injuries of the groin. When controlling for hours trained, low skilled teams appeared to benefit more from the intervention than the high-skilled teams.
Study quality and conclusions	Moderate. Controlled trial without randomisation using teams from three different geographic locations. The amount of training and other factors were not controlled for prospectively – however efforts to control their impact on the injury outcomes were done statistically.

Author	Mandelbaum et al., 2005
Study design and target population	Prospective non-randomised trial with intervention group of 1041 females from 52 teams; control group was 1905 female soccer players from 95 teams competing in the same league (age and skill matched). Participants were aged between 14 and 18 years.
Intervention	Sport-specific neuromuscular and proprioceptive performance program, consisting of education, stretching, strengthening, plyometrics and sport-specific agility drills to replace traditional warm-up.
Outcomes	Non-contact anterior cruciate ligament injuries, confirmed by MRI and/or arthroscopic examination.
Results	In Year 1 there was an 88% (p=.0001) decrease in anterior cruciate ligament injury in the intervention group compared with the controls and year 2 showed a 74% (p=.0047) reduction compared to the controls.
Study quality and conclusions	Moderate – non-randomised study; inherent weakness was the voluntary enrolment of participants in the intervention, however controls were blinded to the intervention and analysis was by matching for age and skill.

Author	Marshall et al., 2002
Study design and target population	Ecologic study. Data extracted from the National Collegiate Athletic Association (NCAA) Injury Surveillance System and the NZ RIPP Study. Females were excluded as no females were in the NCAA. (The Rugby Injury and Performance Project – RIPP - study is a cohort study of rugby players in Dunedin, NZ.)
Intervention	Mandated protective equipment; Football players must use hard-shell helmets, face masks, mouthguards, shoulder pads, hip pads, thigh guards and knee pads. Some players also opt for gloves, elbow pads and additional body padding. Rugby players are forbidden to use hard-shell helmets and any type of padding other than light (<1 cm thick). Rugby players use adhesive tape, elastic body sleeves and the majority opt for mouthguards (not mandated at time of study).
Outcomes	Football exposure & injury data extracted from the NCAA ISS database (a representative sample of all NCAA institutions). Injury and exposure data collected by trainers weekly. RIPP study included all people playing competitive rugby in Dunedin, NZ. Participants were followed up & interviewed by phone weekly. Injury data were reclassified to ‘protected - head and face; partly protected – shoulder, groin, hips, neck; unprotected – arm, wrist, hand, knee, lower leg. Outcome measured by rate of injury per 1000 player-games.
Results	Football had one third the rate of injury than rugby (RR=0.35; 95% CI: 0.31 – 0.40). Overall, protected area had about a tenth rate in football compared with rugby. Pattern observed of decreasing risk with increasing level of protection.
Study quality and conclusions	Weak – However, authors did consider rate variances for injury i.e. injured player more likely to injure again. Recognised confounding potential of difference in the nature of body contact between the sports but authors felt this difference was unlikely to account for the pattern of decreasing risk with increasing protection. Also discussed potential for differences in reporting injuries. Authors concluded that differences in injury rates between the two codes is in part due to differences in protective equipment.

Author	Marshall et al., 2005
Study design and target population	Cohort of 304 rugby players followed weekly during the 19993 club season in New Zealand.
Intervention	Use of protective equipment (mouthguards, shin guards, taping of joints, head tape, padded headgear, grease and support sleeves).
Outcomes	Self-reported injury (in-season injury was one defined as having occurred during the competitive season, and either required medical attention or resulted in either a subsequent game or practice being missed).
Results	For overall injury, there were no statistically significant protective measures for any of the protective equipment. When examined by injury subgroup although there were protective leanings for padded headgear protecting against damage to the scalp or ear (RRadj=0.59, 95% CI:0.19-1.85; similar results for mouthguards protecting against damage to the teeth, mouth or jaw; and support sleeves against sprain or strain to the upper limb, knee or ankle. On the other hand, shin guards, taping the head and body joints and grease were all associated (not significantly) with an increased incidence of injury to the area they were designed to be protecting.
Study quality and conclusions	Strong cohort design. Considered covariates such as level of competition, level of fitness, history of injury, previous rugby history and playing position. Indicates that protective equipment may have limited effect on injury risk, although in some instances (dental damage) the numbers were too small to analyse separately.

Author	McGuine and Keene, 2006
Study design and target population	RCT - 765 high school soccer and basketball players (523 girls and 242 boys) mean age for controls: 16.6 years; intervention 16.4 years.
Intervention	Random assignment of 27 teams (373 subjects) to participate in balance training program or 28 teams (392 subjects) to perform standard conditioning exercises. Component of balance training program included: single leg stances, squats and raised leg with eyes open / closed and on floor / board.
Outcomes	Base-line: self-reported previous ankle sprains in previous 12 months. On-site athletic trainers recorded exposures and sprains – no mention if blinded to intervention – assumed not. An ankle sprain met the following criteria: disrupted ligaments of the ankle; occurred during coach directed competition, practice or conditioning session; resulted in missed practice or competition. Severity determined by number of days last: minor 1-7 days lost; moderate (8-21 days lost) severe (more than 21 days lost).
Results	Rate of ankle sprain significantly lower for intervention group. Risk of ankle sprain for intervention group was 62% less than for control group ie balance training reduces the rate of ankle sprains in subjects by 38%. (6.1%, 1.13 of 1000 exposures versus 9.9%, 1.87 of 1000 exposures p=0.04. Rate significantly less for those I intervention group with a history of ankle sprains. Sustaining ankle sprain in previous 12 months more than doubled the risk of experience a further sprain. For those who did experience an ankle sprain there was no difference in severity between the two groups.
Study quality and conclusions	Strong study - Applied non-compliant subjects to analysis under intention to treat; considered age, gender, weight, sport and history of ankle sprain in analyses. Balance training program protected high school soccer and basketball players from ankle sprains and from re-spraining. If a sprain was experienced then the severity was not affected between the two groups. Attempted to address potential for recall bias by cross-checking self-reported history against records.

Author	Newsome et al., 2001
Study design and target population	Review – not systematic of mouthguard use in prevention of sports-related dental injuries. Few evaluation studies reviewed – this article focused more on type of mouthguards available and their use.
Intervention	Mouthguards
Outcomes	Dental injuries
Results	Not systematic review but did state overwhelming number of studies citing effect of mouthguards. This review failed to give any data or description of evaluation studies other than one study of injury rates to the face and mouth being cut from 50% of all injuries to representing $\geq 0.5\%$ once the introduction of mandatory use of mouthguards in high-school football and college football.
Study quality and conclusions	Weak - Not systematic. Despite stating 'protective effect of mouthguards' no studies were discussed to substantiate this.

Author	Olmsted et al., 2004
Study design and target population	Systematic review to assess the cost-benefit and numbers needed to treat of ankle taping and bracing. Of the 3 studies included in NNT analysis, 2 involved intramural basketball players (n=1601 and the other reported 2562 player games complete) and the third involved 504 male senior soccer players.
Intervention	Ankle taping and bracing – Original articles allowing NNT analysis using experimental design.
Outcomes	Ankle injury rates
Results	Quality ratings assigned to the 8 articles retrieved from the search. Those articles scoring more than 60% of possible quality ratings were reviewed to determine if sufficient information was available to conduct NNT analyses. Of the 8 articles, 3 were included in the analyses. NNT analysis: for players with a history of ankle sprain NNT for ankle taping in one intramural basketball game would be 26 ankles to prevent 1 ankle sprain; in one intramural basketball game, for players without a history of ankle sprain NNT would be 143 ankles to prevent 1 ankle sprain; for players with a history of ankle sprain NNT to prevent an ankle sprain over the course of one basketball season would require 18 ankles to be braced. For players without a history of ankle sprain NNT to prevent an ankle sprain over the course of one basketball season would require 39 ankles to be braced. For players with a history of ankle sprain NNT to prevent an ankle sprain over the entire competitive soccer season would require 5 ankles to be braced. For players without a history of ankle sprain NNT to prevent an ankle sprain over an entire competitive soccer season would require 57 ankles to be braced.
Study quality and conclusions	Strong - Considered confounding such as history of ankle sprains in determining eligibility for review. NNT is affected by the context and duration of the intervention. Bracing may be more effective in preventing ankle sprains when the time and cost of taping is taken into consideration. Unable to generalise results to all sports, ages and skills.

Author	Olsen et al., 2005
Study design and target population	Cluster randomized controlled trial with handball clubs as the unit of randomization to assess structured warm-up program effect on lower limb injuries (Norway). 1837 participants (120 teams) aged 15-17 years playing handball in Eastern Norway followed for one season (8 months). Intervention group: 61 clubs - 958 players (808 females; 150 male). Control group: 59 clubs - 879 players (778 female; 101 male).
Intervention	Structured warm-up program to improve running, cutting and landing technique as well as neuromuscular control and balance and strength in intervention group. Program consisted of 4 different sets of increasing difficulty. Program conducted at the beginning of every training session for 15 consecutive training and then once a week for the remainder of season. Program provided in study (Box 2: p.2) Control group asked to perform their training as usual.
Outcomes	Rate of acute injuries to the knee or ankle recorded by 10 research physiotherapists blinded to group allocation.
Results	Intervention group sustained 0.5 injuries per 1000 player hours (0.2 in training versus 2.5 match play); versus 0.9 injuries per 1000 player hours in control group (0.3 in training and 5.3 in match play). Significantly fewer injuries in intervention versus control group for: all injuries, acute knee injuries and upper limb injuries. The 37% reduction in intervention group for acute ankle injuries did not reach significance (p=0.097). Relative risk intervention versus control: 0.53 (95% CI: 0.35 to 0.81). Number needed to treat varied from 11 to 59 players. On compliance – found 87% compliance among clubs.
Study quality and conclusions	Strong - Well conducted RCT with matching of clubs by region, playing level and gender and number of players. Players who had dropped out of program were included for entire period of their participation; applied intention to treat for those clubs that stopped using program after intensive 15 introductory period. A structured programme of warm-up exercises can prevent knee and ankle injuries in young people (primarily women) playing handball.

