Psychological interventions used to reduce sports injuries: A systematic review of real-world effectiveness.

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Word count: 4668 (incl. references)

ABSTRACT

Objective: To systematically review studies examining the role of psychological interventions in injury prevention. The primary research question was: (1) What is the real-world effectiveness of psychological intervention in preventing sports injuries?

Design: Mixed method systematic review with best evidence synthesis

Data sources: CINAHL, MEDLINE, PsycARTICLES, PsycINFO, SPORTDiscus, Science Direct and PubMed

Eligibility criteria for selecting studies: Randomised control trials (RCTs), non-RCTs that included a comparison group, before and after study designs and qualitative methods. Studies were required to outline specific unimodal or multimodal psychological interventions used in relation to injury prevention in the real-world setting.

Outcome measure: Studies were independently appraised with the Mixed-Methods Appraisal Tool (MMAT).

- **Results:** Thirteen papers (incorporating 14 studies) met the eligibility criteria, of which 93% (13/14) reported a decrease in injury rates (effect size range = 0.2 – 1.21). There was an overall moderate risk of bias in reporting (52%). There is a dominance of stress management-based interventions in literature due to the prominence of the Model of Stress and Athletic Injury within the area.

  Summary/conclusions: Psychological interventions demonstrate small (0.2) to large (1.21) effects on sports injury rates. The research area demonstrates a cumulative moderate risk in reporting bias (52%).

PROSPERO registration: CRD42016035879

What is already known and why this review is needed

- Psychosocial interventions, such as stress management interventions, may reduce injury rates
- Sport injury risk is multifactorial; structured injury prevention programmes must account for this multifactorial nature
- Existing systematic reviews and meta-analyses have excluded potentially relevant studies and have centred attention on the efficacy of interventions (laboratory setting) as opposed to their effectiveness (real world setting).

What are the new findings?

- 93% of studies in this review were associated with a lower sports injury rates and/or injury time-loss
- Psychological interventions demonstrate a range of effect sizes (0.2 – 1.21) which suggest they can contribute to injury prevention.
- Even low frequency and short duration interventions, with a low risk of bias, reduced injury rates (ES = 0.2 – 0.99).
- Future studies should consider sample size estimations, completeness of outcome data, reporting of attrition rates, and monitoring and reporting of compliance and adherence rates more closely.

INTRODUCTION

The incidence of injury in sports range from 0.5-34 injuries/1000 hours,[1] with injury being one of the leading causes of early retirement from sport.[2] Sports injuries have significant psychosocial impacts on athletes that can influence the quality of return to sport (RTS), decrease the chance of RTS[3,4] or increase the time taken to RTS.[5] Injuries have financial[6] and performance-related[7] costs to teams. Injury prevention is a priority for sports injury practitioners and policymakers.[8]

Psychological factors are an intrinsic risk factor predisposing the athlete to injury, and should be considered for injury prevention programmes.[8,9] As injury causation is multifactorial, it follows that injury prevention programmes should target each of the multiple causes. Psychological interventions have often been overlooked.[10-12] Consequently, a comprehensive systematic review would help form a knowledge base, providing sports injury practitioners with information regarding the effectiveness of psychosocial interventions for injury prevention and the quality of the evidence.

Psychosocial factors including attention disturbance, arousal levels, anxiety, stress, daily hassles and negative life events are predictive for sports injuries, and psychological intervention can help to lessen the impact of these on individuals.[13-23] Psychosocial injury prevention strategies have been little used in sport.[1]

Two recent systematic reviews concluded that psychological intervention strategies have the potential to reduce injury risk in broad populations of athletes.[24,25] However, both reviews excluded studies that did not provide information that would allow them to complete the targeted statistical analyses.[24,25] However, in the two previous systematic reviews, studies were excluded if they were not underpinned by the Model of Stress and Athletic Injury.[25] Consequently, these reviews may have excluded relevant evidence,[3] and this could have implications for clinical decision making.[26]

In addition, the focus of both the most recent reviews has been evaluating the efficacy of psychological interventions, rather than their effectiveness. This is important as the effectiveness of systematic injury prevention involves examining efficacy, efficiency and compliance[27,28] (see Box 1 for key terms). Knowledge of intervention effectiveness will enhance understanding of sport psychology interventions in real-world environments.[29] Consequently, the research question for this systematic review was: What is the effectiveness of psychological intervention for preventing sports injuries?

