CHAPTER 1

Is it possible to prevent sports and recreation injuries? A systematic review of randomized controlled trials, with recommendations for future work

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Introduction

To determine whether the prevention of sports injuries merits the attention of the public health authorities and clinical institutions, we need to know whether sports and recreation injuries are a substantial problem, and if so, whether there are factors that can be changed in order to remedy the problem. Figure 1.1 illustrates a sports injury prevention model, the "sequence of prevention," first proposed by van Mechelen and colleagues[1] and used by others to illustrate the process and to promote the critical need for advances in sports injury prevention.[2–7] Some advances have already been seen, including the First World Congress on Sports Injury Prevention (convened in Oslo, Norway in June 2005), special journal supplements focusing on sports injury prevention, and multiple reviews on the topic.[2,5,6] In this chapter, I will review and update the scientific evidence on the topic of sports injury prevention, attempting to answer the question: "Is it possible to prevent sports injuries?"

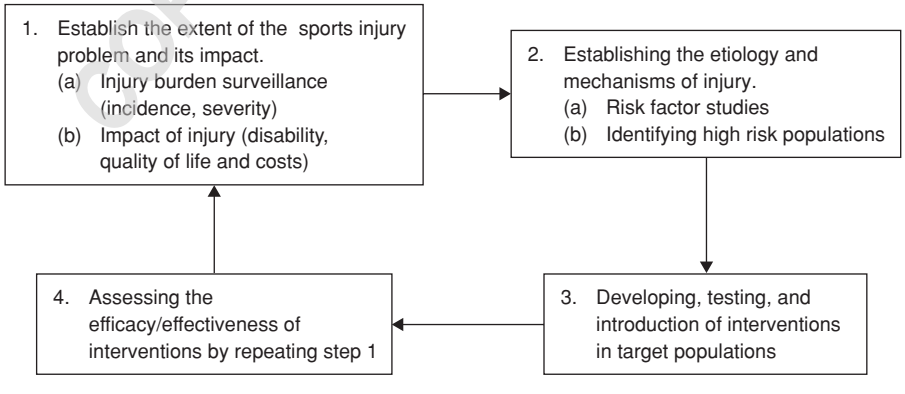


Figure 1.1 A modified version of the "sequence of prevention," an injury prevention model proposed by van Mechelen and colleagues (adapted with permission from ref. 1).

Methods

Inclusion/exclusion criteria

The following inclusion and exclusion criteria were developed and used for computerized bibliographic database searches and to define the final studies to be included in the review.

Inclusion criteria

- *Age range:* all.
- *Publications:* English-language, 1980–July 2005.
- *Interventions:* clinical or community-based, randomized controlled trials.
- *Outcomes:* injury frequency or rates, incidence of injury, hazard ratios; with or without exposure time data.
- *Sport:* sports and recreation activities, including school (interscholastic, intercollegiate, and intramural), community-based activities (Little League, soccer leagues, etc.), recreational individual sports (tennis, skiing, etc.), or team sports (volleyball, soccer, rugby, etc.).

Exclusion criteria

- Fall-related hip fractures.
- Military populations—specifically, recruits in basic or advanced training. Studies including students at U.S. military academies who participate in intramural or intercollegiate athletes were eligible.
- Bicycling (recreational and competitive) and other wheeled activities (skateboarding, scooters, rollerblading, etc.).

Retrieval of published studies

A comprehensive computer bibliographic database search was conducted using MEDLINE, EMBASE and the Cumulative Index to Nursing and Allied Health Literature (CINAHL) for the dates 1980 through July 2005. The search terms used included: 1, "injury" OR "trauma" AND 2, "sports" OR "exercise" OR "athletic" OR "athlete," AND 3, "prevention," and were combined with the Cochrane highly sensitive search strategy for randomized controlled trials (RCTs).[8] The final search results were limited to English-language publications. Figure 1.2 illustrates the subsequent flow of the study selection process. All abstracts identified in the bibliographic search (n = 172) were read and evaluated according to the *a priori* inclusion/exclusion criteria. Any study not explicitly meeting the stated exclusion criteria at this stage was kept for further review. Complete copies of the 27 studies selected at this stage were requested through interlibrary loan. Hand searching of the reference lists of the 27 papers received, as well as the reference lists of select review papers[3,9–12] yielded another 22 potentially relevant papers. Of the 49 total papers identified, one was immediately excluded because it was a duplicate publication from the same study. The remaining 48 papers were evaluated a final time using a checklist of the inclusion/exclusion criteria stated above. This stage excluded 21 papers, leaving 27 RCTs for inclusion in this review.

