Sports Med (2017) 47:353–365
DOI 10.1007/s40279-016-0578-x

SYSTEMATIC REVIEW

Psychosocial Factors and Sport Injuries: Meta-analyses for Prediction and Prevention

Andreas Ivarsson[1] · Urban Johnson[1] · Mark B. Andersen[1] · Ulrika Tranaeus[2] · Andreas Stenling[3] · Magnus Lindwall[4,5]

Published online: 12 July 2016

Abstract
Background Several studies have suggested that psychosocial variables can increase the risk of becoming injured during sport participation.
Objectives The main objectives of these meta-analyses were to examine (i) the effect sizes of relationships between the psychosocial variables (suggested as injury predictors in the model of stress and athletic injury) and injury rates, and (ii) the effects of psychological interventions aimed at reducing injury occurrence (prevention).
Methods Electronic databases as well as specific sport and exercise psychology journals were searched. The literature review resulted in 48 published studies containing 161 effect sizes for injury prediction and seven effect sizes for injury prevention.
Results The results showed that stress responses ($r = 0.27$, 80 % CI [0.20, 0.33]) and history of stressors ($r = 0.13$, 80 % CI [0.11, 0.15]) had the strongest associations with injury rates. Also, the results from the path analysis showed that the stress response mediated the relationship between history of stressors and injury rates. For injury prevention studies, all studies included ($N = 7$) showed decreased injury rates in the treatment groups compared to control groups.
Conclusion The results support the model's suggestion that psychosocial variables, as well as psychologically, based interventions, can influence injury risk among athletes.

✉ Andreas Ivarsson
Andreas.Ivarsson@hh.se

[1] Center of Research on Welfare, Health and Sport, Halmstad University, Halmstad, Sweden

[2] Department of Molecular Medicine and Surgery, Karolinska Institute, Stockholm, Sweden

[3] Department of Psychology, Umeå University, Umeå, Sweden

[4] Department of Food and Nutrition, and Sport Science, University of Gothenburg, Gothenburg, Sweden

[5] Department of Psychology, University of Gothenburg, Gothenburg, Sweden

Key Points

High levels of negative life-event stress and strong stress responsivity were the two variables in the model of stress and athletic injury that had the strongest associations with injury risk.

All psychosocially-based interventions included in the review showed fewer injuries in the intervention groups in comparison to the control groups.

Psychosocially-based interventions should be considered when designing injury prevention programs.

1 Introduction

Sport injuries are common phenomena that many athletes experience every year. Data from elite soccer show that a player, on average, sustains approximately two injuries per year [1]. Sport injuries can have effects beyond sport participation at the individual, team/club, and community levels. In regards

to injury sequelae for athletes, researchers have found that injuries are one of the most common reasons for termination from sport [2]. Moreover, injuries have also been associated with cognitive and emotional reactions (e.g., perceptions of pain, sense of loss, sadness, anger, fear, grief), which in turn could influence athletes' well-being [3–5].

At team/club levels, injuries have been found to have substantial effects. Ekstrand [6], for example, reported that 1-month's participation time loss, due to injury for one starting player in international elite football (soccer), was estimated to equate to a financial loss of approximately €500,000 for the club. In addition, research has shown that injuries are associated with performance outcomes at team level in elite football. For instance, Hägglund et al. [7] found that higher injury rates, in European elite football, were associated with poorer team performance (i.e., lower rank at the end of season).

The treatment of sport injuries is also associated with major costs to healthcare systems [8]. More specifically, the Swedish Civil Contingencies Agency [9] estimated the cost associated with treatment of sport injuries to be €300–€400 million per year in Sweden. Given the high injury rates that are associated with sport participation, together with the (often) negative consequences at the individual, team/club, and community levels, preventive strategies for sport injuries should be highly valued. To develop preventive programs, it is important to first determine predictors of sport injuries. In the history of sport injury prediction and prevention, physiological and biomechanical perspectives have been dominant [10], but during the last two decades the role of psychological factors in sport injury prevention and prediction has been extensively explored [11].

The first studies that focused on pre-injury psychological factors were published more than three decades ago [12, 13]. Most of the early studies targeted personality traits [14] or life event stress [13–15] as predictor variables for sport injury occurrence. One of the limitations of the early studies was that they did not offer any theoretical explanation for the mechanisms connecting the psychological variables and injury occurrence [16]. To provide a theoretical framework to explain the relationship between psychological variables and injury occurrence, the model of stress and athletic injury was developed [17, 18]. This theoretical model suggests that the injury risk an athlete is exposed to may be influenced by the athlete's stress responses (physical/physiological or psychological/attentional changes). In their explanation of the model, Williams and Andersen [17] suggested decreases in neurocognitive and perception processes (e.g., narrowing of peripheral vision) and increases in reaction times because of being distractible and not attending to task-relevant cues, as two examples of "physiological/attentional changes" and "increased distractibility" related to the stress response category. For more information on these neurocognitive deficits and injury, please see Wilkerson [19] and Swanik et al. [20]. In the model the authors suggested that the stress response will have a bidirectional relationship with the athlete's cognitive appraisals of potentially stressful situations (e.g., practice, game competition). Both the magnitude of the stress response and the athlete's appraisals of the situation may be influenced by the interplay between various psychosocial factors, which are divided into three broad categories: personality factors, history of stressors, and coping resources. In the early version of the model [18], the authors suggested that only the history-of-stressors variable directly influences the stress response, whereas personality and coping variables both could act directly on, or moderate the effects of, the stress response. Ten years later, however, the authors argued that an athlete's history of stressors could influence the development of both an athlete's traits and coping mechanisms, and therefore they placed bidirectional arrows between the three psychosocial categories [17]. Interventions for injury prevention are also included in the model. More specifically, the authors suggested intervention approaches targeted to influence/buffer the stress response through psychosocial, physiological, and attentional pathways. This buffering effect could, in turn, decrease an athlete's risk of becoming injured.

Since the model was developed, researchers within the field have identified a number of limitations. One of the major limitations addressed in previous literature is that the model mainly focuses on cognitive stress responses [21]. Appaneal and Perna [21] suggested, in their biopsychosocial model of stress and athletic injury and health (an extension to the model of stress and athletic injury), that behavioural mechanisms associated with the stress response (e.g., impaired self-care, poor sleep quality) should be addressed together with psychological, physiological, and attentional mechanisms in injury prediction research. Also, other psychological variables, not included in the model of stress and athletic injury, have been found to be related to increased injury risk. For example, poor visual and verbal memory [20], high levels of psychophysiological fatigue [22], as well as behaviors related to ignorance of stressors and/or neglecting recovery [23] have all been found to increase the risk of becoming injured.

Another highlighted limitation is that the model does not include the roles of emotional or environmental factors (outside of stress responses) in injury risk [24]. Other models, such as the biopsychosocial sport injury risk profile [5], have also, together with cognitive and behavioral variables, included both emotions as well as environmental factors within a theoretical framework.