Box 1: Key terms

Adherence: The voluntary, collaborative and active involvement of an athlete in an injury prevention programme that is mutually acceptable to the athlete and clinician.

Compliance: The degree to which a participant conforms to the recommended dosage, timing and frequency of an intervention. The athlete is often passive in the process.

Efficacy: The performance of an intervention under controlled conditions (e.g. a purposefully selected sample in artificially controlled game conditions), with greater potential to claim a high degree of internal validity.

Efficiency: The pragmatic considerations (e.g. time requirements, financial implications or administrative requirements) of using an intervention

Effectiveness: A more 'real-world' consideration, jointly determined by efficacy, efficiency and compliance/adherence, with greater potential to claim a high degree of external validity

METHOD

Reporting for the current systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines.[30] The protocol was registered in the PROSPERO database in February 2016 (registration number: CRD42016035879), and was granted ethical approval by the Leeds Beckett University ethics committee (Application Ref: 18124).

Search Strategy

Relevant articles were identified through a search of the following electronic databases: CINAHL, MEDLINE, PsycARTICLES, PsycINFO, SPORTDiscus, Science

Direct and PubMed. Updated searches were completed for dates between the earliest publications available on each database and 5th February 2017

The specific search strategy that was used for this review was: (sport injur* OR athletic injur*) AND (intervention* OR strateg* OR prevention) AND (psychology OR psychosocial factor OR psychosocial) AND (risk factors OR determinants OR predictor). Relevant MeSH terms were added to these keywords to improve the accuracy of the literature discovered. Peer-reviewed journals in sport psychology (Journal of Applied Sport Psychology, The Sport Psychologist, Psychology of Sport and Exercise, the Journal of Sport and Exercise Psychology, the International Journal of Sport and Exercise Psychology and the International Journal of Sport Psychology) were also hand-searched.

The use and reporting of citation searching and bibliographic screening has gained support as a powerful complementary method to keyword searching.[31,32] Consequently, to identify additional studies for the review, backward citation searching of bibliographies of all included studies and forward citation searching via Google Scholar and Web of Science were conducted to determine any additional studies.

Selection Criteria

The specific eligibility criteria for this review can be found in Table 1. The studies included: randomised controlled trials (RCTs), non-randomised intervention studies that included a comparison group, before and after study designs, and qualitative methods.[3,33] Studies were required to outline specific psychosocial interventions used in relation to reducing injury risk.

When applying the selection criteria, the title and abstract of each study were reviewed first. If it was unclear from this whether the article should be included, the full text was obtained and read for review. Three reviewers applied the selection criteria at each step independently; any disagreements were resolved by consensus.[3]

Assessing risk of bias

The Mixed Methods Appraisal Tool (MMAT)[26] was used to appraise the included studies. This tool has high inter-rater reliability (0.72 – 0.94) [26] and contains five sets of criteria: (1) qualitative; (2) randomised controlled studies – quantitative; (3) non-randomised controlled studies – quantitative; (4) observational descriptive studies – quantitative; (5) mixed-method studies. Each study type is judged in its methodological domain apart from mixed-method studies, which are appraised using three sets: the qualitative set, the relevant quantitative set and mixed-method set.[26] The overall quality of a mixed-method study cannot exceed its weakest component.

Establishing rigour

The MMAT appraisal criteria were applied independently by three reviewers to rigorously appraise included studies. Inter-researcher reliability of appraisals was assessed using a two-way mixed, absolute agreement intra-class correlation coefficient[34] and demonstrated high inter researcher reliability in independent study appraisal (0.98). Any disagreements were resolved via consensus discussion. Consistent with recent reviews,[3, 33,35] risk of bias was viewed on the continuum: 0-25% = high risk of bias, 25 – 50% = high to moderate risk of bias, 50 – 75% = moderate to low risk of bias, and 75% - 100% = low risk of bias. The theory behind this is that achieving the fewest MMAT criteria demonstrates the highest risk of bias and achieving more MMAT criteria reduces the risk of bias.[3,26]

Data extraction and synthesis

AG, EM and DF independently extracted the following: operational definition of injury, population, sample size, sex, ethnicity, nationality, intervention used, duration of intervention, compliance rates, results of the study. Given heterogeneity of research designs, populations, interventions and comparator groups, we used best evidence synthesis to summarise the evidence by intervention type (e.g. stress inoculation training) or purpose (e.g.

relaxation) where possible. Risk of bias was assessed for each intervention type/purpose. Evaluation of the overall effectiveness of interventions was based on three areas: (a) efficacy; (b) efficiency; and (c) compliance[28].