Author	Quarrie et al., 2005; Quarrie erratum, 2006
Study design and target population	Ecological study. Use of rugby records (player numbers) and rugby related dental claims.
Intervention	Mouthguard use determined by data from prospective studies in 1993, 2992 and 2003 (type of mouthguard not documented). Mandatory mouthguard use commenced in 1997 for U19 players.
Outcomes	Dental injury claims
Results	Over the period 1993-2003, self-reported mouthguard use increased by 26% (for ale players). Since mandatory use of mouthguards there was a 43% (90% CI: 39%-46%) reduction in rugby-related dental claims to the Accident Compensation Corporation (ACC). Assessed cost – average cost of dental claim was \$NZ321.00; assumed cumulative savings of \$1.87 million if claims had remained constant.
Study quality and conclusions	Weak - Inherent weaknesses in determining rate of wearing mouthguards in practice versus game play – questions varied for each of the prospective studies. Discussed inherent weaknesses of conducting an ecological study. Authors concluded that “the introduction of compulsory wearing of mouthguards for rugby players in New Zealand has been associated with a 43% reduction in rugby related dental injury claims. The relative risk of making a dental injury claim for non-wearers was estimated to be 4.6 (90% CI: 3.8 to 5.6) times that of wearers.” p. 653.

Author	Soderman et al., 2000
Study design and target population	Prospective randomized trial. 221 female Swedish soccer players.
Intervention	Intervention group: 7 teams (n=121) given training program involving balance board. Program was 10-15 min of training on balance board as well as usual standard physical training. Program included 5 exercises of increasing difficulty. Exercises performed for 3 x 15 sec per leg. Players were to perform training at home daily for 30 days; then 3 times / week for the remainder of season. Amount of balance board training recorded by players and practice and game hours recorded by players and coaches.
Outcomes	All traumatic injuries resulting in absence from at least one scheduled practise session of one game recorded by players and diagnosed by the authors of the study.
Results	Total of 81 drop-outs from study. Leaving 62 players in the intervention group and 78 players in the control group. No significant differences in number, incidence or type of traumatic injury. For those who had a recent (3 month) history of injury, there was a significant protective effect of the intervention. Major injury incidence was highest in intervention group (4 of the 5 ACL injuries were in the intervention group).
Study quality and conclusions	Strong - Assessed players age, weight, height, years in soccer training, amount of physical training hours, history of injuries, flexibility and balance at baseline – ns differences between intervention and control groups at baseline. This study found no effect of balance training on rate of injuries amongst female soccer players in the second and third Swedish divisions. Identified results may have been effected by large numbers of drop-outs resulting in a decrease in power and ability to detect a difference.

Author	Stuart et al., 2002 written up by Hart (ed.)
Study design and target population	Cohort - Participants were 10 of the 12 men's Junior A ice hockey teams (players aged 16-21 years) n=282.
Intervention	Measured facial protection being worn (game trainers completed standardised reports) – identified if full cage or full shield worn; half-shield or no facial protection and mouth protection. .
Outcomes	Injury incidence per 1000 hours of player on-ice time. Injury was: dental, eye, nerve or neck injury; concussion; head or facial laceration.
Results	The injury rates for players wearing no protection, partial protection, and full protection were 158.9 (95% CI, 118.7 to 208.5), 73.5 (CI, 53.6 to 98.3) and 23.2 (CI, 13.3 to 37.7)/1000 player hours, respectively. Rates were significantly lower for partial or full protection versus no protection ($p < 0.001$). The rate of concussion was 4 times as great in players wearing no protection as in those wearing full protection ($p = 0.11$). The rate of eye injuries was higher for players wearing no protection than for players wearing partial protection (30.6 vs. 6.5/1000 player hours), and no eye injuries occurred to those wearing full protection.
Study quality and conclusions	Moderate - In Junior A ice-hockey games the use of full facial protection reduced the rate of head and facial injuries significantly more than partial or no protection.

Author	Thacker et al, 1999
Study design and target population	Systematic review examining the prevention of ankle sprains in sport. Majority of studies reviewed had participants who were either high school or college football, basketball or volleyball participants.
Intervention	Various, including: shoes & taping, bracing, training
Outcomes	Ankle sprains sustained in sport.
Results	7 RCTs and 3 cohort studies assessed interventions to prevent ankle injuries. These varied in quality. High-top shoes: mixed results. Protective effect was observed in some but not all studies. When a protective effect was observed, this was enhanced when used with taping for players with and without a history of ankle sprains. Taping compared with wrapping – no difference was found between the 2 groups. Unclear if these studies had controls with neither taping nor wrapping. Taping versus orthotic stabilizer: 4.9 sprains per 1000 participant games versus 2.6 sprains per 1000 participant games. Bracing: semi-rigid orthosis had mixed effects. Some found significant protective effect versus the unprotected ankle for players with a history of ankle injury (soccer) as well as with no recent ankle injury (basketball); while others found no effect with players with no history of ankle injury (soccer). Training: Ankle disc and training program effective against no intervention in players with previous injury (soccer). Training aimed at prevention of ankle sprains (identifying risk factors, treatment, ankle disc training, and 2 hour session on the ankle disc and safe side-to-side and take-off techniques) effective in people with history of ankle sprains.
Study quality and conclusions	Strong systematic review of moderate original articles. Players with previous ankle injury are more likely to experience a protective effect when using bracing, ankle disc & training program. Mixed results for high-top shoes; preseason training, conditioning and ankle disc training show promise; bracing and taping have mixed results but are more likely to be effective in players with a recent history of ankle sprains.

Author	Thacker et al 2003
Study design and target population	Review – broad inclusion criteria – for prevention of knee injuries in sports. Majority of reported studies involved either high school or collegiate participants (total numbers not provided but at least 23, 023 with approx. 43% being possibly older than the age group for this review).
Intervention	
Outcomes	Knee injuries confirmed independently by: 3 orthopaedics; Medical records; Arthroscopically confirmed ACL injury; Weakly injury reports from trainers
Results	<p>Knee braces - Mixed results – some showing protective effect while others showing negative effects. Negative effects included: muscle fatigue, decreased quadriceps and hamstring activity. Double hinged single upright prophylactic knee braces significantly protected against knee injuries (injury rates 3.4/1,000 vs 1.5/1,000 for controls versus intervention $p < 0.05$. 13 injuries in unbraced controls vs 1 acl tear in controls ($p < 0.05$). Another study showed single-hinged brace increased incidence of ACL injury (3.7 fold increase in knee injury $p < 0.001$). NS difference in double-hinged and control group.</p> <p>Other studies – results were pooled and showed either no significant decrease in total injuries ($p = 0.64$); MCL injuries ($p = 0.67$); ACL injuries ($p = 0.86$). When single-hinged bracing was included in the pooling analyses then found a significant increase in total injuries (OR= 2.24; $p = 0.01$); These studies were weak in study design e.g. were pre-post cross sectional & did not allow for such confounders as grounds; players; conditioning programs.</p> <p>Conditioning programs - Some positive effect when pre-season training was initiated but reported study failed to consider confounders e.g. change of rules; Stronger effect in study of soccer players (amateur & professional - ?specific age group) 10 ACL injuries vs 70 $p < 0.001$ for control versus intervention (matched players; objectively measured outcome). Beneficial effect of training in group of 16-18 year old handball female players. Overall injury rate significantly lower in training group compared to controls (0.34 versus 1.17 injuries / hours of practice ($p < 0.05$) and 4.68 versus 23.38 / 1000 hours of games ($p < 0.01$). Other studies also supported findings that conditioning programs lower injury rates (mixed results on knee injuries specifically)</p>
Study quality and conclusions	Weak- moderate - Identified a lack of strong studies (particularly RCTs) and identified need to test results across other sports and to include females. Majority of participants in reported studies appear to be within age group (were high school, collegiate or cadets athletes). Provides a number of research questions.

Author	Verhagen et al., 2000
Study design and target population	Systematic review investigating preventive measures on incidence of ankle sprains. Various – did not provide all the ages / age ranges of participants in included studies. At least half of studies included reported participants one could reasonably assume met the inclusion age range.
Intervention	Various – use of ankle taping or bracing; alterations to shoes; proprioceptive training.
Outcomes	Ankle sprains – measured differently by the included studies.
Results	Included 8 studies (6 RCTs, 1 prospective and 1 retrospective) in the review. Taping - Study involving intramural basketball players found taping reduced incidence & severity of ankle sprains (also reported higher number of those with previous ankle sprain in taped group –suggesting possibly stronger effect than reported); taping versus laced ankle stabilizers in college football players (retrospective study) found laced ankle stabilizers twice as effective in preventing ankle injuries than taping (2.56 sprains per 1000 injury exposures versus 4.91 per 1000 injury exposures) – no control group in this study. Shoe type - One study found high-top shoes more protective than low top, particularly among athletes with taped ankles; while another study found low-top shoes more effective than high-top shoes when worn with laced ankle stabilizers. A further RCT of intramural basketball players found no significant difference between high- and low-top shoes but incidence of ankle sprains was less than in previous studies (suggested reasons for this were newness of shoe – all players wore new shoes – shorter game play time). Ankle bracing - Found to be effective in reducing ankle sprains (mixed findings reported) and severity of ankle injury, particularly in contact injuries and most particularly in people with a previous ankle sprain. Training - Mixed intervention (injury awareness, treatment and rehabilitation, proprioceptive training, and technical training, use of balance board training and taping and bracing were encouraged – found a 47% reduction in ankle sprain incidence. Balance board training specifically – found significantly lower incidence of ankle sprains in intervention group (5% compared with 17%).
Study quality and conclusions	Strong - Bracing appears to be more effective than taping in reducing ankle sprains in athletes. Ankle disk training may reduce incidence of ankle sprains in athletes with a history of ankle sprains to the same degree as those without a history and the same level as those wearing an orthosis.

Author	Wedderkopp et al., 2003
Study design and target population	Prospective RCT - 163 female European handball players aged 14-16 years (16 teams).
Intervention	8 teams randomly allocated to training program only; (cluster sampling). 8 teams to receive ankle disc AND training program. Disc used for 10-15 minutes at each training session. Program included two or more functional strength activities for all major muscle groups. Baseline data collected on injuries sustained in previous season; level of player / teams (elite, intermediate, and recreational)
Outcomes	Injuries sustained measured as number of injury occurrences per 1000 h of practice and per 1000 h of match play (with 95% CI). Investigators contacted coaches each week; any player reported to be injured was contacted by a physician to determine type, location and severity of injury. (Observers were not blinded to allocation). Also surveyed players to determine compliance with study.
Results	Analyses by intention to treat basis. Used multivariate analyses to control for cluster sampling and possible confounding from risk factors. Compared results from expected injury incidence based on previous studies. Comparison with previous studies: No sig. difference in expected injury incidence and observed for previous season. Analyses for this intervention: Ankle disc group (AD) had sig. fewer traumatic injuries than the non-AD group (6 versus 16 p=0.044). (Measured total injuries rather than specific injuries given sample size – would have needed much larger sample to analyse by location of injury. No difference in number of overuse injuries between the two groups. Odds ratio for traumatic injury not using the ankle disc was 4.8 (95% CI: 1.9; 11.7) and it was 1.04 (95% CI: 1.03; 1.05) for 1 hour increase in match time. Test for goodness-of-fit for the model was p=0.92 (indicating a good fit for the model).
Study quality and conclusions	Strong – RCT - Sound study showing effect of using an ankle disc with training program over just training program for females aged 14-16 years playing European handball.