Even though limitations of the model of stress and athletic injury have been addressed and new, extended, models have been developed, the Williams and Andersen

[17] model is the most cited and researched. A search in an electronic database (PubMed) covering psychology, medicine, and sport showed that this model of stress and athletic injury had 99 citations just since 2014 (number of total citations from publication to July 2015 was 746). In comparison the biopsychosocial sport injury risk model had 30 citations since 2014. Accordingly, and notwithstanding mixed opinions on the model's comprehensiveness, it far outstrips any other model as a foundation for research, and it seems warranted to perform meta-analyses on published injury prevention and prediction studies that have explored the relationships suggested by Williams and Andersen.

Our first objective was to conduct a systematic review and meta-analysis of the results from all published studies that examined the relationships between psychosocial variables and injury rates suggested in Williams and Andersen [17]. By using a meta-analytic procedure, it is possible to collectively test a statistical synthesis of research findings. The first step was to examine the effect sizes of relations between the psychosocial correlates of injury rates presented in the model. The second step was to identify moderator variables that could explain variations between studies within a specific psychosocial correlate. More specifically, moderator analyses were conducted for heterogeneous effect sizes.

Also, by using a path analysis model incorporating the meta-analyzed correlation matrix, we evaluated how well the prediction part of the Williams and Andersen's [17] model fit the data provided from empirical prediction studies. Path analysis and meta-analysis procedures can complement each other "because path analysis captures interdependencies between several variables, whereas meta-analysis can only examine the relation of two variables at a time" ([25] p. 330). Because the predictive part of the Williams and Andersen [17] model suggests stress responsivity to mediate the effects of personality, history of stressors and coping, path analysis can be used to test these suggested relationships.

In the second part of our analysis we meta-analyzed the results of intervention studies that used psychosocially-based programs (suggested implicitly or explicitly in the model) to prevent sport injuries. Consistent with the procedures followed in the first part of our analysis, a second step was to investigate potential moderator variables within prevention research.

2 Methods

2.1 Literature Search

The electronic databases CINAHL, Web of Science, PubMed, and PsycINFO were searched using combinations of the keywords: 'sports injury', 'athletic injury', 'psychology', 'prediction', 'prevention', and 'intervention' (March 2015). Boolean expressions and MeSH terms were used as well as truncations adjusted to each database's guidelines. Also, the peer-reviewed journals 'Journal of Sport & Exercise Psychology', 'Journal of Sport Rehabilitation', 'Journal of Applied Sport Psychology', 'Scandinavian Journal of Medicine and Sport Science' and 'Psychology of Sport and Exercise' were manually searched. Finally, previous published review articles [17, 18] and book chapters [16] were manually searched.

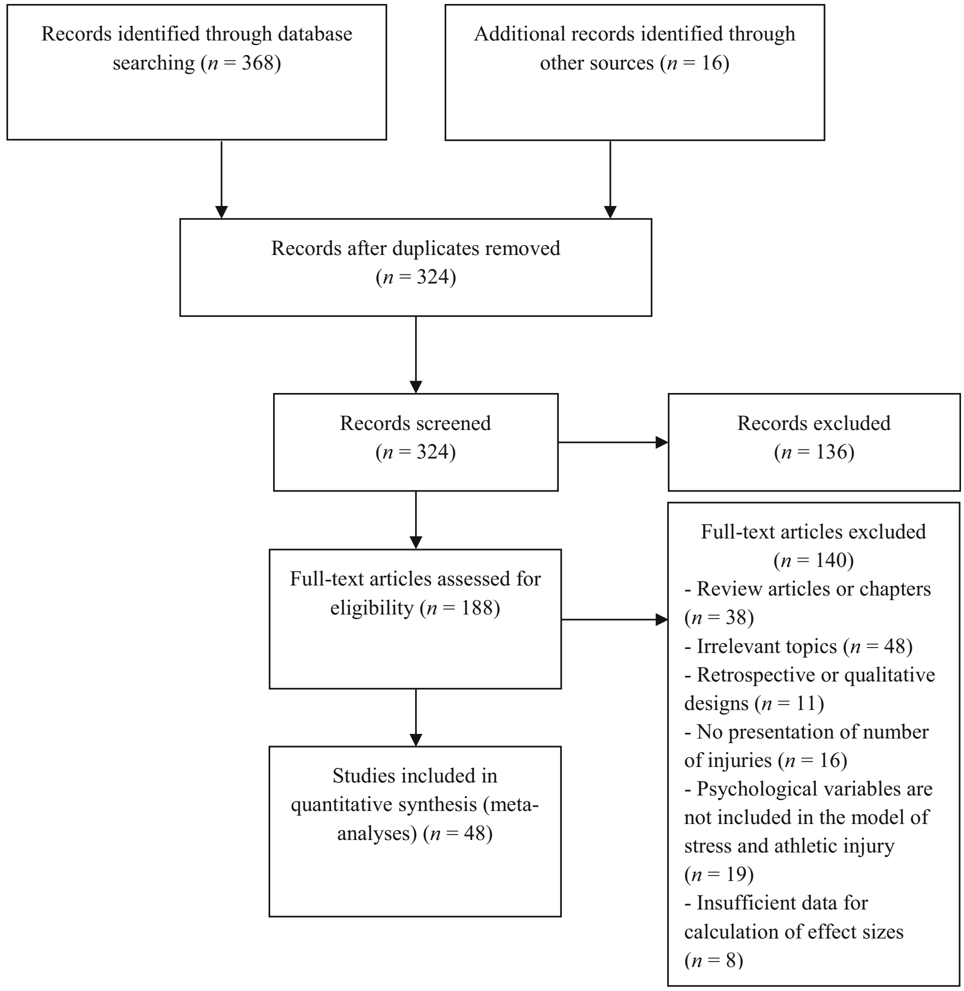
Studies were considered for inclusion in the two meta-analyses if: they were prospective or experimental studies including continuously monitored injury frequency during the study period. Because the model of stress and athletic injury is developed for traumatic injuries (i.e., the injury has a sudden onset in association with a known trauma [26]) only studies with such an injury definition were included.[1] An additional criterion was that the studies presented statistical data (e.g., means and standard deviations, t values, Pearson's r effect sizes, exact p values, Cohen's f effect sizes, z values, sample sizes) necessary for the calculation of zero-inflated Pearson's r effect sizes. For the intervention studies, an additional criterion was that the intervention program was based on recognized psychological treatments (e.g., stress management, cognitive-behavioral therapy, mindfulness training). For studies that did not report the necessary data, the corresponding authors were contacted by e-mail and asked if they had the data available. Some common reasons for exclusion were: (i) authors did not provide sufficient information for the calculation of effect sizes, and (ii) the study did not include variables that are present in the model of stress and athletic injury. The full process of the literature search is illustrated in Fig. 1. For a summary of all studies included in the meta-analyses, see Table 1 (for more specific information about the prevention studies included in the meta-analyses see Table 2).