RESULTS

The electronic database search yielded 6160 records. An additional 193 records were identified through table of contents searches, 9 through bibliographic searching and 4 through forward citation searching (Figure 1). Titles of 6308 records were screened after duplicates (n=58) were removed, and 6284 were excluded through title and abstract screening. Twenty-four articles were screened in full-text, and 11 were excluded (Figure 1), leaving 13 articles, incorporating 14 studies. Supplementary table 1 presents a descriptive overview of data extracted from final included articles.

Demographic characteristics

The 14 included studies reported on 1380 athletes, aged 10-33 years (mean = 18.6 years, SD = 2.8). Twelve articles (n=1355 participants) reported the number of male (n=868; 64.2%) and female (n=484; 35.8%) participants. One article,[36] reporting two separate studies, did not provide sufficient demographic information about their participants to include them in this initial descriptive analysis. Participants' level of competition ranged from international to regional levels in floorball (54.1%); football (32.4%); rugby union and rugby league (3.5%); gymnastics (3.2%); rowing (2.5%); ballet (2.5%); and swimming (1.8%).

Study characteristics

There were nine quantitative randomised, three quantitative non-randomised and one quantitative descriptive studies (Table 2). There was a broad range of definitions of sports injury across the studies. These included a time-loss definition of sports injury ranging from one day[37,38] to four days[39] of restricted or no practice before being recorded as an injury, whereas others did not overtly define an injury beyond anything requiring treatment.[18,36]

Risk of bias assessment

The MMAT rating of included studies (Table 2) ranged from 0% - 100% (mean = 51.9%, SE=7.73; 95% CI= 35.1 – 68.8), denoting an overall moderate risk of bias. The risk of bias was mainly increased by studies not adequately reporting processes of randomisation and/or allocation concealment and/or blinding (n=8), or not providing sufficient information to be able to determine whether participant selection had minimised selection bias (n=3).

Effectiveness of psychosocial interventions for injury prevention

Stress management and relaxation were the most common interventions.[18,36,41-45] Intervention techniques were imagery,[36] goal setting,[36,37,40,] mindfulness, Acceptance and Commitment (MAC) training,[39] attribution training,[37] self-confidence training,[37,40] autogenic training,[38] self-talk,[38] thought stopping,[43,44] abdominal breathing,[43] control of emotions,[36,40] concentration skills,[40] and video clips.[44] Video-based training was also used as a standalone awareness training programme.[46]

Efficacy

Thirteen out of the 14 studies reviewed reported fewer injuries and/or shorter time-loss in the intervention group than the control group. Twelve out of 14 studies had a control group to compare the effectiveness of their intervention. Interventions in these studies demonstrated a range of effect sizes on reduction in injuries, from small (d = 0.2) to large (d = 1.21). Supplementary table 1 provides a study-by-study breakdown of intervention efficacy.

Efficiency

The duration of interventions ranged from 4 weeks to 8 months (mean =15.6 weeks, SD =10.75). The number of intervention sessions varied from 6 to 160 (mean = 10.9, SD = 9.4). The duration of the individual intervention sessions ranged from 10 to 120 minutes (mean =50 minutes, SD =28.4). The most frequent duration of an intervention session was

one hour.[40-46] There was evidence from studies at low risk of bias that up to 2 sessions per week, for 3-6 weeks on interventions based on principles of stress inoculation training was effective (d=0.2-0.99) for reducing sports injuries.[40,41,47]

Compliance

Compliance rates were largely unreported. In 1 study, there was compliance of 82% for a coping intervention and 83% for an autogenic training intervention.[38]

Best evidence synthesis

There was evidence with a moderate risk of bias (M=50%) from five studies that stress inoculation training was effective at reducing injuries. There was evidence with a high risk of bias (M=8.3%) from three studies that relaxation training was effective at reducing injuries. There was evidence with a low risk of bias (M=75%) from three studies that multipurpose interventions (e.g. combination of stress management, concentration, confidence and emotional control training) were effective at reducing injuries.

DISCUSSION

The research question addressed through this systematic review was: What is the effectiveness of psychological intervention for preventing sports injuries? The purposes of the following discussion are to (1) discuss findings relating to efficacy, efficiency and compliance and the associated practical recommendations that can be drawn; (2) discuss the methodological quality of studies; and (3) present future research directions.