Author	Yang et al, 2005
Study design and target population	Use of data from a 3 year prospective cohort study of a stratified 2-stage cluster sample. 11,385 males and 8,343 females in grades 9-12(inc.)
Intervention	Usual discretionary use of lower limb support (not mandated by the rules of the sport)
Outcomes	Rate and severity of lower limb injury (e.g. knee pads, ankle brace and knee brace)
Results	Measured by sport; type of sport e.g. full contact etc. Rate ratios showed athletes with a history of lower limb injury had close to double the rate compared to those without a history; History of either knee or ankle injury had about 3 times the risk (2.92 CI 2.09, 4.09) and 3.42 (2.44, 4.80) respectively. Significant results were: (Adjusting for demographics):Incidence of injury - Athletes who used knee pads had a 56% lower knee injury rate (RR=0.44; CI: 0.27, 0.74). Effect strongest during game sessions 67% reduction (0.33 CI: 0.16, 0.67) and for those with no history of knee injury 59% reduction (0.41 CI: 0.23, 0.74); Knee (adj rr= 2.24 95% CI: 1.35, 3.71) & ankle braces (adj RR= 2.29 95% CI: 1.24, 4.24) were both associated with an increased rate of injury among athletes with no history of knee or ankle injury respectively. Severity of injury - With a history of lower limb injury, in injured athletes use of protective equipment was associated with 22% less chance of sustaining a serious injury (adj RR=.78 95% CI: 0.41, 1.49).
Study quality and conclusions	Moderate - Measured demographics, considered confounders in analyses and identified limitations of the study.

Author	Yeung and Yeung, 2001
Study design and target population	Systematic review of randomised or quasi-randomised trials to prevent running soft tissue injuries to the lower limb. No age / gender / publication limits. Total of 8,806 participants ranging from military recruits (8 studies); prison inmates (1 study); general population (3 studies); only 3 studies involved females but gender breakdown not available; age ranged from
Intervention	3 main preventive strategies: Modification of training schedule; Stretching exercises; use of either external support or modified footwear. Intervention period varied from 8 – 20 weeks; (1 studied 5 days of a refereeing tournament);
Outcomes	Outcomes of studies was injury incidence to: hip, knee, lower leg, ankle or foot.
Results	12 studies reviewed. Reduction in frequency, duration and running distance effective but not graduated running programme; Stretching exercises – only 1 of the 5 studies showed stretching effective (Hartig - stretching outside training session); Some effect of footwear modification and use of knee brace.
Study quality and conclusions	Review quality – determination of inclusion and quality of studies was done independently by 2 researchers. Data from some studies were able to be pooled.

Appendix C: Armed forces related reviewed articles – overviews listed alphabetically by author

Author	Amako et al 2003
Study design and target population	901 Military recruits (Japan) 18-25 years. Non random assignment of entire battalions (90 people) into 2 groups: the static muscle stretching group and the control group
Intervention	Static muscle stretching involving 18 exercises (covering different body parts) for up to three hours daily. Other group was not prevented from stretching and generally did 5-10 minutes before exercise.
Outcomes	Injury for which medical care (“visit to the infirmary”) was sought
Results	A non-significant difference in the overall injury rate between the two groups: Intervention 11.2% (58 injuries) and control 14.1 (56 injuries). When examining the type of injury, the intervention group was significantly lower than the control group on muscle injuries (2.5% vs 6.9%) and spinal injury (1% vs 3.5%) which was generally in the form of lower back pain.
Study quality and conclusions	Moderate. While a large sample size, subjects were not randomly allocated – but rather were assigned based on which battalion group they were in (depended upon the agreement of the leader). Those assessing injuries were not reported to be blind to the intervention status of the subjects.

Author	Finestone et al., 1999
Study design and target population	RCT: 404 infantry recruits in Israel. Mean age 18.77 years; training on same base at same time.
Intervention	Comparison of three orthoses: Group1: n= 132 recruits - Semi-rigid biomechanical; Group 2: n= 128 recruits soft biomechanical; Group 3: n= 126 – simple shoe inserts. Fourth group (Group 4) was formed consisting of those who did not want to wear orthoses at the beginning of the training. All participants had impressions of the feet made in the neutral subtalar position with the recruit partially weight-bearing in a box containing foam. Prior to study, 47% of recruits used orthoses with 30% of these being custom made. All participants were asked not to wear any other orthoses. Any recruit who found the orthosis too uncomfortable after 1 week were allowed to discontinue wearing them. All recruits wore special infantry boots with soles designed like those of basketball shoes.
Outcomes	Stress fractures – assessed every 2 weeks by the senior orthopaedist. If stress fracture was suspected then recruit was sent for further examinations.
Results	Loss to study – 81. All groups had equal distribution of risk factors: age, external rotation of the hip > 65 degrees and physical fitness. No significant difference in incidence of stress fractures between Group 1 and 2; and no significant difference of incidence of stress fractures between Group 3 & 4. Multivariate analysis showed orthotic was protective (OR=0.421 95% CI: 0.198; 0.892); external hip rotation greater than 65 degrees (OR=2.163 95% CI: 1.014; 4.611). Intervention versus control had 12.7 % versus 26.8% with stress fractures (chi sq. p=0.013). Of the 126 recruits who discontinued use of assigned orthosis; incidence of stress fracture was 17.5%; of those 60% had purchased orthoses prior to basic training and 50% of those orthotics were custom-made.
Study quality and conclusions	Strong – RCT. Biomechanical orthotics were effective in reducing the overall incidence of stress fractures in infantry recruits. Analysis does not appear to include intention to treat nor analyses by numbers needed to treat (to determine cost effectiveness of intervention).

Author	Finestone et al., 2004
Study design and target population	RCT - Study aimed to determine if shoe orthoses affected incidence of overuse injuries in young males using Israel infantry recruit study as the basis. First part of study: Base A – groups 1& 2: 451 male infantry recruits (mean age 18.74 years) training on same base at same time. Second part: Base B – groups 3 & 4: 423 infantry recruits (mean age 18.91) training on a different base.
Intervention	Randomly assigned to: Group 1: fitted for soft custom orthoses; Group 2: 'fitted' for prefabricated orthoses; Group 3: fitted for semirigid custom biomechanical orthoses; Group 4: 'fitted' for prefabricated semirigid orthoses. (Description of orthoses provided in study.)
Outcomes	Acceptance rates; comfort scores; incidence of stress fractures, ankle sprains and foot problems.
Results	Clinical follow-up for Group1 – 89.9%; Group 2 – 95%; Group 3 – 83.7% ad Group 4 - 82.7%. Percentage of recruits who finished training in their orthoses was significantly lower for the soft prefabricated orthoses (57%; p=0.003). No significant differences for stress fracture, ankle sprain and foot problems amongst the groups. Significant differences for level of acceptability changed depending on who to include. ie orthoses comfort scores for recruits who finished basic training in assigned orthoses were statistically lower for the semi-rigid biomechanical and semi-rigid prefabricated orthoses (p=0.0001); when those who left study due to discomfort were included in their original group for analysis then the statistically lowest comfort score was the soft prefabricated orthoses (p=0.002).
Study quality and conclusions	Strong – RCT. No difference in type of orthoses and injury; soft custom orthoses had highest (statistically significant) discontinuation rate; most acceptable orthoses depended on how the discontinued recruits were used in analyses.

Author	Hartig 1999
Study design and target population	Prospective cohort study - intervention (n=150) and control group (n=148) design – no randomisation. One military company served as the intervention and another as the control. Average age was 20 years, all subjects were male.
Intervention	All subjects were going through basic military training. The control group had basic stretching before physical activity, including regular hamstring stretching. The intervention group had three additional hamstring stretching sessions each day over the 13 week training course
Outcomes	Lower extremity overuse injuries as reported to the military medical facility, records reviewed weekly.
Results	Significantly fewer injuries in the intervention group (17%) compared to the control group (29%). The intervention group was also assessed to have increased their lower extremity flexibility by a greater amount (7°) compared to the control group (3°).
Study quality and conclusions	Weak-moderate. No randomisation, medical assessors not blind to which group their patients were in. Measured improvement in flexibility increases confidence of link between intervention and reduced injury. While trial was done with military recruits authors report that the findings would apply to athletes.

Author	Larsen et al., 2002
Study design and target population	Prospective, randomised controlled intervention trial. 1 female and 145 male military conscripts (aged 18-24 years) in a Danish regiment. (63 in control group and 67 in intervention at completion of study).
Intervention	Custom-made, bio mechanic shoe orthoses for the intervention group. The orthosis was semi-rigid and fitted to the inside of the boot and heated while inside the boot. At the correct temperature, subjects placed their feet in the boot and shifted their weight to allow for a controlled pronation at the subtalar and midtarsal joint. The orthoses were then to be worn by the intervention group whenever they wore their military boots for three months. No orthoses for the controls.
Outcomes	Self-reported back and / or lower extremity problems; specific problems included: shin splints, Achilles tendonitis, sprained ankle. Number of days off-duty due to lower extremity or back problem.
Results	Follow-up rate of 89% - Significant differences at 3 month follow-up for intervention versus control group were: prevalence of any problems in back or lower extremities (35% versus 56%); Shin splints (13% versus 24%); Number of off-duty days (23 days versus 43 days). Cost to prevent: any problems was \$US98; 1 case of shin splints \$US101 and to prevent at least one case of off-duty days US\$3,750. Based on the numbers needed to treat analysis: 6 for any problems' 6 for shin splints; and Worst Case Scenario analysis included the 25 who were either non-compliant or dropped out of the study. W-CA showed no significant differences for any of the outcome variables.
Study quality and conclusions	Strong - Random allocation to intervention and control groups. Medical and health care practitioners at the infirmary were unaware of allocation. Conducted worst case scenario analyses for those lost to follow-up. Clinical value of intervention depends on the analysis conducted. e.g. actual use analysis (showed significant results) versus cost to prevent a case (\$3,750 to prevent a day off work due to lower extremity or back pain). No discussion of potential for recall bias (outcomes were self-reported).