Quality assessment

Each study meeting the inclusion criteria was evaluated using the methodological quality scoring scale developed by Jadad *et al.*,[13] with slight modifications. The three-item Jadad scale is an easy-to-use scale, with established psychometric properties, that assesses each study with regard to randomization, double-blinding, and reporting of withdrawals

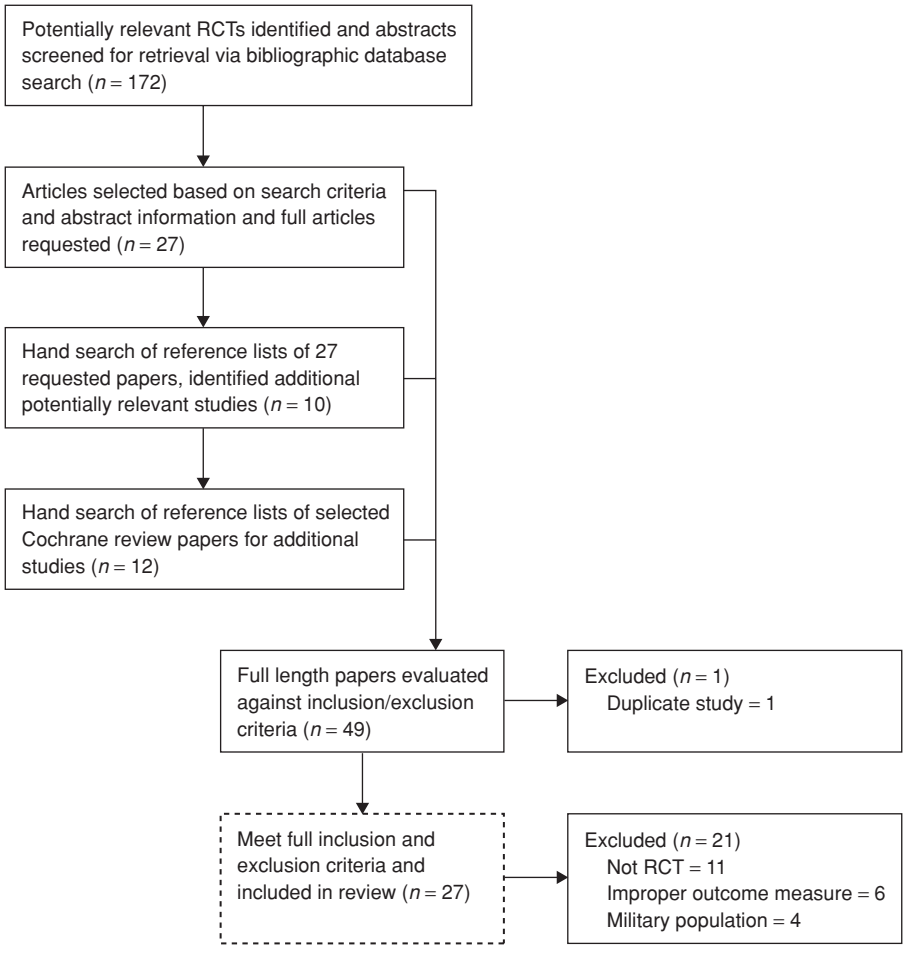


Figure 1.2 Flow chart of study selection for randomized controlled trials (RCTs) included in the review.

or participants lost to follow-up. The total score ranges from a minimum of 0 to a maximum of 5.

Since it is impossible to blind participants to select types of interventions used in sports medicine (e.g., exercise, braces, etc.), the second criterion regarding double-blinding was modified for this study. Studies received one point if the methods stated that the person or persons doing the assessments were blinded to the intervention assignment. An additional point was awarded if the process of blinding the assessors was described and appropriate. Since all studies had to be randomized controlled trials according to the inclusion criteria (assigned one point for the first criterion), the range of possible scores on the Jadad scale for this review was 1 to 5.