2.2 Meta-Analytic Procedures

In our meta-analyses, we used the zero-inflated correlation coefficients as effect size estimates. To calculate the coefficients for the relationships between the variables suggested in the model, all collected effect sizes were first transformed to Fisher's z correlations. Second, all Fisher's z correlations were, to correct for sampling errors, weighted for sample size. Third, the weighted Fisher's z correlations were then used to calculate the average Fisher's

[1] None of the studies in the meta-analyses had data that were normalized for exposure time or included specific calculations for specific types of injuries.

Fig. 1 Description of the selection process for included studies



z correlation for the relationship between the variables suggested in the model. Fourth, the average Fisher's z correlation estimates, representing the effects between the variables, were transformed into zero-inflated standardized correlation coefficients. All effect sizes were corrected for measurement error [27]. This correction procedure was based on the reliabilities (i.e., coefficient alpha, test-retest reliability) for the measures obtained from the study or from prior published studies using the same instrument. For instruments with no reported reliabilities we used, in line with previous recommendations, $r_{xy} = 0.70$ [28]. All the calculations were performed using the Comprehensive Meta-Analysis software [29].

To test for heterogeneity, the I^2 statistic was used. The I^2 statistic describes the degree of inconsistency across studies included in a meta-analysis [30]. The scale ranges from 0 to 100 % where low numbers indicate small inconsistencies between studies. In the present study, moderator analyses were conducted when the I^2 reached 50 % (moderate heterogeneity between effect sizes). Two moderator analyses were performed. For the history of stressors category in the prediction studies, the type of stressor was treated as the moderator variable (total life event stress [$k = 18$] vs. negative life event stress [$k = 21$] vs. positive life event stress [$k = 19$] vs. hassles [$k = 6$] vs. previous injuries [$k = 8$]) for the history of stressors category.

The moderator tested in the prevention studies was group of participants (at risk [$k = 3$] vs. normal [$k = 4$]). In the studies that included at-risk populations, the participants were enrolled in the study if they had high scores on instruments aimed to measure stress and anxiety (scores above the 66th percentile were considered as high), as well as low scores on coping questionnaires (scores below the 33rd percentile were considered as low).

To address the potential response bias that could be present within the literature (e.g., the file-drawer problem), a fail-safe number (FSN) was calculated for each relationship tested in both the meta-analyses [31]. The FSN is used to indicate how many additional studies with mean null results should be needed to reduce the combined statistical significance to a specific alpha level (e.g., 0.05).

Table 1 Overview of the studies included in the meta-analysis

References	Type of publication	Sport type	Age group	Sample size	Participants receiving treatment	Variables included in analyses
Andersen and Williams [68]	J	Mixed	Adolescents	196	N	HoS, SR
Blackwell and McCullagh [69]	J	Football	Adolescents	105	N	HoS, NPers, C
Bond et al. [14]	J	Swimming	Adults	33	N	NPers
Brink et al. [70]	J	Soccer	Adolescents	53	N	HoS
Bum [71]	T	Mixed	Adults	320	N	HoS
Byrd [72]	T	Mixed	Adolescents	113	N	HoS, NPers, C
Coddington and Troxell [12]	J	Football	Adolescents	114	N	HoS
Cryan and Alles [13]	J	Football	Adolescents	151	N	HoS
Devantier [73]	J	Soccer	Adults	87	N	HoS, NPers, C
Edvardsson et al. [61]	J	Soccer	Adolescents	27	Y	I
Fields et al. [74]	J	Running	Adults	40	N	NPers
Galambos et al. [75]	J	Mixed	Adolescents/ adults	845	N	HoS
Gunnoe et al. [76]	J	Football	Adolescents	331	N	HoS
Hanson et al. [77]	J	Track and field	Adolescents	181	N	HoS, C
Hardy and Riehl [78]	J	Mixed	Adolescents	86	N	HoS
Ivarsson and Johnson [79]	J	Soccer	Adults	48	N	HoS
Ivarsson et al. [54]	J	Soccer	Adolescents	41	Y	I
Ivarsson et al. [66]	J	Soccer	Adolescents	101	N	HoS
Ivarsson et al. [80]	J	Soccer	Adults	56	N	NPers, HoS, C
Johnson et al. [56]	J	Soccer	Adults	32	Y	I
Johnson and Ivarsson [81]	J	Soccer	Adolescents	108	N	HoS, NPers, C
Keller et al. [82]	J	Tennis	Adolescents	60	N	NPers
Kerr and Goss [57]	J	Gymnastics	Adolescents	24	Y	I
Kerr and Minden [83]	J	Gymnastics	Adolescents	41	N	HoS; NPers
Kolt and Kirkby [84]	J	Gymnastics	Adolescents	162	N	NPers
Kontos [85]	J	Football	Adolescents	260	N	HoS
Krasnow et al. [86]	J	Dance	Adolescents	65	N	HoS
Lavallée and Flint [87]	J	Mixed	Adults	55	N	NPers
Lysens et al. [88]	J	Mixed	Adolescents	99	N	HoS
Maddison and Prapavessis [58]	J	Rugby	Adults	470 (study 1), 48 (study 2)	N (study 1), Y (study 2)	HoS, NPers, C, I
Nigorikawa et al. [89]	J	Mixed	Adolescents/ adults	2164	N	NPers
Noh et al. [90]	J	Dance	Adolescents	105	N	HoS; NPers, C
Noh et al. [60]	J	Dance	Adolescents	35	Y	I
Osborn et al. [91]	J	Ice hockey	Adults	18	N	NPers
Passer and Seese [92]	J	Football	Adolescents	104	N	HoS
Patterson et al. [93]	J	Dance	Adults	46	N	HoS, C
Quarrie et al. [94]	J	Football	Adults	258	N	HoS
Rogers and Landers [51]	J	Football	Adolescents	171	N	HoS, C, SR
Steffen et al. [95]	J	Soccer	Adolescents	1430	N	HoS, NPers, C
Swanik et al. [20]		Mixed	Adults	160	N	SR

Table 1 continued

References	Type of publication	Sport type	Age group	Sample size	Participants receiving treatment	Variables included in analyses
Tranaeus et al. [59]	J	Floorball	Adults	401	Y	I
Horst [96]	T	Football	Adults	653	N	HoS
Van Mechelen et al. [97]	J	Mixed	Adults	182	N	HoS
Vassos [98]	T	Mixed	Adolescents	119	N	HoS, NPers, C
Wadey et al. [99]	J	Mixed	Adolescents	694	N	HoS
Wadey et al. [100]	J	Mixed	Adolescents	694	N	HoS
Wilkerson [19]	J	Football	Adolescents	76	N	SR
Williams et al. [15]	J	Volleyball	Adolescents	179	N	HoS

J published in a peer reviewed journal, *T* master or doctoral thesis, *Y* studies where the participants received treatment, *N* studies where the participants did not receive treatment, *HoS* history of stressors, *NPers* personality traits that may increase stress responses, *C* coping, *SR* stress responses; *I* intervention, *Adolescents* mean age <20 y, *Adults* mean age >20 y

All results are reported using mean effect sizes as well as *p* values. A result of $p < 0.05$ was considered statistically significant. In line with the recommendations of Cohen [32], we also reported 80 % confidence intervals (CIs) around the mean effect sizes.