Author	Pope, 1999
Study design and target population	Retrospective, observational study examining the effect of a change in training regime for female Australian Army recruits in their incidence of pelvic stress fractures. N= 143 female recruits in historical control group; n= 161 female recruits in intervention group.
Intervention	Reduction of route march speed from 7.5 km/h to 5 km/h; marching occurred at own step; running occurred on softer surfaces; march & run formations more widely spaced and interval-running training replaced traditional middle-distance runs.
Outcomes	Incidence of pelvic stress fractures determined from bone scan reports
Results	Significant decrease in incidence of pelvic stress fractures (11.2% in historical group versus 0.6% in intervention group (p<0.001).
Study quality and conclusions	Weak - Moderate - Considered some potential confounders; attempted to provide control (measured male pelvic stress fracture incidence for corresponding period).

Author	Pope et al., 2000
Study design and target population	RCT - 1538 male army recruits undergoing basic training allocated to determine effect of stretching on incidence of lower leg injury.
Intervention	Stretch group assigned using blocked, stratified random allocation. Stretch group 19 platoons, 735 recruits performed stretches of 20 sec. per muscle group in each leg. Stretches mixed with 4 min warm-up activities (jogging & side-stepping. Controls - non-stretch group 20 platoons, 803 subjects. Performed only warm-up activities and no stretches.
Outcomes	All injuries reported to medical assistants or nursing staff. Injury for this study was any injury to the lower limb prevented the participant from resuming full duties without signs or symptoms within 3 days. RMO assessed all injuries and was blinded to allocation of participant. Injury categorized by area (location) and type.
Results	Analysis involved multivariate analysis examining interactions of stretching with fitness, age, height, weight, BMI and day of enlistment. No significant effect of stretching on all-injuries risk (Likelihood Ratio = 0.18 p=0.67. Hazard ratio (=injury rate in stretch group divided by the injury rate in the control group = 0.95 95% CI: 0.77; 1.18.) Note: HR close to 1 shows no difference in injury rates between groups. Also no sig. effect on injury risk when soft-tissue injuries were examined separately; same for bone injuries – ns.
Study quality and conclusions	Strong - The results of this randomized, controlled trial indicate that pre exercise muscle stretching does not produce a clinically worthwhile reduction in the risk of lower-limb injury. Injury risk is strongly associated with age and 20mSRT scores. This suggests that fitness may be a modifiable risk factor for injury.

Author	Popovich et al., 2000
Study design and target population	To examine effect of resting from running for 1 week during the second, third or fourth week of intensive training on stress fractures in military recruits compared with basic military training. 1357 male army recruits involved in basic military training with a median age of 18 years.
Intervention	Group 1: standard progressive training with weekly marching and running; (C 1). Group 2: “cyclic training” with rest from running in the 2 nd , 3 rd or 4 th week; (R2,3,4,5). Group 3: increased running mileage. (C 2)
Outcomes	Incidence of overuse injuries (e.g. stress fractures) and traumatic injuries (e.g. sprains) through extraction of medical records.
Results	Baseline anthropometric measures and fitness recorded within 2 days of commencing basic military training. Running and marching mileage differed from company to company (e.g. C1 & C2 logged similar marching mileage but C2 logged more running miles (52 versus 34 miles - no presentation of statistically significant difference); R2 logged 127 miles marching; R3 logged highest total running miles (65 miles) and lowest marching miles (55 miles) ; R 4 logged high marching miles (110 miles and lowest total running (26 miles); R5 had highest marching miles (161 miles). No significant difference in overuse injury when comparing intervention companies with control companies. Different intervention companies had significantly higher total overuse injuries (R4) significantly higher stress fracture rates (R2) when compared with the combined non-intervention companies. (Injury cases reported as rate per 100 recruits).
Study quality and conclusions	Weak - No mention of random allocation of intervention groups; daily training logs completed by drill instructor for each platoon; log books showed amounts of running and marching varied from company to company.; this variation could account for the results.

Author	Rome et al., 2005
Study design and target population	Systematic review investigating interventions for preventing and treating stress fractures and stress reactions of bone of the lower limbs in young adults as reported in RCT or quasi RCTs. Military recruits – as studies targeting military recruits in a number of countries report median age being about 18 years or majority of participants being aged 17-24 years, this review (Rome et al.) met our inclusion criteria.
Intervention	10 trials tested effects of various foot inserts / footwear modification. Leg muscle stretching during warm-up before exercise. Pneumatic braces (3 trials).
Outcomes	Stress fractures; incidence of other lower-limb injuries; compliance / acceptability with intervention
Results	<p>Identified 13 prevention trials; 3 of which allowed for pooling of data; highly heterogeneous – differences in control group interventions and outcome definitions.</p> <p>Footwear modification: Insoles/orthotics versus controls: significantly fewer people with injuries (including overuse injuries) in insoles group; Comparison of different insoles: no statistically significant differences in numbers with tibial, calcaneal or metatarsal stress reactions with those wearing cushioned insoles compared with those wearing standard insoles; no statistically significant differences in stress fracture rates for those wearing elastic insoles versus mesh insoles; borderline significance in stress fracture rates for those wearing custom-made semi-rigid or soft-foot orthoses compared with those with standard insoles (I²= 0.52; 95% CI 0.2762-1.0); reduction in tibial stress fracture in orthotics groups reached significance. Urethane versus grid-like mesh insoles found no statistically significant differences in numbers with tibial, calcaneal or metatarsal stress reactions although there were significantly more wearing urethane insoles who were discharged for medical reasons. Semi-rigid foot orthoses: no difference in stress fracture rates in participants wearing custom made semi-rigid orthoses versus soft biomechanical orthoses; semi-rigid orthoses were significantly more intolerable. Custom-made versus prefabricated soft foot orthoses: no significant differences in stress fracture rates; significantly fewer gave up wearing orthosis in the custom-made group. Custom-made mechanical semi-rigid versus prefabricated semi-rigid orthoses: no significant difference in stress fracture rates; Basketball shoes versus military boots: inconclusive results for stress fractures and overall overuse injuries; training in basketball shoes significantly associated with significant reduction in incidence of other overuse foot injuries.</p> <p>Reduction in frequency and intensity of running: Spurious findings due to</p>

	<p>failure to conduct intention-to-treat analysis.</p> <p>Pre-exercise leg muscle stretching: No statistical significance in stretching and controls for overall numbers of stress fractures (methodological issues – cluster randomization so reduced power to detect changes; recording of injury may have resulted in some stress fractures not being counted for participants with multiple injuries).</p> <p>Oral calcium supplements: Based on randomisation to individual recruits found significantly fewer overuse injuries in the calcium group - so interpret with caution.</p>
<p>Study quality and conclusions</p>	<p>Strong - Systematic review of RCTs or quasi- RCTs with generally weak quality rating. Review included authors independently assessing methodological quality of trials. Most cluster randomization presented analysis as if individual randomization had occurred – not by cluster, so could result in narrowing of CI. Some evidence to suggest ‘shock-absorbing insoles’ in boots of military recruits reduce overall incidence of stress fractures and stress reactions; insufficient evidence to determine best design but identified need to consider acceptability (comfort) in design. Some evidence for lack of protection from leg muscle stretching during warm-up; insufficient evidence to inform on training regime effect on stress fractures.</p>

Author	Rudzki and Cunningham, 1999
Study design and target population	Retrospective, uncontrolled observational study comparing rates of injury and medical discharge before the change in standard Australian Army physical training program with the rates after the change. Total recruit population was 3,181 people (2,700 males and 481 females); included in this study were 1634 males and 318 females. Three groups; Group 1 n=708; Group 2 n=667; Group 3 n=579 Platoons entering first Recruit Training during 1995/1996.
Intervention	Group 1: prior to change; Group 2 began training when both physical (original and the new) were in place; Group 3 began training when new program was universal. The training program change involved: cessation of road runs as a formed body and a 26.5 km reduction in running distance; introduction of interval training on grassed surfaces; reduction of terminal test run distance from 5 to 2.4 km; standardization of road marches with controlled march speed, graduated load increments and no running and deep-water running. One author observed PT staff to ensure compliance with program change.
Outcomes	Injuries presented to the physiotherapy department.; number of bone scans to diagnose stress fractures. Rates of medical discharge determined by number of discharges / number of recruits (Reviewed previous 4 years medical discharge to determine trends).
Results	For males there was a statistically significant decline in injury rate from Group 1 to Group 2 and Group 1 to Group 3 but not from Group 2 to Group 3. For females the decrease in injury rate from Group 1 to Group 3 was 35.3% but was not statistically significant. Number of bone scans ordered after introduction of new program decreased by 50% (p=0.0001) Male medical discharge rates showed a 40% reduction while females showed a 60% increase.
Study quality and conclusions	Moderate retrospective observational study. Does not mention if those ordering the bone scans were blinded to the study – assume they weren't. Potential confounding factors include time of year; changes in staff; comparative levels of fitness for each group at entry to training. New program appeared to reduce the incidence of injury in men and to a lesser (and not significant degree) in females. This difference could possibly be accounted for by the changes in levels of physical fitness at baseline (females less fit than men at baseline).

Author	Sherrard et al., 2004
Study design and target population	Systematic review. Aim of review was to identify effective and promising countermeasures to prevent unintentional injuries in the ADF (specifically injuries associated with sport and military training).
Intervention	Included articles were assessed for quality.
Outcomes	Reduction in injuries sustained during basic military training and participating in sport.
Results	<p>Training: Most promising: modify basic training to gradually increase duration, frequency and intensity of training activities over the training period. Some promise: reduction of running distance and substitution with other fitness activities for recruits; performing deep water running. Minimal effect – role of pre- and post-exercise stretching. Further research required for :types of shock absorbent boot insoles and footwear; use of outside the boot ankle brace for parachutists.</p> <p>Sport: Prevention of knee injuries - Promising: programs designed to increase balance and neuromuscular control (e.g. balance board, plyometrics) effective to reduce serious non-contact knee ligament injuries; Note: plyometrics to be conducted by skilled trainer. Further research: introduction of playing techniques (e.g. landing with bent knee); shoe, surface and shoe-surface interface.</p> <p>Preventing ankle injuries - Most promising: ankle supports (taping and semi-rigid bracing); Promise: ankle disc (balance boards training); Further research: footwear and playing surface interface.</p> <p>Preventing shoulder injuries - Further research: shoulder pads and coaching for landing and tackling techniques.</p>
Study quality and conclusions	Strong Systematic review - Summary of conclusion found in results; refer to report on: http://www.monash.edu.au/muarc/reports/Other/defence.pdf for results of review for touch football, rugby and soccer.