Data abstraction/statistical analysis

Information on the intervention type, publication year, subjects, country of origin, sport, primary and secondary outcome measures and quality scores were abstracted from each

study and entered into a spreadsheet. Average quality scores were computed for each of the four intervention types.

RCTs were grouped according to the type of intervention: 1, neuromuscular, functional, or proprioceptive exercise programs (n = 12); 2, protective or prophylactic equipment (n = 10); 3, educational programs (n = 2); and 4, other programs (one warm-up/cool-down/stretching program and one multiple-component program). Several individual studies could be included in more than one category or had more than one comparison, since these reports included multiple interventions in the same study. For example, Stasinopoulos[14] compared three intervention groups: a technical sport-specific skill training group, an ankle disk proprioception exercise group, and an ankle orthosis group. Three separate outcome comparisons were presented for this study: technical skill versus orthosis, ankle disk exercise versus orthosis, and orthosis versus technical skill. For each of the four intervention types, a level of evidence rating was assigned using the Oxford Centre for Evidence-based Medicine criteria.[15]

For pooling of the 27 included studies, the data that were abstracted and entered into an analysis database included the author, year, quality score, effect (primary injury outcome), number injured (intervention and control), and number not injured (intervention and control) for each study. Mantel–Haenszel odds ratios (OR), 95% confidence intervals (CI) and Forrest plots were created, and summary effectiveness estimates were calculated using Comprehensive Meta-Analysis software (BioStat, Inc., Englewood, New Jersey, USA). Both fixed and random-effects models are presented, but since interventions were combined across sports, populations, and countries of origin (with possible heterogeneity), an *a priori* decision was taken to use the random-effects estimate and 95% confidence interval as the primary measure of effectiveness. The *Q*-statistic to test for homogeneity was also used to confirm heterogeneity.[16]

Results

Description of interventions

Neuromuscular, functional or proprioceptive exercise programs. The 12 studies classified in this category basically consisted of: 1, sport-specific or skill-specific functional exercise training (i.e., acceleration/deceleration activities, technical skills for landings and take-offs, plyometric and agility tasks, and power, strengthening and stabilization exercises, n = 5;[17–21] 2, balance or proprioception training programs, mostly using ankle disks/balance boards (n = 4);[22–25] and 3, a combination of both (n = 3).[14,26,27] The length of the interventions ranged from 7 weeks to the entire sport season. In general, details regarding the frequency per week, session duration, and length of the intervention were poorly reported.

Protective or prophylactic equipment. Of the 11 studies in this category, five investigated the effectiveness of ankle or knee braces/orthoses,[14,23,28–30] two studied custom mouth guards,[31,32] two studied wrist protectors,[33,34] and one each studied break-away bases in softball and baseball[35] and different shoe styles (high versus low top)[36] in basketball.

Educational programs. The two studies investigating educational approaches to injury prevention both used video formats to present information to subjects. One study[37] showed a 45-minute video on skiing injury prevention and proper equipment use during a bus

ride to a ski resort. The other study[38] used a 2-hour workshop format to present a video analysis of injury mechanisms in soccer, followed by a group discussion.

Other interventions. One study[39] described a seven-component global soccer injury prevention program that included correction of training errors, provision of safety equipment, prophylactic ankle taping, controlled rehabilitation of injuries, exclusion of players with knee instability, education, and on-field medical supervision. The other study[7] consisted of a warm-up/cool-down and stretching program for runners.

Qualitative summary

Table 1.1 summarizes the studies by the four categories of intervention type and by individual studies. For neuromuscular, functional, or proprioception exercise programs, the majority (92%) of the studies reported significant reductions in injury outcomes and on average scored 2.4 in terms of methodological quality. Sixty-four percent of protective equipment interventions reported significant reductions in injury outcomes and had an average quality score of 2.7. Only half (50%) of the educational and other intervention types reported reduced injury outcomes and scored relatively low in terms of quality (educational = 1.5 and other = 1.0). Of the 27 studies, most (n = 16) originated from Scandinavian or European countries, six from the United States, and five from other countries.

