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

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26 **ABSTRACT**

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

30 **Design:** Mixed method systematic review with best evidence synthesis

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

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

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

- 39 • **Results:** Thirteen papers (incorporating 14 studies) met the eligibility criteria, of which
40 93% (13/14) reported a decrease in injury rates (effect size range = 0.2 – 1.21). There was
41 an overall moderate risk of bias in reporting (52%). There is a dominance of stress
42 management-based interventions in literature due to the prominence of the Model of
43 Stress and Athletic Injury within the area.

44 **Summary/conclusions:** Psychological interventions demonstrate small (0.2) to large
45 (1.21) effects on sports injury rates. The research area demonstrates a cumulative
46 moderate risk in reporting bias (52%).

47 **PROSPERO registration:** CRD42016035879

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51 **What is already known and why this review is needed**

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

59 **What are the new findings?**

- 60 • 93% of studies in this review were associated with a lower sports injury rates and/or
61 injury time-loss
- 62 • Psychological interventions demonstrate a range of effect sizes (0.2 – 1.21) which suggest
63 they can contribute to injury prevention.
- 64 • Even low frequency and short duration interventions, with a low risk of bias, reduced
65 injury rates (ES = 0.2 – 0.99).
- 66 • Future studies should consider sample size estimations, completeness of outcome data,
67 reporting of attrition rates, and monitoring and reporting of compliance and adherence
68 rates more closely.

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INTRODUCTION

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77 The incidence of injury in sports range from 0.5-34 injuries/1000 hours,¹ with injury being
78 one of the leading causes of early retirement from sport.² Sports injuries have significant
79 psychosocial impacts on athletes that can influence the quality of return to sport (RTS),
80 decrease the chance of RTS^{3,4} or increase the time taken to RTS.⁵ Injuries have financial⁶ and
81 performance-related⁷ costs to teams. Injury prevention is a priority for sports injury
82 practitioners and policymakers.⁸

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

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

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

101 In addition, the focus of both the most recent reviews has been evaluating the efficacy
102 of psychological interventions, rather than their effectiveness. This is important as the
103 effectiveness of systematic injury prevention involves examining efficacy, efficiency and
104 compliance^{27,28} (see Box 1 for key terms). Knowledge of intervention effectiveness will
105 enhance understanding of sport psychology interventions in real-world environments.²⁹
106 Consequently, the research question for this systematic review was: What is the effectiveness
107 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

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METHOD

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

Search Strategy

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

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

120 The specific search strategy that was used for this review was: (sport injur* OR
121 athletic injur*) AND (intervention* OR strateg* OR prevention) AND (psychology OR
122 psychosocial factor OR psychosocial) AND (risk factors OR determinants OR predictor).

123 Relevant MeSH terms were added to these keywords to improve the accuracy of the literature
124 discovered. Peer-reviewed journals in sport psychology (Journal of Applied Sport
125 Psychology, The Sport Psychologist, Psychology of Sport and Exercise, the Journal of Sport
126 and Exercise Psychology, the International Journal of Sport and Exercise Psychology and the
127 International Journal of Sport Psychology) were also hand-searched.

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

133 **Selection Criteria**

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

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

143 **Assessing risk of bias**

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

152 **Establishing rigour**

153 The MMAT appraisal criteria were applied independently by three reviewers to
154 rigorously appraise included studies. Inter-researcher reliability of appraisals was assessed
155 using a two-way mixed, absolute agreement intra-class correlation coefficient³⁴ and
156 demonstrated high inter researcher reliability in independent study appraisal (0.98). Any
157 disagreements were resolved via consensus discussion. Consistent with recent reviews,^{3, 33,35}
158 risk of bias was viewed on the continuum: 0-25% = high risk of bias, 25 – 50% = high to
159 moderate risk of bias, 50 – 75% = moderate to low risk of bias, and 75% - 100% = low risk of
160 bias. The theory behind this is that achieving the fewest MMAT criteria demonstrates the
161 highest risk of bias and achieving more MMAT criteria reduces the risk of bias.^{3,26}

162 **Data extraction and synthesis**

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

168 relaxation) where possible. Risk of bias was assessed for each intervention type/purpose.
169 Evaluation of the overall effectiveness of interventions was based on three areas: (a) efficacy;
170 (b) efficiency; and (c) compliance²⁸.

171 **RESULTS**

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

179 **Demographic characteristics**

180 The 14 included studies reported on 1380 athletes, aged 10-33 years (mean = 18.6
181 years, SD = 2.8). Twelve articles (n=1355 participants) reported the number of male (n=868;
182 64.2%) and female (n=484; 35.8%) participants. One article,³⁶ reporting two separate studies,
183 did not provide sufficient demographic information about their participants to include them in
184 this initial descriptive analysis. Participants' level of competition ranged from international to
185 regional levels in floorball (54.1%); football (32.4%); rugby union and rugby league (3.5%);
186 gymnastics (3.2%); rowing (2.5%); ballet (2.5%); and swimming (1.8%).

187 **Study characteristics**

188 There were nine quantitative randomised, three quantitative non-randomised and one
189 quantitative descriptive studies (Table 2). There was a broad range of definitions of sports
190 injury across the studies. These included a time-loss definition of sports injury ranging from
191 one day^{37,38} to four days³⁹ of restricted or no practice before being recorded as an injury,
192 whereas others did not overtly define an injury beyond anything requiring treatment.^{18,36}

193 **Risk of bias assessment**

194 The MMAT rating of included studies (Table 2) ranged from 0% - 100% (mean =
195 51.9%, SE=7.73; 95% CI= 35.1 – 68.8), denoting an overall moderate risk of bias. The risk of
196 bias was mainly increased by studies not adequately reporting processes of randomisation
197 and/or allocation concealment and/or blinding (n=8), or not providing sufficient information
198 to be able to determine whether participant selection had minimised selection bias (n=3).