Author	Thacker et al, 2002
Study design and target population	Systematic review for prevention of shin splints - Four RCTs reported. All participants were military recruits involved in basic training.
Intervention	Study 1- Foam heel pads; heel cord stretching exercises; graduated running program; Study 2 – hot weather boot vs standard boot; Study 3 – foam inserts, moulded inserts and standard mesh inserts; Study 4 - Neoprene insoles vs control
Outcomes	AMA criteria to define shin splints (?Blind to participants) Uniform diagnostic criteria.
Results	From Study 1: 97 cases (4.1%) developed shin splints with no intervention showing any statistically significant effect. 2 nd stage after initial treatment for shin splints; mid shipment were randomly assigned heel pads. Shin splints reoccurred in 22% of midshipman with heel pads and in 11% without (ns). Of those who developed shin splints: 66% had no physical training immediately prior to the study while 34% had (p<0.001). No significant difference of developing shin splints between group of male & female army basic training participants who were assigned different boots: hot weather boots & standard boots (Study 2). No significant differences for shin splints among any of the inserts (urethane foam; moulded grid and standard mesh) (Study 3). Rate of injuries (unspecified) was 36.3 per thousand per week versus 25.8 per thousand per week in the intervention group. Rate of tibial stress syndrome (shin splints) 6.8 per thousand per week in control versus 2.8 per thousand per week in intervention group (p<0.05)(Study 4).
Study quality and conclusions	Moderate review of original studies with flaws in design. Noted serious flaws in study design and implementation but identified most promise and requiring closer research was the use of shock-absorbing insoles to prevent shin splints. Changes were also made in the training program in Study 4 which could account for significant differences.

Author	Thacker et al, 2004
Study design and target population	Systematic review to examine the evidence for or against stretching as a means to protect against injury. Six studies were reviewed. Of those six, it was reasonable to assume that the participants were predominantly aged between 15-24 years (i.e. they were either army recruits involved in basic training, or college or high school football players).
Intervention	Some studies compared the impact of stretching against a control group, while others examined not only stretching but also heel pads, graduated running; stretching ranged from heel stretching, calf stretching, wrist and triceps stretching, hamstring stretching, static stretching, stretching of 6 major leg muscle groups.
Outcomes	Injuries to the lower extremity, some studies specifically measured occurrence of shin splints and / or tibial stress reaction.
Results	Analyses for five of the studies were pooled and found stretching was not significantly associated with a reduction in total injuries.
Study quality and conclusions	Strong systematic review of studies of varying quality. Insufficient evidence to suggest stretching is either protective or causal for injury to the lower extremities.

Appendix D: Young people and road safety references

- Begg D, Stephenson S. (2003) Graduated driver licensing: the New Zealand experience. *Journal of Safety Research*. Jan;34(1): 99-105.
- Begg DJ, Stephenson SCR, Alsop JC, Langley JD. (2001) Impact of graduated driver licensing restrictions on crashes involving young drivers in New Zealand. *Injury Prevention*. 7:292-296.
- Berg, H.Y. (2006) Reducing crashes and injuries among young drivers: what kind of prevention should we be focussing on? *Injury Prevention* Jun 12(Suppl 1): i15-8.
- Branas CC, Knudson MM. (2000) Helmet laws and motorcycle rider death rates. *Accident Analysis and Prevention* Volume 33, Number 5, September 2001, pp. 641-648(8)
- Carcaillon LI, Salmi LR; Atout-Route Evaluation Group. (2005). Evaluation of a program to reduce motor-vehicle collisions among young adults in the county of Landes, France. *Accident Analysis and Prevention* Nov;37(6):1049-55. Epub 2005 Jul 19.
- Carrabba JJ, Field WE, Tormoehlen RL, Talbert BA. (2000). Effectiveness of the Indiana 4-H tractor program at instilling safe tractor operating behaviors and attitudes in youth. *Journal of Agricultural Safety & Health*. Aug;6(3):179-89.
- Chen LH, Baker SP, Li G. (2006) Graduated driver licensing programs and fatal crashes of 16-year-old drivers: a national evaluation. *Pediatrics*. 118(1): 56-62.
- Chiu W, Kuo C, Hung C, Chen M. (2000) The effect of the Taiwan motorcycle helmet use law on head injuries. *American Journal of Public Health* 90: 793-796.
- Christian WJ, Carroll M, Meyer K, Vitaz TW, Franklin A. (2003) Motorcycle helmets and head injuries in Kentucky, 1995-2000. *Journal of the Kentucky Medical Association*. 101(1):21-6.
- Ditter SM, Elder RW, Shults RA, Sleet DA, Compton R, Nichols JL; .Task Force on Community Preventive Services. (2005) Effectiveness of designated driver programs for reducing alcohol-impaired driving: a systematic review. *American Journal of Preventive Medicine* Jun;28(5 Suppl): 280-7.
- Elder RW, Shults RA, Sleet DA, Compton R, Nichols JL; Task Force on Community Preventive Services. (2005) Effectiveness of designated driver programs for reducing alcohol-impaired driving: a systematic review. *American Journal of Preventive Medicine* . Jun;28(5 Suppl): 280-7.
- Foss RD, Beirness DJ (2000) Bicycle helmet use in British Columbia: Effects of the Helmet use law. University of North Carolina Highway Safety Research Centre.
- Hall M, Cross D, Howat P, Stevenson M, Shaw T. (2004) Evaluation of a school-based peer leader bicycle helmet intervention. *Injury Control & Safety Promotion*; 11?:165-174
- Hartling L, Wiebe N, Russell K, Petruk J, Spinola C, Klassen TP. (2004) Graduated driver licensing for reducing motor vehicle crashes among young drivers. *Cochrane Database of Systematic Reviews* Issue 2. Art. No.: CD003300. DOI: .1002/14651858.CD003300.pub2.

- Hyde LK, Cook LJ, Knight S, Olson LM. (2005) Graduated driver licensing in Utah: is it effective? *Annals of Emergency Medicine*. Feb;45(2):147-54.
- Ivers R, Wells S, Blows S, Liu BC, Stevenson MS, Lo SK, Norton R. (2003) Increasing motorcycle and rider conspicuity for preventing death and injury in motorcyclists. (Protocol)Cochrane Database of Systematic Reviews Issue 3. Art. No.: CD004608. DOI: 10.1002/14651858.CD004608.
- Ivers RQ, Blows S, Liu BC, Lo SK, Norton R, Stevenson MS, Zhang J. (2004) Motorcycle helmet legislation for preventing injuries in motorcyclists. *Cochrane Database of Syst Rev* 2004; Issue 3. *Cochrane Database of Syst Rev* 2004; Issue 3.
- Ivers R, Kardamanidis K, Blows S, Liu BC, Stevenson M, Norton R. (2006) .Motorcycle helmet legislation for preventing injuries in motorcyclists. *Cochrane Database Syst Rev* 2006; In press.
- Kardamanidis K, Ivers RQ, Lo SK, Blows S, Zhang J, Stevenson MS. (2003). Motorcycle rider training for preventing road traffic crashes. (Protocol) *Cochrane Database of Systematic Reviews* Issue 2. Art. No.: CD005240. DOI: 10.1002/14651858.CD005240.
- Ker K, Roberts I, Collier C, Beyer F, Bunn F, Frost C (2003) Post-licence driver education for the prevention of road traffic crashes *Cochrane Database of Systematic Reviews*. Issue 3. Art. No.: CD003734. DOI: 10.1002/14651858.CD003734.
- Kopjar B, Wickizer TM. (2000). Age gradient in the cost-effectiveness of bicycle helmets. *Preventive Medicine*. 30(5): 401-406.
- Kwan I, Mapstone J, Kwan I, Mapstone J, Kwan I, Mapstone J. (2003) Interventions for increasing pedestrian and cyclist visibility for the prevention of death and injuries. In: *Cochrane Database of Systematic Reviews*, 3, 2003. Chichester, UK: John Wiley & Sons, Ltd.
- Lacey JH, Jones RK, Anderson EW. (2000). Evaluation of a Full-Time Ride Service Program. Aspen, Colorado's Topsy Taxi Service. National Highway Traffic Safety Administration. Vol.DOTHS 809155.
- Lin, M.L., Fearn, K.T. (2003) The provisional license: nighttime and passenger restrictions: a literature review. *Journal of Safety Research*. Jan. 34(1): 56-62.
- Lindqvist K, Timpka T, Schelp L. (2001) Evaluation of inter-organizational traffic injury prevention in a WHO safe community. *Accident Analysis Prevention* 33(5):599-607.
- Liu B, Ivers R, Norton R, Blows S, Lo SK. (2003) Helmets for preventing injury in motorcycle riders. *Cochrane Database of Systematic Reviews* Issue 4. Art. No.: CD004333. DOI: 10.1002/14651858.CD004333.pub2.
- Marlenga B, Doty B.C, Berg R.L., Linneman J.G. (2006) Evaluation of a policy to reduce youth tractor crashes on public roads. *Injury Prevention* Feb;12(1):46-51
- McKnight, A.J., Peck, R.C. (2002) Graduated driver licensing: what works? *Injury Prevention* Sep 8 (Supple 2):ii32-6.
- Morrissey MA, Grabowski DC, Dee TS, Campbell C. (2006) The strength of graduated drivers license programs and fatalities among teen drivers and passengers. *Accident Analysis Prevention* 38(1):135-41
- Newstead SV, Cameron M. (2003) Evaluation of the crash effects of the Queensland speed camera program. Monash University Accident Research Centre Report No. 204 2003: 1-35.