Psychological interventions are associated with reductions in injury rates

Thirteen out of the 14 studies reviewed reported fewer injuries and/or shorter time-loss, with small to large effects (*d* 0.2 to 1.21) of psychological interventions for reducing injury rates and/or time loss. Psychological interventions are efficient, given the low weekly time requirement and the low number of weeks taken to complete interventions. Therefore,

practitioners may wish to consider psychosocial interventions as part of their interdisciplinary injury prevention programmes.[24,25]

There are different plausible explanations for the efficacy of psychological interventions. Most contained a stress management component, and stress is associated with injury risk.[22,25] Periods of high stress influence cortisol and oxytocin release, which may have a relationship to injury risk[48, 49] via immune[50,51] and pain[49] responses. Stress management interventions can have a beneficial effect on these immune and pain responses.[18,36,40-43,47] Reduced stress levels are also associated with reduced amydgala activation.[25] This may reduce injury risk as it is associated with improved attention and decision-making capacity.[25,39] This is important as decreased attention and decision-making ability is linked with increased injury risk.[52] Moreover, elevated stress can impact on neurocognitive functioning and decrease neuromuscular control, which is linked with non-contact ACL injuries.[53] Stress Inoculation Training[54] is a progressive multi-modal stress reduction technique prominent in this review. It aims to reduce tension and increase attention, which have both been linked with increased injury risk.[25,39]

Methodological quality of included studies

Overall, the body of evidence shows a moderate risk of bias (52%). The lack of clarity over processes for concealment or blinding, difficulties over assessing dropout rates, and difficulties in assessing a lack of bias in sampling procedures, all contributed to this (see table 2). Most studies had a small sample size and few provided evidence of sample size estimation. This calls into question the statistical power of the studies,[55,56] and draws potential concerns over the reproducibility of the findings.[57] There is also a lack of replication research within this field. [57] The definition of injuries varied across studies, ranging from no definition[36] to varying time-loss definitions.[40] This makes it difficult to accurately assess the effectiveness of different interventions.

There was a substantial under-representation of female athletes within included studies. Injury is a major contributor to retirement in female athletes.[2] Therefore, more research is required to determine whether psychological interventions may be beneficial to female athletes. The under-representation of female athletes also calls into question the application of research findings to female athletes.[2,3,33]

Practical implications

Wampold[58] noted that the factors of goal collaboration, empathy, alliance and therapist effects all had greater effect sizes on treatment intervention than treatment differences. Therefore, sports injury practitioners (SIPs) contemplating psychologically-based interventions for injury prevention should consider creating a strong alliance with their athletes founded on a strong bond, reaching agreement about the goals of the therapy, and reaching agreement about the type of intervention, as these 'alliance' factors are likely to increase the effectiveness of the selected intervention.[59] Many SIPs will recognise issue with limitations of practice when considering including psychological interventions for injury prevention. Box 2[60] provides details of professional organisations that SIPs may contact, to access appropriate sport psychology professionals.

Box 2: Examples of professional sports psychology associations

- American Psychological Association (APA): http://www.apa.org/
- Association for Applied Sport Psychology (AASP): http://www.appliedsportpsych.org/
- Australian Psychological Society (APS): http://www.psychology.org.au/
- British Psychological Society (BPS): http://www.bps.org.uk/
- British Association of Sport and Exercise Sciences (BASES): http://www.bases.org.uk/
- North American Society for the Psychology of Sport and Physical Activity (NASPSPA): https://naspspa.com/

Future research directions

Replication research is needed to confirm and extend existing clinical recommendations.[57] Using established protocols such as Gardner and Moore's[61] MAC programme, which has demonstrated clinically meaningful effect size (d=0.59) in reducing

injury risk[39] makes the potential for wider replication research greater. Given the multifactorial nature of injury mechanisms,[8] we would encourage multidisciplinary working between SIPs and sport psychology practitioners in future injury prevention research.