Rating the evidence

On the basis of the Oxford Centre for Evidence-based Medicine levels of evidence, the studies included in both the neuromuscular, functional, or proprioception exercise and the protective or prophylactic equipment categories meet the 1A level of evidence, in which evidence is based on reports from large RCTs or systematic reviews. The educational program studies were graded A4 (evidence from at least one RCT) and the "Other" intervention group was graded A3 (evidence from at least one moderate-sized RCT or systematic review) (Table 1.1).

Quantitative summary

Pooled summary estimates are presented in Fig. 1.3 for the two intervention types that included more than two studies. Pooled estimates for the two educational program interventions were not significant (random-effects model OR 0.87; 95% CI, 0.34–2.21; $P = 0.77$) and are therefore not included in Fig. 1.3. Pooled estimates could not be calculated for the "Other" intervention types due to a lack of sufficient information in the printed manuscripts and the obvious heterogeneity between the two studies included in this category. All 12 of the neuromuscular, functional, or proprioception exercise studies reported data that could be pooled. However, one study in the protective equipment group[31] did not report sufficient raw data for summary estimates to be calculated, and therefore only nine studies were included in this analysis.

Neuromuscular, functional and proprioception exercise interventions. The *Q*-statistic to test for homogeneity indicated significant heterogeneity (*Q*-value 32.3, $P < 0.001$). Pooled effect estimates for the random-effects model suggest that neuromuscular, functional, or proprioception exercise interventions can reduce sports injuries by 65% (OR 0.35; 95% CI, 0.23–0.52; $P < 0.0001$).

Table 1.1 Summary of evidence for the effectiveness of interventions to prevent sports injuries, arranged by intervention type and individual studies

Evidence summary by intervention type

Intervention type (n*)	Components of interventions	Those favoring intervention† % (n)	Average quality score‡	Level of evidence§
Neuromuscular, functional, and/or proprioception exercise programs (n = 12)	Neuromuscular training programs, stability, power and strength exercises, balance and proprioception activities, sport- and skill-specific training	92% (11)	2.4	A1
Protective or prophylactic equipment interventions (n = 11)	Mouth guards, ankle braces and stirrup orthoses, lateral knee braces, break-away bases, wrist protectors, shoe styles	64%	2.7	A1
Educational programs (n = 2)	Video and video + group discussion	50% (1)	1.5	A4
Other (n = 2)	Warm-up/cool down and stretching program and multiple-component program	50% (1)	1.0	A3

Evidence summary for individual studies by intervention type

Neuromuscular, functional, and/or proprioception exercise programs

First author	Year	Country	Sport or activity	Intervention	Primary findings +/–†	Quality score‡
Tropp[23] (ankle disk vs. control)	1985	Sweden	Soccer	Ankle disk training	+	2
Wester[25]	1996	Denmark	Recreational athletes	Ankle disk training	+	2
Holme[19]	1999	Denmark	Recreational athletes	Strength and balance exercise	+	2
Wedderkopp[26]	1999	Denmark	Handball	Ankle disk + functional exercise training	+	1
Heidt[18]	2000	United States	Soccer	Frappier Acceleration Training Program	+	3

Soderman[22]	2000	Sweden	Soccer	Ankle disk training	–	2
Wedderkopp[27]	2003	Denmark	Handball	Ankle disk + functional exercise training	+	1
Sherry[21]	2004	United States	Recreational athletes	Progressive agility and trunk stabilization exercises	+	3
Stasinopoulos[14]	2004	Greece	Volleyball		+	2
Ankle disk vs. orthosis				Ankle disk training		
Skill vs. orthosis				Technical sport-specific skill training		
Verhagen[24]	2004	Denmark	Volleyball	Ankle disk training	+	3
Emery[17]	2005	Canada	PE students	Home-based balance training exercises	+	3
Olsen[20]	2005	Sweden	Handball	Strength, power, balance and technical skill program	+	5