- Newstead SV, Cameron MH, Leggett LMW (2001) The crash reduction effectiveness of a network-wide traffic police deployment system. *Accident Analysis and Prevention* 33(3):393-406.
- Nolen S, Engstrom I, Folkesson, Jonsson A, Meyer B, Nygard B. (2002) PILOT - Further education of young drivers. Final report [PILOT - Vidareutbildning av unga bilforare. Slutrapport]. Swedish National Road and Transport Research Unit (VTI) Vol. rapport 457.
- Nolen S, Lindqvist K. (2004). A local bicycle helmet 'law' in a Swedish municipality - the effects on helmet use. *Injury Control & Safety Promotion*. Mar;11(1): 39-46.
- Norvell DC, Cummings P. (2002) Association of helmet use with death in motorcycle crashes: A matched-pair cohort study. *American Journal of Epidemiology* 156(5):483-487.
- O'Connor P, Kloeden C, McLean A. (2002) Do full-face helmets offer greater protection against cervical spinal cord injury than open-face helmets? *Traffic Injury Prevention* 3: 247-250.
- Reeder AI, Alsop JC, Langley JD, Wagenaar AC. (1999) An evaluation of the general effect of the New Zealand Graduated Driver Licensing System on motorcycle traffic crash hospitalisations. *Accident Analysis and Prevention*. 31:651-661.
- Retting RA, Kyrychenko SY (2002) Reductions in Injury Crashes Associated with Red Light Camera Enforcement in Oxnard, California. *American Journal of Public Health*. 92(11): 1822-5.
- Rice TM, Peek-Asa C, Kraus JF. (2004) Effects of the California graduated driver licensing program. *Journal of Safety Research*. 35(4):375-81.
- Richter ED, Berman T, Friedman L, Ben-David G. (2006) Speed, road injury, and public health. *Annual Review of Public Health*. 27:125-152.
- Roberts, I., Kwan, I. and the Cochrane Injuries Group Driver Education Reviewers. (2001) School-based driver education for the prevention of traffic crashes. *Cochrane Database of Systematic Reviews Issue 3*. Art. No.: CD003201. DOI: 10.1002/14651858.CD003201.
- Robinson DL. (2001) Changes in head injury with the New Zealand bicycle helmet law. *Accident Analysis and Prevention* 33:687-91.
- Royal ST, Kendrick D, Coleman T. (2005) Non-legislative interventions for the promotion of cycle helmet wearing by children. *Cochrane Database of Systematic Reviews Issue 2*. Art. No.: CD003985. DOI: 10.1002/14651858.CD003985.pub2.
- Scuffham P, Alsop J, Cryer C, Langley D. (2000) Head injuries to cyclists and the New Zealand bicycle helmet law. *Accident Analysis and Prevention* 32: 565-573.
- Senserrick, T. (2002) Training young drivers: Can it work? *Proceedings Developing Safer Drivers and Riders, Brisbane, Qld., Australian College of Road Safety*, 71-79 .
- Shope JT, Elliott MR, Raghunathan TE, Waller PF. (2001) Long-term follow-up of a high school alcohol misuse prevention program's effect on students' subsequent driving. *Alcoholism Clinical & Experimental Research* Mar;25(3):403-10.
- Shope JT, Molnar LJ. (2004) Michigan's graduated driver licensing program: evaluation of the first four years. *Journal of Safety Research*. 35(3): 337-44.
- Shults RA, Elder RW, Sleet DA, Nichols JL, Alao MO, Carande-Kulis VG, Zaza S, Sosin DM, Thompson RS; Task Force on Community Preventive Services. (2001). Reviews of evidence regarding interventions to reduce alcohol-impaired driving. *American Journal of Prevention Medicine* Nov;21(4 Suppl): 66-88.

- Simons-Morton BG, Hartos JL and Leaf WA. (2002). Promoting parental management of teen driving. *Injury Prevention* 8:ii24-ii31.
- Simons-Morton, B., Ouimet, M.C. (2006) Parent involvement in novice teen driving: a review of the literature. *Injury Prevention* Jun 12(Suppl 1):i30-7.
- Simons-Morton BG, Winston FK. (2006). Translational research in child and adolescent transportation safety. *Evaluation and the Health Professions*. 29(1): 33-64.
- Thompson DC, Rivara FP, Thompson R. (1999) Helmets for preventing head and facial injuries in bicyclists. *Cochrane Database of Systematic Reviews*. Issue 4. Art. No.: CD001855. DOI: 10.1002/14651858.CD001855.
- Vaca F; National Highway Traffic Safety Administration. (2006) National Highway Traffic Safety Administration (NHTSA) notes. Evaluation of the repeal of the all-rider motorcycle helmet law in Florida. *Annals of Emergency Medicine*. Feb;47(2):203: discussion 204-6.
- Vernick, J.S., Li, G., Ogaitis, S., MacKenzie, E.J., Baker, S.P., Gielen, A.C. (1999) *American Journal of Preventive Medicine*. Jan. 16(Suppl 1):40-6.
- Votta E, MacKay M. (2005) Evaluating the acceptability and feasibility of the I Promise Program: a driving program for families with young new drivers. *Injury Prevention* Dec;11(6): 369-72.
- Wagenaar AC, Toomey TL. (2002) Effects of minimum drinking age laws: review and analyses of the literature from 1960 to 2000. *Journal of Studies on Alcohol*. (suppl 14):206–25.
- Whelan, M. & Senserrick, T. (2003) Review of graduated driver licensing systems & the effectiveness of specific components. *Proceedings 2003 Road Safety Research, Policing and Education Conference*. 24-26 September, Sydney, Roads and Traffic Authority, NSW, CD-ROM.
- Willis C, Lybrand S, Bellamy N. (2004) Alcohol ignition interlock programmes for reducing drink driving recidivism. *Cochrane Database of Systematic Reviews* Issue 3. Art. No.: CD004168. DOI: 10.1002/14651858.CD004168.pub2.
- Zwerling C, Jones MP. (1999) Evaluation of the effectiveness of low blood alcohol concentration laws for younger drivers. *American Journal of Preventive Medicine*. Jan;16(1 Suppl): 76-80.

Appendix E:

Work and sports related references for articles included in the review

- Amako M, Oda T, Masuoka K, Yokoi H, Campisi P. (2003) Effect of static stretching on prevention of injuries for military recruits. *Military Medicine* 168(6):442-6.
- Arnason, A, Engebretsen, L Bahr, R. (2005) No effect of a video based awareness program on the rate of soccer injuries. *American Journal of Sports Medicine*. Jan 33(1): 77-84.
- Barbic D, Pater J, Brison RJ. (2005) Comparison of mouth guard designs and concussion prevention in contact sports: a multicenter randomized controlled trial. *Clinical Journal of Sport Medicine*. Sep;15(5): 294-8.
- Benson, B.E., Rose, M.S., Meeusisse, W.H. (2002) The impact of face shield use on concussion in ice hockey: a multivariate analysis. *British Journal of Sport Medicine*. 36(1): 27-32.
- Benson, B.W., Mohtadi, N.G., Rose, M.S., Meeuwisse, W.H. (1999) Head and Neck Injuries Among Ice Hockey Players Wearing Full Face Shields vs Half Face Shields. *Journal of American Medical Association* 282:2328-2332.
- Brunelle JP, Goulet C, Arguin H. (2005) Promoting respect for the rules and injury prevention in ice hockey: evaluation of the fair-play program. *Journal of Science & Medicine in Sport*. Sep;8(3):294-304.
- Cross, K. M., and T. W. Worrell. (1999). Effects of a static stretching program on the incidence of lower extremity musculotendinous strains. *Journal of Athletic Training*. 34:11-14.
- Daley RM, Bass SL, Finch CF (2001) Balancing the risk of injury to gymnasts: how effective are the counter measures? *British Journal of Sports Medicine*. 35: 8-20.
- Danis RP, Hu K, Bell M. (2000) .Acceptability of baseball faceguards and reduction of oculofacial injury in receptive youth league players. *Injury Prevention*, 6:232-234.
- Dong X, Entzel P, Men Y, Chowdhury R, Schneider S. (2004) Effects of safety and health training on work-related injury among construction laborers . *Journal of Occupational & Environmental Medicine*. Dec;46(12):1222-8.
- Emery CA (2005b). Injury prevention and future research. *Medicine & Sport Science*. 49:170-9.
- Emery CA, Cassidy JD, Klassen TP, Rosychuk RJ, Rowe BH. (2005a) Effectiveness of a home-based balance-training program in reducing sports-related injuries among healthy adolescents: a cluster randomized controlled trial. *Canadian Medical Association Journal*. Mar 15;172(6):749-54.
- Finestone A, Giladi M, Elad H, Salmon A, Mendelson S, Eldad A, et al. (1999) Prevention of stress fractures using custom biomechanical shoe orthoses. *Clinical Orthopaedics & Related Research*. 360: 182-90.
- Finestone A, Novack V, Farfel A, Berg A, Amir H, Milgrom C. (2004) A prospective study of the effect of foot orthoses composition and fabrication on comfort and the incidence of overuse injuries. *Foot & Ankle International*. 25(7): 462-6.

- Gabbe BJ, Branson R, Bennell KL. (2006) A pilot randomised controlled trial of eccentric exercise to prevent hamstring injuries in community-level Australian Football. *Journal of Science & Medicine in Sport*. May;9(1-2):Epub 2006 Mar 30, 103-109.
- Hagel BE, Pless IB, Goulet C, et al. (2005) Effectiveness of helmets in skiers and snowboarders: case-control and case crossover study. *British Medical Journal* Feb-05: 281-284.
- Hagel BE, Pless IB, Goulet C, et al. (2005) The effect of wrist guard use on upper-extremity injuries in snowboarders. *American Journal of Epidemiology*. 162(2): 149.
- Handoll, H.H.G., Rowe, B.H., Quinn, K.M., de Bie R. (2001). Interventions for preventing ankle ligament injuries. *Cochrane Database of Systematic Reviews*, Issue 3. Art. No.:CD000018. DOI: 10.1002/14651858. CD000018.
- Hart, L.E.(ed.) (2002) Full Facial Protection Reduces Injuries in Elite Young Hockey Players. *Clinical Journal of Sports Medicine*. 12 (6):406.
- Hartig, (1999) Increasing hamstring flexibility decreases lower extremity overuse injuries in military basic trainees. *American Journal of Sports Medicine*. 27: 173-176.
- Heidt, RS. Jr., Sweeterman, L.M., Carlonas, R.L., Traub, J.A., Tekulve, F.X. (2000) .Avoidance of soccer injuries with preseason conditioning. *American Journal of Sports Medicine*. 28: 659-662.
- Herbert, R., Gabriel, M. (2002). Effects of stretching before and after exercising on muscle soreness and risk of injury: systematic review. *British Medical Journal*. 325:468-479.
- Hewett TE, Ford KR, Myer GD. (2006) Anterior cruciate ligament injuries in female athletes: Part 2, a meta-analysis of neuromuscular interventions aimed at injury prevention. *American Journal of Sports Medicine*. Mar;34(3): 490-8.
- Hewett, T.E., Lindenfeld, T.N. Riccobene, J.V., Noyes, F.R. (1999) The effect of neuromuscular training on the incidence of knee injury in female athletes. *American Journal of Sports Medicine*. 27:699-704.
- Jones SJ, Lyons RA, Evans R, et al. (2004) Effectiveness of rugby headgear in preventing soft tissue injuries to the head: a case-control and video cohort. *British Journal of Sports Medicine*. 38:159-162.
- Junge, A.Rösch, D. Peterson, L. Graf-Baumann, T. and Dvorak, J. (2002) Prevention of Soccer Injuries: A Prospective Intervention Study in Youth Amateur Players. *American Journal of Sports Medicine*. 30:652-659.
- Larsen, K., Weidich, F., Leboeuf-yde, C. (2002) Can custom-made biomechanic shoe orthoses prevent problems in the back and lower extremities? A randomised, controlled intervention trial of 146 military conscripts. *Journal of Manipulative Physiology Therapy*. 255:326-331.
- Lee BC, Westaby JD, Berg RL. (2004) Impact of a national rural youth health and safety initiative: results from a randomized controlled trial. *American Journal of Public Health*. Oct; 94 (10):1743-9.
- Lipscomb HJ, Li L, Dement J, Nolan J, Patterson D. (2006) Nail gun injuries in apprentice carpenters: risk factors and control measures. *American Journal of Industrial Medicine*. 49(7): 505-13.