2.3 Path Analysis

In the second step for the injury prediction studies, we wanted to test if stress responses mediated the relationship between the three psychosocial variables/categories (i.e., personality, history of stressors, coping) and injury rates. A meta-analytic path-analysis approach using the meta-analytic structural equation modelling (MASEM) framework was applied. This framework is the only path analysis approach available for meta-analyses where none of the included studies provides effect estimates for all relationships suggested within the model [33]. In the MASEM framework, the researcher "treats the correlation matrix from each study as sufficient statistics for a group in multi-group SEM" ([27] p. 289).

The zero-inflated standard correlation coefficients were inserted into a correlation matrix. In this matrix, one cell consisted of zero identified studies (i.e., the path between personality traits and the stress response). Also, in the cell for the relationship between coping and stress response only one effect size was identified. Because using just one effect size to determine an average correlation (i.e., one cell in the correlation matrix) will not be reliable [34] we decided to consider this cell as empty as well. To deal with this problem we followed the recommendations from Landis [33]. More specifically, meta-analytic estimates from another field of research that investigated the relationship between personality traits (i.e., trait anxiety) and cognitive functions as well as between coping (i.e., active coping) and psychological distress were, therefore, included in the correlation matrix [35, 36]. Also, to obtain a more reliable estimate for the path between history of stressors and the stress response, the effect sizes from Williams et al. [37, 38] and Rogers et al. [39] found amongst the studies that were identified in the first step of the current literature review were added to the two effect sizes already included (total number of effect sizes = 6).

Based on the correlation matrix, a path analysis, using Mplus 7.3 [40], was conducted to test injury prediction. In line with previous recommendations, the harmonic mean of the sample sizes for each effect size (i.e., the sample size in each cell in the correlation matrix) included in the path model was used as the sample size in the analysis [41]. Indirect effects (Sobel method) with 95 % CIs were calculated in the path model [42]. The goodness-of-fit indices used to evaluate the model in this study were: comparative fit index (CFI), the root mean square error of approximation (RMSEA) with 90 % CIs, and the standardized root mean squared residual (SRMR). Traditional cut-off criteria (CFI >0.90, SRMR and RMSEA <0.08) were used to indicate acceptable fit [43].

3 Results

3.1 Effect Sizes of Relations Between the Psychosocial Correlates of Injury Rates

3.1.1 Prediction Studies

The zero-inflated standard correlation coefficients between the psychosocial variables included in the model and injury rates were entered in the first meta-analysis (for a summary see Table 3). The results showed that the stress response

Table 2 Characteristics of the included prevention studies

Study	Study design	Population	At-risk screening (yes/no)	Group size	Outcome	Intervention content	Study length; intervention length; sessions/time
Edvardsson et al. [61]	Quasi-experimental	High school soccer players	No	Intervention: $n = 13$ control: $n = 14$	Number of injuries, time loss due to injuries	Self-regulation techniques (thought stopping, somatic relaxation, breathing) video clips and stress management	9 weeks; 9 weeks; 7 sessions/ 30–60 min
Ivarsson et al. [54]	Matched on previous injuries, RCT	Junior elite soccer players	No	Intervention: $n = 21$ control: $n = 20$	Number of injuries, time loss due to injuries	MAC program Active control: sport psychology skills	6 months; 7 weeks: 7 sessions; 45 min
Johnson et al. [56]	RCT	Soccer players at high competitive level	Yes	Intervention: $n = 16$ control: $n = 16$	Number of injuries	Relaxation, stress management, goal setting, attribution, self-confidence, critical incidence diary	19 weeks; 19 weeks; 6 sessions/ 45–90 min
Kerr and Goss [57]	Matched on sex, age, and previous performance, RCT	Gymnasts at high level	No	Intervention: $n = 12$ control: $n = 12$	Number of injuries, time loss due to injuries	Stress management program (e.g., cognitive thought stopping, relaxation, imagery)	8 months; 8 months; 16 sessions/ 60 min
Maddison and Prapavessis [58]	RCT	Elite rugby players	Yes	Intervention: $n = 24$ control: $n = 24$	Number of injuries, time loss due to injuries	Cognitive behavioral stress management	A rugby season; 4 weeks; 6 sessions/ 90–120 min
Noh et al. [60]	Quasi experimental	Female ballet dancers	Yes	Intervention group 1: $n = 12$ Intervention group 2: $n = 11$ control: $n = 12$	Number of injuries	Autogenic training, broad-based coping skills	48 weeks; 12 weeks; 3/ week Intervention group 1: 25 min Intervention group 2: 40 min
Tranaeus et al. [59]	Cluster (team) RCT	Elite floorball players	No	Intervention: $n = 193$ control: $n = 208$	Number of injuries	Stress management, relaxation, emotion control	1 year; 3 months; 6 sessions/ 60 min

RCT randomized controlled trial, *MAC* mindfulness acceptance commitment

($r = 0.27$, 80 % CI [0.20, 0.37]) was the predictor that had the strongest associations with injury rates. Moreover, history of stressors ($r = 0.13$, 80 % CI [0.11, 0.15]) and coping ($r = -0.07$, 80 % CI [−0.10, −0.03]) had weaker relationships with injury rates. Finally, the association between personality traits and injury rates was marginal ($r = 0.01$, 80 % CI [−0.01, 0.03]).

3.1.2 Prevention Studies

For the second meta-analysis on intervention/prevention studies, the result showed that the mean effect of the difference between the intervention and control conditions was $r = -0.31$, 80 % CI [−0.41, −0.19], corresponding to a Cohen's d effect size of −0.63, 80% CI [−0.88, −0.38] (Table 3). The negative direction of the overall effect size corresponded to an effective intervention (i.e., fewer injuries in treatment conditions compared to control conditions).

3.2 Moderator Analyses for Heterogeneous Effect Sizes

3.2.1 Prediction Analysis

The results indicated large heterogeneity between the studies included in the history of stressors category

($I^2 = 86$ %). Moderate heterogeneity was found between studies in the coping ($I^2 = 62$ %) as well as in the intervention ($I^2 = 68$ %) categories, whereas small heterogeneity was found between personality ($I^2 = 35$ %) as well as stress response ($I^2 = 0$ %) studies.

In terms of the moderator analyses for the prediction studies, we found that negative life event stress ($r = 0.23$, 80 % CI [0.17, 0.29]), hassles ($r = 0.25$, 80 % CI [0.14, 0.36]), as well as previous injuries ($r = 0.18$, 80 % CI [0.13, 0.22]) had larger associations with injury occurrence compared to total life event stress ($r = 0.16$, 80 % CI [0.08, 0.24]) and positive life event stress ($r = 0.03$, 80 % CI [−0.01, 0.06]).

3.2.2 Prevention Analysis

The moderator analysis for injury prevention showed that intervention studies including at-risk samples (Cohen's $d = -0.88$, 80 % CI [−1.31, −0.44]) were more effective in decreasing injury rates in comparison to the studies using normal samples (Cohen's $d = -0.45$, 80 % CI [−0.72, −0.18]). Nevertheless, the magnitudes of the effect sizes indicated that the intervention programs were effective both for at-risk as well as normal samples.