Protective or prophylactic equipment interventions

First author	Year	Country	Sport or activity	Intervention	Primary findings +/–[†]	Quality score[‡]
Tropp[23] (orthosis vs. control)	1985	Sweden	Soccer	Ankle stirrup orthosis	+	2
Janda[35]	1988	United States	Baseball/softball	Break-away bases	+	4
Sitler[29]	1990	United States	Football	Lateral knee braces	+	2
Barrett[36]	1993	United States	Basketball		–	3
High top vs. low top				High-top basketball shoes		
High top + stirrup vs. low top				High top + air stirrup basketball shoes		
Sitler[28]	1994	United States	Basketball	Semi-rigid ankle stabilizing brace	+	1
Surve[30]	1994	South Africa	Soccer	Ankle stirrup orthosis	+	1
Ronning[34]	2001	Norway	Snowboarding	Wrist brace	+	5
Machold[14]	2002	Austria	Snowboarding	Wrist brace	+	3
Stasinopoulos[14] (orthosis vs. skill)	2004	Greece	Volleyball	Ankle stirrup orthosis	–	2
Barbic[31]	2005	Canada	Football/rugby	WIPSS Brain-Pad mouth guard	–	5
Finch[32]	2005	Australia	Australian football	Custom mouth guard	–	2

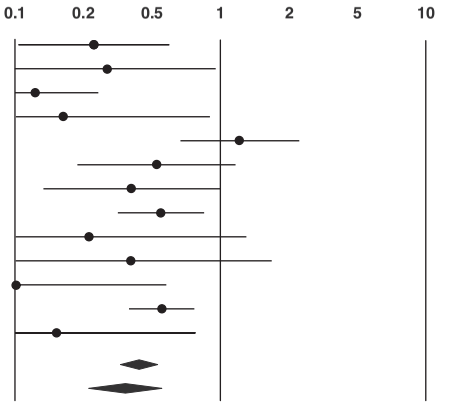
Continued

Table 1.1 (*Continued*)

Educational programs **First author**	**Year**	**Country**	**Sport or activity**	**Intervention**	**Primary findings +/–†**	**Quality score‡**
Jorgenson[37]	1998	Denmark	Downhill skiing	Educational video	+	1
Arnason[38]	2005	Iceland	Soccer	Educational video + group workshop	–	2
Other interventions **First author**	**Year**	**Country**	**Sport or activity**	**Intervention**	**Primary findings +/–†**	**Quality score‡**
Ekstrand[39]	1983	Sweden	Soccer	Multiple-component injury prevention program	+	1
Van Mechelen[7]	1993	Netherlands	Runners	Warm-up, stretching, cool-down	–	1

* A total of 27 studies were included in this review. Several studies had multiple intervention groups and subsequent comparisons, which are labeled separately in the lower part of the table.
† Number and percent of studies in each category reporting positive outcomes. Individual studies were graded positive (+) if significant ($P < 0.05$) reductions in injury or re-injury outcomes for their stated primary outcome measure were reported, and negative (–) if no statistical differences were reported.
‡ Quality scores ranged from 1 to 5, using a modified Jadad Scale for assessing study quality.[13]
§ Evidence levels based on the Oxford Centre for Evidence-based Medicine chart:[15]
A1, evidence comes from large randomized controlled trials (RCTs) or systematic review/meta-analysis.
A2, evidence comes from at least one high-quality cohort.
A3, evidence comes from at least one moderate-sized RCT or systematic review.
A4, evidence comes from at least one RCT.
B, evidence comes from at least one high-quality, nonrandomized study.
C, evidence based on expert opinion.