- Mandelbaum BR, Silvers HJ, Watanabe DS, Knarr JF, Thomas SD, Griffin LY, Kirkendall DT, Garrett Jr W. (2005) Effectiveness of a neuromuscular and proprioceptive training program in preventing anterior cruciate ligament injuries in female athletes: 2-Year follow-up. *American Journal of Sports Medicine*. 33(7): 1003-1010.
- Marshall S, Waller AE, Dick RW, et al. (2002) An ecologic study of protective equipment and injury in two contact sports. *International Journal of Epidemiology*. 31:587-92.
- Marshall SW, Loomis DP, Waller AE, Chalmers DJ, Bird YN, Quarrie KL, Feehan M. (2005) Evaluation of protective equipment for prevention of injuries in Rugby Union. *International Journal of Epidemiology*. 34: 113-118.
- McGuine TA, Keene JS. (2006) The effect of a balance training program on the risk of ankle sprains in high school athletes. *American Journal of Sports Medicine*. 34(7): 1103-1111.
- Olmsted LC, Vela LI, Denegar CR, Hertel J. (2004). Prophylactic Ankle Taping and Bracing: A Numbers-Needed-to-Treat and Cost-Benefit Analysis. *Journal of Athletic Training*. 39(1): 95-100.
- Olsen OE, Myklebust G, Engerbreetsen L, Holme I, Bahr R. (2005) Exercises to prevent lower limb injuries in youth sports: cluster randomised controlled trial. *British Medical Journal*. 330:449.
- Pope RP et al. (2000) A randomized trial of pre-exercise stretching for prevention of lower limb injury. *Medicine and Science in Sports and Exercise*. 32: 271-77.
- Pope, R. (1999) Prevention of pelvic stress fractures in female army recruits. *Military medicine*. 164(5): 370-373.
- Popovich, R. M., J. W. Gardner, R. Potter, J. J. Knapik, and B. H. Jones. (2000) Effect of rest from running on overuse injuries in Army basic training. *American Journal of Preventive Medicine*. 18: 147-155.
- Pryor SK, Caruth AK, McCoy CA. (2002) Children's injuries in agriculture related events: the effect of supervision on the injury experience. *Issues in Comprehensive Pediatric Nursing*. Jul-Sep;25(3):189-205.
- Quarrie KL, Gianotti SM, Chalmers DJ, Hopkins WG. (2006) An evaluation of mouthguard requirements and dental injuries in New Zealand rugby union. *British Journal of Sports Medicine*. Feb;40(2): 186.
- Quarrie, K.L., Gianotti SM, Chalmers DJ, Hopkins WG. (2005) An evaluation of mouthguard requirements and dental injuries in New Zealand rugby union. *British Journal of Sports Medicine*. 39(9): 650-654.
- Rome, K., Handoll, H.H.G., Ashford, R. (2005) Intervention for preventing and treating stress fractures and stress reactions of bone of the lower limbs in young adults. *Cochrane Database of Systematic Reviews*. Issue 2 Art. No.: CD000450. DOI: 10.1002/14651858.CD000450.pub2.
- Rudzki, S. J., and M. J. Cunningham. (1999) The effect of a modified physical training program in reducing injury and medical discharge rates in Australian Army recruits. *Military medicine*. 164: 648-652
- Runyan CW, Zakocs RC. (2000). Epidemiology and prevention of injuries among adolescent workers in the United States. *Annual Reviews Public Health*. 21: 247-69.

- Sherrard J, Lenne M, Cassell E, Stokes M, Ozanne-Smith J. (2004) Injury prevention during physical activity in the Australian Defence Force. *The Journal of Science and Medicine in Sport*. Mar;7(1):106-17.
- Soderman, K., Werner, S., Pietila, T., Engstrom, B., Alfredson, H. (2000) Balance board training: prevention of traumatic injuries of the lower extremities in female soccer players. A prospective randomised intervention study. *Knee Surgery, Sports Traumatology, Arthroscopy* 8(6): 356-363.
- Stuart, M.J., Smith, A.M., Malo-Ortiguera, S.A., Fischer, T.L., Larson, D.R. (2002) A comparison of facial protection and the incidence of head, neck and facial injuries in Junior A Hockey players. A function of individual playing time. *The American Journal of Sports Medicine*. 30: 39-44 .
- Thacker SB, Gilchrist J, Stroup DF, Kimsey CD Jr. (2004) The impact of stretching on sports injury risk: a systematic review of the literature. *Medicine and Science in Sports and Exercise*. Mar;36(3): 371-8.
- Thacker SB, Gilchrist J, Stroup DF, Kimsey CD. (2002) The prevention of shin splints in sports: a systematic review of literature. *Medicine and Science in Sports and Exercise* Jan;34(1): 32-40.
- Thacker SB, Stroup DF, Branche CM, Gilchrist J, Goodman RA, Porter Kelling E. (2003) Prevention of knee injuries in sports. A systematic review of the literature. *Journal of Sports Medicine & Physical Fitness*. Jun;43(2):165-79.
- Thacker, S.B., Stroup, D.F., Branche, C.M., Gilchrist, J., Goodman, R.A., Weitman, E.A. (1999) The prevention of ankle sprains in sports: a systematic review of the literature. *American Journal of Sports Medicine*. 27: 753-760.
- Wedderkopp, N., Kalltoft, M., Holm, R., Froberg, K. (2003) Comparison of two intervention programmes in young female players in European handball – with and without ankle disc. *Scandinavian Journal of Medical Science & Sports*. 13: 371-375.
- Verhagen, E.A.L.M., van Mechelen, W., de Vente, W. (2000) The effect of preventive measures on the incidence of ankle sprains. *Clinical Journal of Sport Medicine* 10: 291-296.
- Yang J, Marshall SW, Bowling JM, Runyan CW, Mueller FO, Lewis MA. (2005) Use of discretionary protective equipment and rate of lower extremity injury in high school athletes. *American Journal of Epidemiology* Mar 15;161(6):511-9.
- Yeung EW, Yeung SS. (2001) A systematic review of interventions to prevent lower limb soft tissue running injuries. *British Journal of Sports Medicine*. Dec;35(6): 383-9.

Appendix F:

Work and sports related references identified but not included in the review

- Andersen JC. (2005) Stretching before and after exercise: effect on muscle soreness and injury risk. *Journal of Athletic Training*. Jul;40(3):218-20
- Askling, C., Karlsson, J., Thorstensson, A. 2003. Hamstring injury occurrence in elite soccer players after preseason strength training with eccentric overload. *Scandinavian Journal of Medical Science & Sports* 13(4) 244-250
- Bird, Y.N., Waller, A.E., Marshall, S.W., Alsop, J.C., Chalmers, D.J. and Gerrard, D.F. (1998) The New Zealand Rugby Injury and Performance Project: V. Epidemiology of a season of rugby injury. *British Journal of Sports Medicine* .32, 319-325.
- Campbell MK, Elbourne DR, Altman DG for the CONSORT Group (2004). The CONSORT statement: extension to cluster randomised trials. *BMJ*; 328: 702-8
- Carrivick PJ, Lee AH, Yau KK. (2002) Effectiveness of a workplace risk assessment team in reducing the rate, cost, and duration of occupational injury. *Journal of Occupational & Environmental Medicine* Feb;44(2):155-9.
- Cassell EP (2001) Spiking injuries out of volleyball: A review of injury countermeasures MUARC Report; 181
- Cassell, E; McGrath, A (1999) Lobbing injury out of tennis: a review of the literature MUARC Report; 144 <http://www.monash.edu.au/muarc/reports/rpts99.html>
- Castillo DN, Davis L, Wegman DH. (1999) Young Workers. *Occupational Medicine*. Jul-Sep;14(3): 519-36
- Cerulli G, Benoit DB, Caraffa A, Ponteggia F. (2001) Proprioceptive training and prevention of anterior cruciate ligament injuries in soccer. *The Journal of Orthopaedic & Sports Physical Therapy*.31 655-660.
- Chalmers D. (2002) Injury Prevention in Sport: Not yet part of the game . *Injury Prevention* 8; 22-25
- Chalmers D, Simpson JC, Depree R (2004) Tackling rugby injuries: lessons learned from the implementation of a five year injury prevention program. *Journal of Science and Medicine in Sport*. Mar; 7(1): 74-84
- Clavisi O, Finch CF (2000) Squash injury countermeasures: a review of the literature *Journal of Science and Medicine in Sport* 3 13-22
- Clavisi O, Finch CF. (1999) Striking out squash injuries—what is the evidence?. *International Journal for Consumer & Product Safety* , 6 145–57
- Cook, D. J (2003) Evaluation of the ThinkFirst Canada: Smart Hockey brain and spinal cord injury prevention video. *Injury Prevention* 9 361-66
- Davis, L., Castiollo, D.N., Wegman, D.H. (2000). Child and adolescent workers. In B.S. Levy & D.H.Wegman (Eds.). *Occupational health: recognising and preventing work-related disease* (4th ed.), 689-699. Boston: Little, Brown and Company.