199 **Effectiveness of psychosocial interventions for injury prevention**

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

206 **Efficacy**

207 Thirteen out of the 14 studies reviewed reported fewer injuries and/or shorter time-
208 loss in the intervention group than the control group. Twelve out of 14 studies had a control
209 group to compare the effectiveness of their intervention. Interventions in these studies
210 demonstrated a range of effect sizes on reduction in injuries, from small (d = 0.2) to large (d
211 = 1.21). Supplementary table 1 provides a study-by-study breakdown of intervention
212 efficacy.

213 **Efficiency**

214 The duration of interventions ranged from 4 weeks to 8 months (mean =15.6 weeks,
215 SD =10.75). The number of intervention sessions varied from 6 to 160 (mean = 10.9, SD =
216 9.4). The duration of the individual intervention sessions ranged from 10 to 120 minutes
217 (mean =50 minutes, SD =28.4). The most frequent duration of an intervention session was

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

221 **Compliance**

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

224 **Best evidence synthesis**

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

231 **DISCUSSION**

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

237 **Psychological interventions are associated with reductions in injury rates**

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

242 practitioners may wish to consider psychosocial interventions as part of their interdisciplinary
243 injury prevention programmes.^{24,25}

244 There are different plausible explanations for the efficacy of psychological
245 interventions. Most contained a stress management component, and stress is associated with
246 injury risk.^{22,25} Periods of high stress influence cortisol and oxytocin release, which may have
247 a relationship to injury risk^{48, 49} via immune^{50,51} and pain⁴⁹ responses. Stress management
248 interventions can have a beneficial effect on these immune and pain responses.^{18,36,40-43,47}
249 Reduced stress levels are also associated with reduced amygdala activation.²⁵ This may
250 reduce injury risk as it is associated with improved attention and decision-making
251 capacity.^{25,39} This is important as decreased attention and decision-making ability is linked
252 with increased injury risk.⁵² Moreover, elevated stress can impact on neurocognitive
253 functioning and decrease neuromuscular control, which is linked with non-contact ACL
254 injuries.⁵³ Stress Inoculation Training⁵⁴ is a progressive multi-modal stress reduction
255 technique prominent in this review. It aims to reduce tension and increase attention, which
256 have both been linked with increased injury risk.^{25,39}

257 **Methodological quality of included studies**

258 Overall, the body of evidence shows a moderate risk of bias (52%). The lack of clarity
259 over processes for concealment or blinding, difficulties over assessing dropout rates, and
260 difficulties in assessing a lack of bias in sampling procedures, all contributed to this (see table
261 2). Most studies had a small sample size and few provided evidence of sample size
262 estimation. This calls into question the statistical power of the studies,^{55,56} and draws potential
263 concerns over the reproducibility of the findings.⁵⁷ There is also a lack of replication research
264 within this field.⁵⁷ The definition of injuries varied across studies, ranging from no
265 definition³⁶ to varying time-loss definitions.⁴⁰ This makes it difficult to accurately assess the
266 effectiveness of different interventions.

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

272 **Practical implications**

273 Wampold⁵⁸ noted that the factors of goal collaboration, empathy, alliance and
274 therapist effects all had greater effect sizes on treatment intervention than treatment
275 differences. Therefore, sports injury practitioners (SIPs) contemplating psychologically-
276 based interventions for injury prevention should consider creating a strong alliance with their
277 athletes founded on a strong bond, reaching agreement about the goals of the therapy, and
278 reaching agreement about the type of intervention, as these ‘alliance’ factors are likely to
279 increase the effectiveness of the selected intervention.⁵⁹ Many SIPs will recognise issue with
280 limitations of practice when considering including psychological interventions for injury
281 prevention. Box 2⁶⁰ provides details of professional organisations that SIPs may contact, to
282 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/>

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284 **Future research directions**

285 Replication research is needed to confirm and extend existing clinical
286 recommendations.⁵⁷ Using established protocols such as Gardner and Moore’s⁶¹ MAC
287 programme, which has demonstrated clinically meaningful effect size ($d=0.59$) in reducing

288 injury risk³⁹ makes the potential for wider replication research greater. Given the
289 multifactorial nature of injury mechanisms,⁸ we would encourage multidisciplinary working
290 between SIPs and sport psychology practitioners in future injury prevention research.

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

298 Scant research in this review has delineated between traumatic and overuse injuries.
299 This is important as the relationship between psychosocial stress and overuse injury is
300 potentially stronger than for traumatic injuries, because of the associated physiological and
301 behavioural outcomes of psychosocial stress. For example, a behaviour such as altered sleep
302 that can accompany psychosocial stress is associated with elevated evening cortisol levels
303 and suppressed human growth hormone release, both of which may inhibit muscle repair post-
304 exercise.²³ In addition, behavioural considerations such as compliance or adherence with
305 injury prevention programmes²⁸ and neglecting recovery strategies⁶⁸ are also likely to
306 increase the risk of overuse injuries. Consequently, future injury prevention studies would
307 benefit from examining the role of behaviour change strategies in reducing overuse injuries.

308 **Strengths and limitations of this review**

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

313 application of findings²⁹ and is a shift in thinking from previous reviews conducted in this
314 area.

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

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

329 **Conclusions**

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

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494 Table 1.

495 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).

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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.