Examining the effectiveness of less represented psychological intervention strategies (e.g. imagery training) would advance the research area. Imagery may reduce injury risk for a number of reasons. It can result in neuromuscular patterning which innervates targeted muscles in similar ways to physically performing movements. [62,63] Well-trained imagers have MRI-confirmed neurological activation that reflects actual movements.[64,65] There is also an increase in muscle activity following sports imagery training.[66] Finally, imagery may act as a coding mechanism by which athletes process and learn optimal movement patterns.[67]

Scant research in this review has delineated between traumatic and overuse injuries. This is important as the relationship between psychosocial stress and overuse injury is potentially stronger than for traumatic injuries, because of the associated physiological and behavioural outcomes of psychosocial stress. For example, a behaviour such as altered sleep that can accompany psychosocial stress is associated with elevated evening cortisol levels and supressed human growth hormone release, both of which may inhibit muscle repair post-exercise.[23] In addition, behavioural considerations such as compliance or adherence with injury prevention programmes[28] and neglecting recovery strategies[68] are also likely to increase the risk of overuse injuries. Consequently, future injury prevention studies would benefit from examining the role of behaviour change strategies in reducing overuse injuries.

Strengths and limitations of this review

The inclusive nature of the review to evaluate the overall published evidence base has likely provided a fuller picture of the existing evidence.[3] Considering each facet of effectiveness (efficacy, efficiency and compliance) as opposed to efficacy alone has also provided new insight into the body of research which has the potential for real-world

application of findings[29] and is a shift in thinking from previous reviews conducted in this area.

The inclusion criteria for this review stipulated peer-reviewed articles only, meaning that grey literature was not included. There is debate over the appropriateness of including grey literature in systematic reviews, with some suggestions that unpublished studies may enhance the findings of systematic reviews.[69] However, this recommendation is often due to publication bias whereby studies which demonstrate statistical significance and/or large effects are more likely to be published.

The search combinations used may also be considered limiting, given their strict nature, and may have increased the risk of relevant literature being missed. For example, not including specific intervention types (e.g. stress inoculation training) with 'injur*' may have increased the chances of relevant studies being missed. Equally, by using the terms 'sport injur* OR athletic injur*', this may have increased the risk of unintentionally excluding any studies which named specific injuries within the abstract (e.g. ACL rupture, hamstring strains). To address this, we used table of contents searches, forward citation searching and backward citation searching to supplement the electronic database search.

Conclusions

Psychological interventions, particularly those with a stress reduction focus such as Stress Inoculation Training, are efficient and efficacious methods of reducing sports injury rates and injury time-loss. Future investigators should be mindful of ensuring that sample sizes, statistical power and reproducibility of findings are planned for, and that appropriate reporting of processes of randomisation and reporting mechanisms for minimising selection bias takes place.

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Table 1.

Study inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Studies that evaluate the role of psychosocial interventions with the aim of reducing injury risk.	Non-English language reports
Studies that measured pre- and post-intervention injury rates.	Primary injury data not presented
First published in English language	Intervention studies that were stakeholder-facing as opposed to player facing (e.g. coach or parent intervention programmes) that did not have player-level injury data
	Textbooks, monographs, consensus statements or conference proceedings, unpublished studies
	Studies which combined psychological interventions with other techniques (e.g. neuromuscular training).

Table 2

Study appraisals

Article/Rating	Screening Questions	Quantitative (Randomised)				Quantitative (Non-randomised)				Quantitative (Descriptive)				Mixed Methods			Quality Score (%)
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	
Davis (1991)**	✓✓									x	x	x	x				0
Kerr and Goss (1996) ***	✓✓	✓	x	✓	x												50
Perna et al. (2003) **	✓✓	✓	✓	✓	✓												100
Kolt et al. (2004) ***	✓✓	x	x	✓	x												25
Arnason et al. (2005) ***	✓✓	x	x	✓	✓												50
Johnson et al. (2005) ***	✓✓	✓	x	✓	✓												75
Maddison and Prapavessis (2005) ***	✓✓	x	x	✓	x												25
Noh et al. (2007) ***	✓✓	x	x	✓	x												25
Edvardsson et al. (2012)***	✓✓	x	x	✓	✓												50
Ivarsson et al. (2015) ***	✓✓	✓	x	✓	✓												75
Traneus et al. (2015a)***	✓✓					x	✓	✓	✓								75
Traneus et al. (2015b) ***	✓✓					x	✓	✓	✓								75
Olmedilla-Zafra (2016) ***	✓✓					x	x	✓	✓								50

✓ = denotes criteria met, x = denotes criteria not met or cannot tell, shaded = not applicable criteria. *** denotes full agreement for the inclusion of the study, ** denotes majority agreement for the inclusion of the study.

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