	Citation[a,b]	EffectName	Year	QS	Intervention*	Control*	Effect	Lower	Upper	PValue
	Tropp	Ankle sprains (Ankle disk vs. Control)	1985	2	7 / 142	30 / 171	.244	.104	.574	.001
	Wester	Ankle re-injury	1996	2	6 / 24	13 / 24	.282	.083	.959	.039
	Wedderkopp	All traumatic injuries	1999	1	14 / 111	66 / 126	.131	.068	.254	.000
	Holme	Ankle re-injury	1999	2	2 / 29	11 / 38	.182	.037	.899	.024
	Soderman	All traumatic injuries	2000	2	28 / 62	31 / 78	1.249	.636	2.453	.519
	Heidt	All injuries	2000	3	6 / 41	87 / 336	.491	.200	1.206	.114
	Wedderkopp	Any traumatic injury	2003	1	6 / 77	16 / 86	.370	.137	1.000	.044
	Verhagen	Acute ankle sprains	2004	3	29 / 641	41 / 486	.514	.315	.840	.007
	Stasinopoulos	Ankle sprains (Skill vs. Orthosis)	2004	2	2 / 18	6 / 17	.229	.039	1.352	.089
	Stasinopoulos	Ankle sprains (Ankle disk vs. Orthosis)	2004	2	3 / 18	6 / 17	.367	.075	1.797	.208
	Sherry	Hamstring re-injury	2004	3	1 / 13	7 / 11	.048	.004	.515	.004
	Olsen	Acute ankle/knee injuries	2005	5	48 / 958	81 / 879	.520	.359	.752	.000
	Emery	Any injury	2005	3	2 / 66	10 / 61	.159	.033	.760	.010
Fixed	**Combined (13)**				**154 / 2200**	**405 / 2330**	**.403**	**.327**	**.496**	**.000**
Random	**Combined (13)**				**154 / 2200**	**405 / 2330**	**.345**	**.229**	**.521**	**.000**



	Citation	EffectName	Year	QS	Intervention*	Control*	Effect	Lower	Upper	PValue
	Tropp	Ankle sprains (Orthosis vs. Control)	1985	2	2 / 60	30 / 171	.162	.038	.700	.006
	Janda	Sliding injuries	1988	4	2 / 635	45 / 672	.044	.011	.182	.000
	Sitler	Knee injuries	1990	2	16 / 691	37 / 705	.428	.236	.777	.004
	Barrett	Ankle injuries (High+stirrup vs. Low top)	1993	3	4 / 203	4 / 158	.774	.190	3.144	.719
	Barrett	Ankle injuries (High vs. Low top)	1993	3	7 / 208	4 / 158	1.341	.386	4.662	.644
	Surve	Ankle injuries	1994	1	48 / 244	75 / 260	.604	.399	.914	.017
	Sitler	Ankle injuries	1994	1	11 / 789	35 / 812	.314	.158	.623	.000
	Ronning	Wrist fracture/sprain	2001	5	8 / 2515	29 / 2514	.273	.125	.599	.001
	Machold	Mod/Severe wrist injuries	2002	3	1 / 342	9 / 379	.121	.015	.957	.017
	Stasinopoulos	Ankle sprain (Orthosis vs. Ankle disk)	2004	2	6 / 17	5 / 36	3.382	.858	13.332	.073
	Barbic	Concussion injuries	2005	5	22 / 308	21 / 306	1.044	.562	1.941	.892
Fixed	**Combined (11)**				**127 / 6012**	**294 / 6171**	**.437**	**.350**	**.546**	**.000**
Random	**Combined (11)**				**127 / 6012**	**294 / 6171**	**.459**	**.272**	**.773**	**.003**

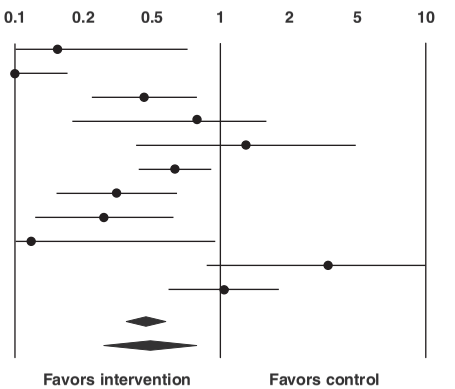


Figure 1.3 Study characteristics, summary estimates, and Forrest plots for the primary injury outcomes for (**a**) neuromuscular, functional, or proprioception exercise programs, and (**b**) protective or prophylactic equipment interventions. QS, quality score; Effect, Mantel–Haenszel odds ratio; Lower, lower boundary of 95% confidence interval; Upper, upper boundary of 95% confidence interval.

Protective or prophylactic equipment interventions. The *Q*-statistic to test for homogeneity indicated significant heterogeneity (*Q*-value 37.7, $P < 0.0001$). Pooled effect estimates for the random-effects model suggest that protective or prophylactic equipment interventions can reduce sports injuries by 54% (OR 0.46; 95% CI, 0.27–0.77; $P = 0.003$).