3.3 Evaluation of the Prediction Part of the Model: A Path Analysis

The model indicated acceptable fit χ^2 (3) = 28.18, $p < 0.001$, CFI = 0.93, RMSEA = 0.06 (90 % CI [0.04, 0.09]), SRMR = 0.03. The model explained 7.3 % of the variance in injury occurrence and 7.0 % of the variance in stress responses. All paths were statistically significant ($p < 0.05$) with effects ranging from 0.08 to 0.27. All effect estimates for the different paths are provided in Fig. 2.

The unstandardized indirect effects between the psychological variables and injury frequency showed that all three variables had statistically significant indirect effects on injury frequency through stress responses: history of stressors (unstandardized estimate = 0.04, 95 % CI [0.03, 0.06], $p < 0.001$), personality traits (unstandardized estimate = 0.04, 95 % CI [0.03, 0.05], $p < 0.001$), and coping (unstandardized estimate = −0.04, 95 % CI [−0.06, −0.03], $p < 0.001$).

4 Discussion

4.1 Effect Sizes of Relations Between the Psychosocial Factors and Injury Rates

4.1.1 Prediction Studies

The result from the meta-analysis of injury prediction variables showed that the history of stressors, as well as the stress response variables, had the strongest relationships with injury rates. One explanation for the two stress variables having the strongest relationships with injury is that prolonged stress can generate changes in the functions of the brain's neurological networks [44–46]. More specifically, the communication between the left and right cerebral hemispheres may decrease when a person is exposed to stressors for extended periods. This change in network activation and communication could lead to decreased information flow between the brain functions that process affect and cognition [47]. A diminished communication between these two networks might increase the risk of poor decision-making during, for example, the stress of competition, and decreased ability in making decisions has been related to increased injury risk [48].

Concerning the result from the moderator analysis for the history of stressors variables, the result showed that it was the stress associated with negative events (i.e., negative life event stress, hassles, previous injuries) that had the strongest associations with injury rates in comparison to more positively valenced events (i.e., total life event stress, positive life event stress). One explanation for this result is that negative (or threatening) information is processed more thoroughly and has more severe and long-lasting effects on

Table 3 Results of meta-analyses and homogeneity tests for injury prediction and prevention studies

Variable	*k*	*n*	Effect size (*r*)	80 % CI	FSN	I^2 (%)
Prediction						
Personality	44	5166	0.01	−0.01, 0.03	0	35
History of stressors	72	8465	0.13	0.11, 0.15	4556	86
Coping	41	2991	−0.07	−0.10, −0.03	99	62
Stress response	4	603	0.27	0.20, 0.33	28	0
Prevention	7	608	−0.31[a]	−0.41, −0.19	48	68

k number of effect sizes, *n* total number of participants, *CI* confidence interval, *FSN* fail-safe number

[a] corresponding Cohen's $d = -0.63$, 80 % CI [−0.88, −0.38] and number needed to treat = 4.3

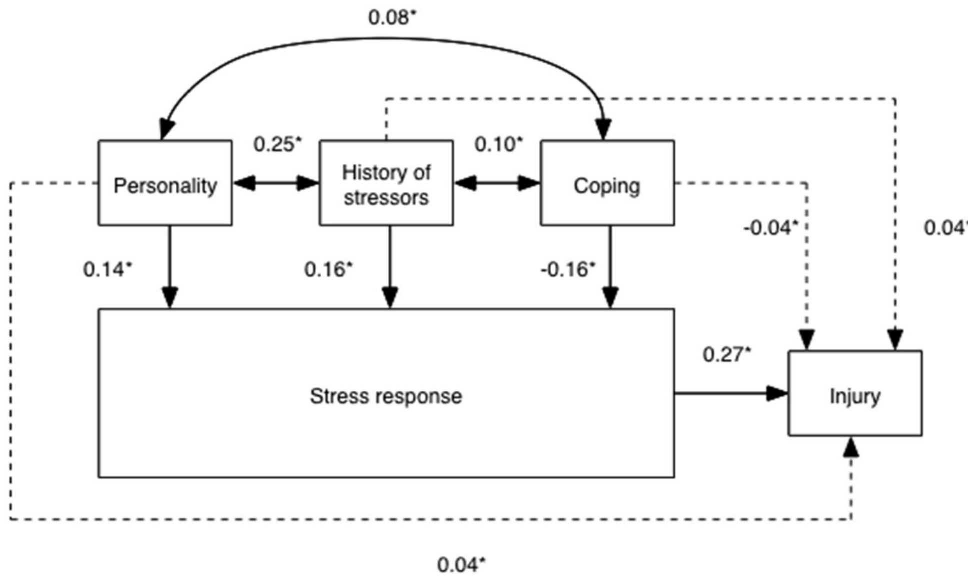


Fig. 2 Path diagram of the model of stress and athletic injury using meta-analysed correlations

behaviors than positive information has [49]. One plausible mechanism for the relationship between these long-lasting negative effects and an increase in injury risk may, for example, be the strong emotional distress responses associated with these effects [50]. Increased emotional reactivity is related to decreased activity in the parts of the brain where attention is processed [47]. This decrease in attentional capacity might increase the risk for injuries [51].

In the path analysis, the stress response was found to be a statistically significant mediator for the relationships between psychological variables (i.e., history of stressors, personality) and injury rates. This result should be viewed with caution because of the small number of studies that have investigated the path between stress response and injury rates (number of effect sizes = 4), but these results are in line with the model's suggestion that the stress response mediates the relationship between psychosocial variables and injury occurrence [17]. One explanation is that both personality traits and experiences of stressful events will have effects on the magnitude of the stress response through changed neural activation [47]. Between coping and the stress response, also, a statistically significant indirect effect was found. One potential explanation for this result is that, as previous research has suggested, adequate coping strategies will facilitate a person's decision-making processes [52]. The ability to make quick and adequate decisions during both training and competition is related to decreased injury risk [48].

4.1.2 Prevention Studies

Concerning preventive interventions based on psychological training programs, the result from the meta-analysis showed an average main effect of -0.63 (Cohen's d) indicating that psychological interventions appear effective in preventing sport injuries, especially those that target at-risk populations. Of the studies included in the meta-analysis, all interventions resulted in fewer injuries in the treatment groups in comparison to the control groups (Cohen's ds ranged between -0.10 and -1.21). Almost all interventions have, to some extent, focused on stress management techniques that target the stress process. Decreased stress levels are related to reduced amygdala activation [53], which is associated with improved attention and decision-making capacities, and this down-regulation may then help lower injury risk [54]. We would speculate that changes in the brain's functions as well as decreases in neural activation could be the mechanism (e.g., increased capacity to pay attention to relevant cues in the environment, down-regulation of sympathetic activation) behind many of the successful psychologically-based preventive interventions that have been performed within the field of sport injury prevention research. More specifically, the model explicitly states that interventions aimed at physiology (e.g., relaxation) and attention (e.g., mindfulness training) should be beneficial in reducing the stress response and injury risk. The example of mindfulness training, even though not specifically mentioned in the original Williams and Andersen model, directly addresses the stress response and the physiological and attentional changes that may lead to injury. Mindfulness has at its core paying attention (with intention) to what is happening right here in the present moment and to acknowledging current states (e.g., anxiety) but not becoming fused with those states, which usually leads to those amygdala/sympathetic activations to become down-regulated [54, 55].