- Ehlers-JK (2005) Community partners for healthy farming intervention research. *Journal of Agricultural Safety and Health*. 11(2): 193-203.
- Eime R, Finch C, Wolfe R, Owen N, McCarty C. (2005) A controlled evaluation of a squash eyewear promotion strategy. 2005 Australian Conference of Science and Medicine in Sport, Melbourne, 13-16 October 2005. *Journal of Science and Medicine in Sport* 8(4): 221
- Elkington J, Hunter K, Makay L (2000) A systematic review of the evidence on preventing injuries to young people (15-24 years). Youthsafe www.youthsafe.org
- Elphinston J. Hardman SL. (2006) Effect of an integrated functional stability program on injury rates in an international netball squad. *Journal of Science & Medicine in Sport*. epub
- Erikson, J. C (2000) Prevention of injuries in soccer . *Knee Surg Sports Traumatol Arthrosc* 8 (6)
- Faude, O., Junge, A., Kindermann, W., and Dvorak, J. (2005) Injuries in Female Soccer Players: A Prospective Study in the German National League *American Journal of sports medicine* 33(11) 1694 - 1700.
- Finch C, Braham R, McIntosh A, McCrory P, Wolfe R. (2005) Should football players wear custom fitted mouthguards? results from a randomised controlled trial. *Injury Prevention*.11:242-246
- Finch CF, Elliott BC, McGrath AC. (1999) Measures to prevent cricket injuries: an overview *Sports Medicine* 28 263–72
- Finch, C., Cassell, E., Stathakis, V. (1999) Active recreation injury in the Latrobe Valley Monash University Accident Research Centre Report No. 151
- Francisco, A C (2000) Comparison of soccer shin guards in preventing tibia fracture. *American Journal of sports medicine* 28 227-233.
- Fuller, C. Drawer, S. (2004) The application of risk management in sport. *Sports Medicine* 34(6): 349-356.
- Gabbe B, Finch CF. (2000). Injury countermeasures in Australian Football. *Journal of Science and Medicine in Sport* 3 31-40
- Gadomski A, Ackerman S, Burdick P, Jenkins P. (2006) Efficacy of the North American guidelines for children's agricultural tasks in reducing childhood agricultural injuries. *American Journal of Public Health*.. Epub 2006 Feb 28. Apr; 96(4) 722-7
- Gillespie, W J (1999) Intervention for preventing and treating stress fractures and stress reactions of bone of the lower limbs in young adults. *Cochrane Library* – Issue 4 appears to be superseded by Rome 2005 Cochrane review
- Griffin, L.Y., Albohm, M.J., Arendt, E.A., Bahr, R., Beynon, B.D., DeMaio, M. Dick, R.W. Engebretsen, L. Garrett Jr, W.E., Hannafin, J.A. Hewett, T., Huston, L.J., Ireland, M.L., Johnson, R.J., Lephart, S., Mandelbaum, B.R., Mann, B.J., Marks, P.H., Marshall, S.W. Myklebust, G., Noyes, F.R. Powers, Shields Jr, C., Shultz, S.J., Silvers, H., Slauterbeck, J., Taylor, D.C., Teitz, C.C., Wojtyls, E.M. and Yu, B. (2006) Understanding and Preventing Non contact Anterior Cruciate Ligament Injuries: A Review of the Hunt Valley II Meeting, January 2005. *American Journal of sports medicine* 34(9) 1512 - 1532.

- Hagel, B., Meeuwisse, W. (2004). Risk compensation: a 'side-effect' of sport injury prevention? *Clinical Journal of Sport Medicine* 14(4): 193-196.
- Hart, L (2005) Effect of stretching on sport injury risk: a review. *Clinical Journal of Sport Medicine* Mar;15(2): 113
- Hume, P. A., and J. R. Steele (2000) A preliminary investigational injury prevention strategies in netball: are players heeding the advice? *Journal of Science & Medicine in Sport* 3 406-413
- Janda, D. H (2003) The prevention of baseball and softball injuries. *Clinical Orthopaedics & Related Research*. Apr;(409): 20-8
- Janda, D. H, Bir C, Kedroske B. (2001) A comparison of standard versus breakaway bases: an analysis of a preventative intervention for softball and baseball foot and ankle injuries. *Foot & Ankle International* 22 810-16.
- Junge, A., Dvorak, J. (2004) Soccer injuries: a review on incidence and prevention. *Sports Medicine* 34(13): 929-938.
- Knudson, D. (1999) Stretching during warm-up: do we have enough evidence? *The Journal of Physical Education, Recreation & Dance* 70 24-27,51,
- Lee AJ, Garraway WM, Arneil DW. (2001) Influence of preseason training fitness, and existing injury on subsequent rugby injury. *British Journal of Sports Medicine* 35 412-17
- Lipscomb , H J (2000) Effectiveness of interventions to prevent work-related eye injuries. *American journal of preventive medicine*. 18(4 Suppl. 1) 27-32
- Lipscomb HJ, Li L, Dement J. (2003) Work-related falls among union carpenters in Washington State before and after the Vertical Fall Arrest Standard. *American Journal of Industrial Medicine*. 44(2): 157-165.
- Machold W, Kwasny O, Eisenhardt P, Kolonja A, Bauer E, Lehr S, Mayr W, Fuchs M. (2002) Reduction of severe wrist injuries in snowboarding by an optimized wrist protection device: a prospective randomized trial. *Journal of Trauma*. Mar; 52(3): 517-2
- MacKay M, Scanlan A, Olsen L, et al. (2001) Sports and recreation injury prevention strategies: systematic review and best practices. Executive summary. B.C. Injury Research and Prevention Unit & Plan-it Safe, Children's Hospital of Eastern Ontario. www.injuryresearch.bc.ca/Publications/Reports.
- MacKay M, Scanlan A, Olsen L, Reid D, Clark M, McKim K, Raina P. (2004) Looking for the evidence: a systematic review of prevention strategies addressing sport and recreational injury among children and youth. *Sci Med Sport*. Mar;7(1):58-73.
- Macnab AJ, Smith T, Gagnon FA, et al. (2002) Effect of helmet wear on the incidence of head/face and cervical spine injuries in young skiers and snowboarders. *Inj Prev* 8 324-7.
- Marlenga-B; Doty-BC; Berg-RL; Linneman-JG (2006) Evaluation of a policy to reduce youth tractor crashes on public roads. *Injury-Prevention*. 2006 Feb 01; 12(1): 46-51

- Marshall SW, Mueller FO, Kirby DP, Yang J. (2003) Evaluation of safety balls and faceguards for prevention of injuries in youth baseball. *Journal of the American Medical Association* Feb 5;289(5): 568-74.
- McIntosh AS, McCrory P, Finch CF, Chalmers DJ, Best JP. (2003) Rugby headgear study. *Journal of Science and Medicine in Sport* 6 355–8.
- McIntosh AS, McCrory P. (2001) Effectiveness of headgear in a pilot study of under 15 rugby union football. *Br J Sports Med* 35 167–9
- McIntosh, A S; McCrory, P (2005) Preventing head and neck injury. *British Journal of Sports Medicine* 39(6) : 314-318
- Micheli LJ, Glassman R, Klein M (2000) The prevention of sports injuries in children *Clinical Sports Medicine* . Oct;19(4): 821-34, ix
- Moher, D., Schulz, K. F., & Altman, D. G. (2001). The CONSORT statement: Revised recommendations for improving the quality of reports of parallel-group randomised trials. *The Lancet*, 357, 1191M 1194.
- Myklebust, Grethe MSc, PT *; Engebretsen, Lars MD, PhD *+; Braekken, Ingeborg Hoff MSc, PT *; Skjolberg, Arnhild PT *; Olsen, Odd-Egil MSc, PT *; Bahr, Roald MD, PhD (2003) Prevention of Anterior Cruciate Ligament Injuries in Female Team Handball Players: A Prospective Intervention Study Over Three Seasons. *Clin J Sport Med* 13 71-78
- National Institute for Occupational Safety and Health (NIOSH)(2003) NIOSH alert: Preventing deaths, injuries and illnesses of young workers (DHHS Publication No. 2003-128).
- Newsome PR, Tran DC, Cooke MS. (2001) The role of the mouthguard in the prevention of sports-related dental injuries: a review. *International Journal of Paediatric Dentistry* Nov;11(6):396-404
- Odegaard TT, Risberg MA. (2005) Warm-up exercise prevents acute knee and ankle injuries in young handball players. *Australian Journal of Physiotherapy*. 51(2):131
- Olsen L, Scanlan A, MacKay M, Babul S, Reid D, Clark M, Raina P. (2004) Strategies for prevention of soccer related injuries: a systematic review. *British Journal of Sports Medicine*. Feb;38(1): 89-94
- Parkkari J, Kujala UM, Kannus P (2001) Is it possible to prevent sports injuries? Review of controlled clinical trials and recommendations for future work. *Sports Medicine* 31(14):985-95
- Pless, B. (2005) Commentary: evaluation of protective equipment for prevention of injuries in rugby union. *International Journal of Epidemiology* Feb; 34(1): 119-120.
- Pluim, B.M., Staal, J.B., Windler, G.E., Jayanthi, N. (2006) Tennis injuries: occurrence, aetiology, and prevention. *British Journal of Sport Medicine* 40 415-423.
- Pollack KM, Canham-Chervak M, Gazal-Carvalho C, Jones BH, Baker SP. (2005) Interventions to prevent softball related injuries: a review of the literature. *Injury Prevention*. Oct;11(5): 277-81.
- Quarrie K L, Alsop J C, Waller A E, Bird Y N, Marshall S W and Chalmers D J (2001) The New Zealand Rugby Injury and Performance Project: VI. A prospective cohort study of risk factors for injury in rugby union football. *British Journal of Sports Medicine*. 35 157-166

- Reed-DB; Kidd-PS; Westneat-S; Rayens-MK. (2001) Agricultural Disability Awareness and Risk Education (AgDARE) for high school students. *Injury prevention*. Vol. 7, suppl. 1p. i59-i63
- Rivara FP, Thompson DC. (2000) Systematic reviews of injury-prevention strategies for occupational injuries: an overview. *American Journal of Preventive Medicine*. May;18 (4 Suppl.) 1-3.
- Rivara FP, Thompson DC. (2000) Prevention of falls in the construction industry: evidence for program effectiveness. *American Journal of Preventive Medicine*; 18 23-7
- Sherman, C.A., & Finch, C.F. (2000). Preventing injuries to competitive and recreational adult golfers: what is the evidence? *Journal of Science and Medicine in Sport* 3 (1): 65-78.
- Shrier, I. (1999) Stretching before exercise does not reduce the risk of local muscle injury: a critical review of the clinical and basic science literature. *Clinical Journal of Sports Medicine*.9 221–227
- Webborn N (2005) Rapid Response to Olsen E et al. Exercises to prevent lower limb injuries in youth sports: cluster randomised controlled trial *British Medical Journal* 330 449
- Wedderkopp, N., Kalsoft, M., Lundgaard, B., Rosendahl, M., Froberg, K.(1999) Prevention of injuries in young female players in European team handball. *Scandinavian Journal of Medical Science in Sports* 9 41-47.
- Weldon, S. M., and R. H. Hill. (2003) The efficacy of stretching for prevention of exercise-related injury: a systematic review of the literature. *Manual Therapy: an International journal*. 8141–150
- West C, de Castro AB, Fitzgerald ST. (2005) The youth work force: unique occupational health considerations and challenges. *American Association of Occupational Health Nurses Jul;53(7): 297-305*
- Williams-AN; Hickman-CD; Lindgren-P; Merchant-Langner-D; Brunner-W; Hill-D: (2004) Evaluation of a school-based agricultural health and safety curriculum: work safe work smart . NIOSH.