Discussion

The answer to the question: "Is it possible to prevent sports injuries?" is essentially "yes." The results of this systematic review suggest that sports injuries can be reduced by 54–65%, depending on the type of intervention. For some interventions, effectiveness is even greater among persons with previous injuries. This review could only pool studies on the basis of two very general groupings of intervention types and suggests that there is still a critical need for well-designed sport-specific or activity-specific studies to identify risk factors for injuries, to develop and test interventions, and to document post-intervention changes in the injury burden using the "sequence of prevention" model proposed by van Mechelen *et al.*[1]

One area that warrants further inspection and discussion is the relatively enhanced effectiveness for various exercise programs and ankle-stabilizing braces (semi-rigid braces or stirrup orthoses) among those with a previous history of ankle injuries. Several studies reported subgroup analyses for individuals who had prior injuries in comparison with individuals without. In all cases, individuals with previous ankle injuries had a significant reduction in the incidence of injury even if the intervention was not effective among individuals without prior injuries. Five studies[14,17,22–24] reported that interventions were more effective for ankle disk training/balance exercises among individuals with a previous ankle injury. Four studies[23,28,31,36] found similarly enhanced intervention effectiveness for various types of ankle stabilizers (rigid stirrup orthosis, semi-rigid ankle braces, high-top basketball shoes) among those with a previous ankle injury. These subgroup findings suggest that the potential "best practice" would be to recommend prophylactic ankle bracing and ankle disk/balance exercise programs for athletes participating in jumping and twisting sports who have a history of ankle injuries.

What is interesting in the results of this review is the fact that most of the sports injury prevention work is being done in Scandinavian and European countries. There is a dearth of well-designed studies from the United States, Canada, Australia, and Africa, and none from other continents, despite the fact that sports and recreational activities are popular pastimes across the globe. In addition, there are no studies for many types of sports and activities that are very popular worldwide. Soccer has considerable worldwide participation and was the sport most often studied (six studies) in this review. However, the numbers of children and adults participating in many different sports or activities, such as football, baseball, and softball, walking and running, aerobics, swimming, and others, are high[40,41] and this suggests that attention should be paid to injury prevention in a wider variety of activities and across different age groups.

In general, the quality of the studies included was relatively poor (average score 2.4 out of 5), and only four individual studies scored above a 4. The reason for this is unclear, but it is likely to be multifactorial. One reason may be that there is a lack of training opportunities for sports-medicine researchers in the methods of RCT study design, conduct, and analysis, and only a handful of agencies funding research in this area. There is also a lack of

the sport-specific and activity-specific injury risk factor information that is needed to design appropriate interventions. These data often have to come from expensive and long-term longitudinal cohort studies, which may explain the difficulty in conducting such studies. Also, in comparison with clinical settings, conducting research on the athletic field or in recreational sports settings may be fraught with "uncontrollable" factors (weather, field conditions, spectator behavior, etc.), the inability to blind subjects to some types of intervention (exercise, bracing/taping, etc.), and there may be an inherent "distrust" of researchers on the athletic fields on the part of coaches, parents, and athletes. The issue of poor study quality is not a new problem in this field; others have also discussed this limitation and called for more high-quality research.[3,9,42–44]

Another factor related to study quality is the type of instrument used to rate study methodology. A wide variety of quality rating instruments have been published in the literature, none however, specific to sports injury prevention RCT study designs. The Jadad scale[13] was chosen for its ease of use and because it has been shown to be reliable[45] and had been used previously[42] in sports injury prevention research. Three Cochrane reviews used a generic, 11-item scoring tool developed by the Cochrane Musculoskeletal Injuries Group.[10–12] A series of systematic reviews published by the U.S. Centers for Disease Control and Prevention developed a 100-point, checklist-type tool to rate study quality.[43,44,46–48] To date, there has not been any consistent use of a single quality assessment tool in the field of sports injury prevention. The field is unique in terms of factors that may bias study design and execution, and as such, a rating scale specific to the field may need to be developed and psychometrically tested. This tool would need to be very flexible to accommodate different sports, different populations, and different types of intervention.