One interesting aspect concerning these intervention studies is that they have used different intervention programs, such as psychological skills training [56–60], cognitive-behavioral therapy [61], and mindfulness [54], all showing similar results. One potential explanation is that all of the interventions across the studies are, in some way, directed at down-regulating stress-related brain activations that interfere with functioning on a variety of levels (e.g., attention, decision making, and neurocognitive reaction time). The interventions may look somewhat different, but their targets, in many cases, seem similar. Another potential explanation for the effectiveness of the intervention studies can be that the information provided during the intervention sessions, together with the hands-on exercises, might have influenced the athlete's motivation to engage in injury preventive behaviors as well as modify their attitudes and beliefs about behaviors and actions related to injury prevention. More specifically, information about the potential benefits of engaging in preventive behaviors together with reflections and exercises may increase the likelihood of practicing the exercises (e.g., mindfulness training) [62], and, subsequently, help reduce the risk of becoming injured.

The results from the moderator analysis of interventions with at-risk participants appeared to show more effective prevention of sport injuries than other studies where at-risk participants were not identified or selected. This result is expected because it is more likely that participants in these studies will be helped more by taking part in the intervention than participants not at risk because they have experienced high stress levels (often in combination with limited coping strategies and high anxiety levels). The differences in the magnitudes of the stress responses between the participants in the control groups and intervention groups might therefore be even larger than the differences between groups in studies where the participants were not screened for risk. That said, the mean effect sizes for the studies that have included normal samples indicate that psychologically-based training programs also have the potential to decrease the risk of becoming injured in normal populations. We therefore conclude that it could be beneficial to include psychologically-based intervention programs for injury prevention whether the athletes are at-risk or not.

4.2 Limitations

First, some of the meta-analyzed effect sizes were based on a smaller number of studies than others. This issue is especially important to consider when interpreting results involving the stress response variable and its relation to injury (number of effect sizes = 4). The results for this path should, therefore, be interpreted with caution. Second, we included an effect estimate from a meta-analysis performed outside the sport context, and that might have influenced the results. Nevertheless, we have followed the recommendations for MASEM [33], and this procedure allowed us to more fully examine the hypothesized model than has been done in individual studies. Third, because no studies have investigated the path between interventions and stress responses, this relationship was not investigated in the path model. The full model of stress and athletic injury was, therefore, not tested, and this limitation restricts us from drawing conclusions about the overall robustness of the model.

5 Conclusions

Even though stress seems to be an important construct to consider when discussing injury risk factors, the effect estimates, especially in the prediction studies, were rather small. One reason for this finding is that most of the studies included in the meta-analyses have investigated self-reported psychological constructs (neither behaviors nor decision making). Because it is likely that it is actual behaviors that will also be closely related to injury risk [21], we would suggest that behaviors will also mediate the relationships between cognitive constructs and injury risk. That behavior is important to consider in the relationship between risk factors that predispose athletes for injury risk and actual injury outcomes has been suggested in, for example, the comprehensive model for injury causation [63]. To integrate the findings from our study with the comprehensive model for injury causation we suggest that personality factors (such as anxiety) can be included as internal factors that might predispose an athlete for injury risk. Concerning life event stress and especially the magnitude of the stress response (e.g., neurocognitive processes), these variables, in relation to the findings from the meta-analysis, seems to make athletes more or less susceptible to incurring injuries. In the comprehensive model of injury causation, the authors suggest that behaviors will mediate the relationships between the various internal as well as external risk factors and injury. Because behaviors are one class of variables suggested to be closely related to injury risk [21, 63], future studies should include behavioral variables in their research designs.

Also, most of the studies included in the prediction meta-analysis used only one time point to measure the psychosocial variables, and future studies should use repeated-measures designs to determine the potential impact varying psychological states or stress levels could have on injury risk [64] (examples of studies that have used this design are: Fawkner et al. [65]; Ivarsson et al. [66]). When applying repeated-measures designs, it is also important to use analyses that take within-person changes into consideration. Most studies have used analyses that compare scores for injured athletes with scores for non-injured participants. Such between-person analyses will not be able to grasp whether the within-person changes in psychological states are related to injury risk. To detect within-person changes, researchers are recommended to use, for example, latent growth curve analysis in combination with a Cox proportional hazards model for survival data (for information about this analysis see Wang et al. [67]).

For other potential methodological limitations in relation to intervention studies, one of the major deficiencies is that none of the included interventions have measured potential mechanisms for the links between the intervention programs and injury rates. Therefore, we can only speculate about what the relationships between the interventions and the lowered injury rates actually are. Research into mechanisms (most likely neurobiological or behavioral) that explain how interventions lower injury risk needs to become a focus in future research. Also, the specific focus on the model of stress and athletic injury does not exclude the need for other similar explanatory models. For instance, future research should measure other biopsychosocial sport injury risk variables as complements to those suggested in the model of stress and athletic injury.

Given that stress seems to be the biopsychosocial construct that has the strongest relationship with injury occurrence, psychosocially-based interventions should include programs targeting stress management skills. Including psychological training programs into other types injury prevention programs (e.g., biomechanical, strength training) within sports has the potential to reduce the risk of sport injuries and may have positive outcomes for athletes, clubs, and communities.

Compliance with Ethical Standards

Funding No sources of funding were used to assist in the preparation of this article.

Conflict of interest Andreas Ivarsson, Urban Johnson, Mark Andersen, Ulrika Tranaeus, Andreas Stenling, and Magnus Lindwall declare that they have no conflicts of interest relevant to the content of this review.