The studies included in this review were deliberately limited to RCTs, which may be considered both a strength and a limitation. This study design is considered the "gold standard" for assessing intervention effectiveness and is often used to inform clinical decisions. An RCT, if properly conducted, can help control for various biases that cannot be assessed or controlled with other experimental or observational study designs.[49,50] Due to the difficulties in conducting RCTs in the sports setting discussed above, some may feel that limiting evidence for effectiveness to this stringent type of study design may be overly conservative.[51] Studies using quasi-experimental or observational study designs may still be informative in terms of prevention effectiveness, but were not included in this review, and this may be viewed as a limitation.[52] Even when effective interventions exist, there is still considerable difficulty in disseminating these interventions to the populations who will benefit the most from them.

A decade has passed since the publication of the landmark report *Physical Activity and Health: a Report from the Surgeon General.*[53] In the ensuing years, public health, clinical, and community-based organizations have been promoting moderate daily physical activity for all persons in order to benefit their health. Despite this, physical inactivity is still a critical problem both in the United States[54] and worldwide. The benefits of an active lifestyle are well known, but the risks associated with physical activity and exercise are less well understood. One of the most common possible adverse events associated with exercise and/or sports participation is musculoskeletal injury. To better promote safe, yet healthful, physical activity and exercise, we need evidenced-based information regarding injury mechanisms and risk factors that can be used to develop and evaluate injury prevention programs.

Recommendations

Clinical practice

• Comprehensive neuromuscular, functional exercise and/or proprioception training programs should be incorporated into all conditioning activities for soccer, volleyball, handball and other sports with a high incidence of lower-extremity injuries, especially ankle sprains.
• Participants in sports that involve jumping, twisting, and pivoting should be counseled to wear ankle-stabilizing devices such as a rigid stirrup orthosis or a semi-rigid brace. Such prophylactic ankle stabilizers should be strongly recommended to athletes with prior ankle injuries.

Future research

• Develop and implement standardized data systems for sports injury research.
• Increase training and funding opportunities for sports-medicine researchers to gain skills and experience in conducting clinical or community-based intervention studies and outcomes research.
• Recruit multidisciplinary partners, including health-care providers (physicians, nurses, etc.), allied health practitioners (Certified Athletic Trainers, physical therapists, exercise physiologists, etc.), coaches, athletic administration personnel, and parents to improve the evaluation and dissemination of effective methods of injury prevention.
• Convene an international sports injury prevention forum/network to develop a sports injury research agenda.
• Expand the reach of known effective interventions and evaluate promising interventions across activities and populations.

Summary

• Some sports and recreation-related injuries can be prevented.
• Level 1A evidence suggests that neuromuscular, functional, or proprioception exercise programs and prophylactic equipment are effective in reducing sports injuries.
• There is a critical need for high-quality randomized controlled trials of injury prevention interventions among physically active children and adults.

Key messages

• Sports injuries can be prevented.
• Neuromuscular, functional or proprioception exercise programs should be a integral part of sport training.
• A suggested "best practice" would be to recommend prophylactic ankle bracing and ankle disk/balance exercise programs for athletes participating in jumping and twisting sports who have a history of ankle injuries.

Sample examination questions

Multiple-choice questions (answers on page 602)

1 For the purposes of this review, "neuromuscular, functional, or proprioception exercise programs" consisted of all of the following except:
A Ankle disk/balance board training

B Acceleration/deceleration activities
C Calisthenics
D Plyometrics/agility training

2 What type of interventions had the highest proportion of studies reporting significant reductions in injury outcomes?
A Neuromuscular, functional, or proprioception exercise programs
B Protective or prophylactic equipment
C Educational
D Other

3 In terms of pooled effect estimates, which interventions were effective in reducing sports injuries by more than 50%? (Choose two.)
A Neuromuscular, functional, or proprioception exercise programs
B Protective or prophylactic equipment
C Educational
D Other

Essay questions

1 Define a common sports-related injury and, using the "sequence of prevention" model, describe the burden, risk factors, and development and evaluation of a sports injury prevention program for this injury problem.
2 In terms of summarizing intervention effectiveness, why is it crucial to report the details of individual interventions in publications?
3 As judged by the quality-scoring scale used in this study, the overall quality of studies included in this review was low. Discuss factors that may contribute to poor study quality in studies of sports injury prevention and how they may be improved in future research.
4 Discuss three ways in which the reach of effective sports injury interventions can be increased.

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