References

1. Ekstrand J, Hägglund M, Waldén M. Injury incidence and injury patterns in professional football: the UEFA injury study. Br J Sports Med. 2011;45(7):553–8.
2. Drawer S, Fuller CW. Perceptions of retired professional soccer players about the provision of support services before and after retirement. Br J Sports Med. 2002;36(1):33–8.
3. Drawer S, Fuller CW. Propensity for osteoarthritis and lower limb joint pain in retired professional soccer players. Br J Sports Med. 2001;35(6):402–8.
4. Hagger MS, Chatzisarantis NLD, Griffin M, et al. Injury representations, coping, emotions, and functional outcomes in athletes with sports-related injuries: a test of self-regulation theory. J Appl Sport Psychol. 2005;35(11):2345–74.
5. Wiese-Bjornstal DM. Psychology and socioculture affect injury risk, response, and recovery in high-intensity athletes: a consensus statement. Scand J Med Sci Sports. 2010;20(Suppl 2):103–11.
6. Ekstrand J. Keeping your top players on the pitch: the key to football medicine at a professional level. Br J Sports Med. 2013;47(12):723–4.
7. Hägglund M, Waldén M, Magnusson H, et al. Injuries affect team performance negatively in professional football: an 11-year follow-up of the UEFA Champions League injury study. Br J Sports Med. 2013;47(12):738–42.
8. Frisch A, Croisier JL, Urhausen A, et al. Injuries, risk factors and prevention initiatives in youth sport. Br Med Bull. 2009;92(1):95–121.
9. Physical activities and injuries-statistics and analysis (Swedish). Swedish Civil Contigencies Agency. https://www.msb.se/RibData/Filer/pdf/25550.pdf. 2010.
10. Almeida PL, Olmedilla A, Rubio VJ, et al. Psychology in the realm of sport injury: what it is all about. Rev Psicol Deporte. 2014;23:395–400.
11. Johnson U, Tranaeus U, Ivarsson A. Current status and future challenges in psychological research of sport injury prediction and prevention: a methodological perspective. Rev Psicol Deporte. 2014;23(2):401–9.
12. Coddington RD, Troxell JR. The effect of emotional factors on football injury rates-a pilot study. J Hum Stress. 1980;6(4):3–5.
13. Cryan PD, Alles WF. The relationship between stress and college football injuries. J Sport Med Phys Fit. 1983;23(1):52–8.
14. Bond J, Miller B, Chrisfield P. Psychological prediction of injury in elite swimmers. Int J Sports Med. 1988;9(5):345–8.
15. Williams J, Tonymon P, Wadsworth W. Relationship of life stress to injury in intercollegiate volleyball. J Hum Stress. 1986;12(1):38–43.
16. Williams JM, Andersen MB. Psychosocial antecedents of sport injury and interventions for risk reduction. In: Tenenbaum G, Eklund R, editors. Handbook of sport psychology. 3rd ed. New York: Wiley; 2007. p. 379–403.
17. Williams JM, Andersen MB. Psychosocial antecedents of sport injury: review and critique of the stress and injury model. J Appl Sport Psychol. 1998;10(1):5–25.
18. Andersen MB, Williams JM. A model of stress and athletic injury—prediction and prevention. J Sport Exerc Psychol. 1988;10(3):294–306.
19. Wilkerson GB. Neurocognitive reaction time predicts lower extremity sprains and strains. Int J Athl Ther Train. 2012;17:4–9.
20. Swanik CB, Covassin T, Stearne DJ, et al. The relationship between neurocognitive function and noncontact anterior cruciate ligament injuries. Am J Sports Med. 2007;35:943–8.
21. Appaneal RN, Perna FM. Biopsychosocial model of injury. In: Eklund R, Tenenbaum G, editors. Encyclopedia of sport and exercise psychology. Thousand Oaks: SAGE Publications, Inc.; 2014. p. 74–7.
22. Liederbach, Compagno J M. Psychological aspects of fatigue-related injuries in dancers. J Dance Med Sci. 2001;5:116–120.
23. Richardson SO, Andersen MB, Morris T. Overtraining athletes: personal journeys in sport. Champaign: Human Kinetics; 2008.

24. Hackfort D, Kleinert J. Research on sport injury development: former and future approaches from an action theory perspective. Int J Sport Exerc Psychol. 2007;5(4):324–39.
25. Ng JYY, Ntoumanis N, Thogersen-Ntoumani C, et al. Self-determination theory applied to health contexts: a meta-analysis. Perspect Psychol Sci. 2012;7(4):325–40.
26. Olsen OE, Myklebust G, Engebretsen L, et al. Exercises to prevent lower limb injuries in youth sports: cluster randomised controlled trial. BMJ. 2005;330:449.
27. Card NA. Applied meta-analysis for social science research. Guilford Press: New York; 2011.
28. Cohen J, Cohen P. Applied multiple regression/correlation analysis for the behavioural sciences. Hillsdale: Erlbaum; 1983.
29. Borenstein M, Hedges L, Higgins J, et al. Comprehensive meta-analysis. Englewood: Biostat; 2009.
30. Higgins JPT, Thompson SG, Deeks JJ, et al. Measuring inconsistency in meta-analyses. BMJ. 2003;327(7414):557–60.
31. Rosenberg MS. The file-drawer problem revisited: a general weighted method for calculating fail-safe numbers in meta-analysis. Evolution. 2005;59:464–8.
32. Cohen J. Things I have learned (so far). Am Psychol. 1990;45(12):1304–12.
33. Landis RS. Successfully combining meta-analysis and structural equation modeling: recommendations and strategies. J Bus Psychol. 2013;28(3):251–61.
34. Valentine JC, Pigott TD, Rothstein HR. How many studies do you need? A primer on statistical power for meta-analysis. J Educ Behav Stat. 2010;35(2):215–47.
35. Byron K, Khazanchi S. A meta-analytic investigation of the relationship of state and trait anxiety to performance on figural and verbal creative tasks. Pers Soc Psychol Bull. 2011;37(2):269–83.
36. Kato T. Frequently used coping scales: a meta-analysis. Stress Health. 2015;31:315–23.
37. Williams JM, Tonymon P, Andersen MB. The effects of stressors and coping resources on anxiety and peripheral narrowing. J Appl Sport Psychol. 1991;3(2):126–41.
38. Williams JM, Tonymon P, Andersen MB. Effects of life-event stress on anxiety and peripheral narrowing. Behav Med. 1990;16(4):174–81.
39. Rogers TJ, Alderman BL, Landers DM. Effects on life-event stress and hardiness on peripheral vision in a real-life stress situation. Behav Med. 2003;29(1):21–6.
40. Muthén L, Muthén B. Mplus user's guide (Vol. 6). Los Angeles: Muthén & Muthén; 1998.
41. Viswesvaran C, Ones DS. Theory testing: combining psychometric meta-analysis and structural equations modeling. Pers Psychol. 1995;48(4):865–85.
42. MacKinnon DP. Introduction to statistical mediation analysis. New York: Routledge; 2008.
43. Marsh HW. Application of confirmatory factor analysis and structural equation modeling in sport and exercise psychology. In: Tenenbaum G, Eklund R, editors. Handbook of sport psychology. 3rd ed. Hoboken: Wiley; 2007. p. 774–98.
44. Fuchs E, Flugge G. Chronic social stress: effects on limbic brain structures. Physiol Behav. 2003;79(3):417–27.
45. McEwen BS. The neurobiology of stress: from serendipity to clinical relevance. Brain Res. 2000;886(1–2):172–89.
46. McEwen BS. Central effects of stress hormones in health and disease: understanding the protective and damaging effects of stress and stress mediators. Eur J Pharmacol. 2008;583(2–3):174–85.
47. Cozolino L. The neuroscience of psychotherapy: healing the social brain (Norton Series on Interpersonal Neurobiology). New York: WW Norton & Company; 2010.
48. Gabbett TJ, Ullah S, Jenkins D, et al. Skill qualities as risk factors for contact injury in professional rugby league players. J Sports Sci. 2012;30(13):1421–7.
49. Baumeister R, Bratslavsky E, Finkenauer C, et al. Bad is stronger than good. Rev Gen Psychol. 2001;5(4):323–70.
50. Berntsen D, Rubin DC, Siegler IC. Two versions of life: emotionally negative and positive life events have different roles in the organization of life story and identity. Emotion. 2011;11(5):1190–201.
51. Rogers T, Landers D. Mediating effects of peripheral vision in the life event stress/athletic injury relationship. J Sport Exerc Psychol. 2005;27(3):271–88.
52. Soares JM, Sampaio A, Ferreira LM, et al. Stress-induced changes in human decision-making are reversible. Transl Psychiatry. 2012;2:e131.
53. Davis M. Neurobiology of fear responses: the role of the amygdala. J Neuropsychiatry Clin Neurosci. 1997;9(3):382–402.
54. Ivarsson A, Johnson U, Andersen MB, et al. It pays to pay attention: a mindfulness-based program for injury prevention with soccer players. J Appl Sport Psychol. 2015;27(3):319–34.
55. Andersen MB, Ivarsson A. A methodology of loving kindness: how interpersonal neurobiology, compassion and transference can inform researcher-participant encounters and storytelling. Qual Res Sport Exerc Health. 2016;8(1):1–20.
56. Johnson U, Ekengren J, Andersen MB. Injury prevention in Sweden: helping soccer players at risk. J Sport Exerc Psychol. 2005;27(1):32–8.
57. Kerr G, Goss J. The effects of a stress management program on injuries and stress levels. J Appl Sport Psychol. 1996;8(1):109–17.
58. Maddison R, Prapavessis H. A psychological approach to the prediction and prevention of athletic injury. J Sport Exerc Psychol. 2005;27(3):289–310.
59. Tranaeus U, Johnson U, Engström B, et al. A psychological injury prevention group intervention in Swedish floorball. Knee Surg Sports Traumatol Arthrosc. 2015;23(11):3414–20.
60. Noh YE, Morris T, Andersen MB. Psychological intervention programs for reduction of injury in ballet dancers. Res Sports Med. 2007;15(1):13–32.
61. Edvardsson A, Ivarsson A, Johnson U. Is a cognitive-behavioural biofeedback intervention useful to reduce injury risk in junior football players? J Sci Med Sport. 2012;11(2):331–8.
62. Chan DKC, Hagger M. Theoretical integration and the psychology of sport injury prevention. Sports Med. 2012;42(9):725–32.
63. Bahr R, Krosshaug T. Understanding injury mechanisms: a key component of preventing injuries in sport. Br J Sports Med. 2005;39:324–9.
64. Shrier I, Raglin JS, Levitan EB, et al. Procedures for assessing psychological predictors of injuries in circus artists: a pilot prospective study. BMC Med Res Methodol. 2014;14:77.
65. Fawkner HJ, McMurrary NE, Summers JJ. Athletic injury and minor life events: a prospective study. J Sci Med Sport. 1999;2(2):117–24.
66. Ivarsson A, Johnson U, Lindwall M, et al. Psychosocial stress as a predictor of injury in elite junior soccer: a latent growth curve analysis. J Sci Med Sport. 2014;17(4):366–70.
67. Wang P, Shen W, Boye ME. Joint modeling of longitudinal outcomes and survival using latent growth modeling approach in a mesothelioma trial. Health Serv Outcomes Res Methodol. 2012;12(2–3):182–99.
68. Andersen M, Williams J. Athletic injury, psychosocial factors and perceptual changes during stress. J Sports Sci. 1999;17(9):735–41.

69. Blackwell B, McCullagh P. The relationship of athletic injury to life stress, competitive anxiety and coping resources. Athl Train. 1990;25(1):23–7.
70. Brink MS, Visscher C, Arends S, et al. Monitoring stress and recovery: new insights for the prevention of injuries and illnesses in elite youth soccer players. Br J Sports Med. 2010;44(11):809–15.
71. Bum D. Stress, attention and sports injury [Doctoral dissertation]: Victoria University of Technology; 1998.
72. Byrd B. The relationship of history of stressors, personality, and coping resources, with the incidence of athletic injuries [Master's thesis]: University of Colorado at Boulder; 1993.
73. Devantier C. Psychological predictors of injury among professional soccer players. Sport Sci Rev. 2011;20(5–6):5–36.
74. Fields KB, Delaney M, Hinkle JS. A Prospective-study of type—a behavior and running injuries. J Fam Pract. 1990;30(4):425–9.
75. Galambos S, Terry P, Moyle G, et al. Psychological predictors of injury among elite athletes. Br J Sports Med. 2005;39(6):351–4 (discussion 4).
76. Gunnoe AJ, Horodyski M, Tennant LK, et al. The effect of life events on incidence of injury in high school football players. J Athl Train. 2001;36(2):150.
77. Hanson SJ, McCullagh P, Tonymon P. The relationship of personality-characteristics, life stress, and coping resources to athletic injury. J Sport Exerc Psychol. 1992;14(3):262–72.
78. Hardy C, Riehl R. An examination of the life stress-injury relationship among noncontact sport participants. Behav Med. 1988;14(3):113–8.
79. Ivarsson A, Johnson U. Psychological factors as predictors of injuries among senior soccer players. A prospective study. J Sci Med Sport. 2010;9(2):347–52.
80. Ivarsson A, Johnson U, Podlog L. Psychological predictors of injury occurrence: a prospective investigation of professional Swedish soccer players. J Sport Rehabil. 2013;22:8.
81. Johnson U, Ivarsson A. Psychological predictors of sport injuries among junior soccer players. Scand J Med Sci Sports. 2011;21(1):129–36.
82. Keller B, Braga AM, Coelho RW. Relationship between personality trait and muscle injuries in tennis players. Rev Bras Med Esporte. 2013;19(2):120–2.
83. Kerr G, Minden H. Psychological-factors related to the occurrence of athletic injuries. J Sport Exerc Psychol. 1988;10(2):167–73.
84. Kolt G, Kirkby R. Injury in Australian female competitive gymnasts: a psychological perspective. J Physiother. 1996;42(2):121–6.
85. Kontos A. Perceived risk, risk taking, estimation of ability and injury among adolescent sport participants. J Pediatr Psychol. 2004;29(6):447–55.
86. Krasnow D, Mainwaring LM, Kerr G. Injury, stress, and perfectionism in young dancers and gymnasts. J Dance Med Sci. 1999;3(2):51–8.
87. Lavallee L, Flint F. The relationship of stress, competitive anxiety, mood state, and social support to athletic injury. J Athl Train. 1996;31(4):296–9.
88. Lysens R, Vanden Auweele Y, Ostyn M. The relationship between psychosocial factors and sports injuries. J Sports Med Phys Fit. 1986;26(1):77–84.
89. Nigorikawa T, Oishi K, Yasukawa M, et al. Type A behavior pattern and sports injuries. Jpn J Phys Fit Sport Med. 2003;52(4):359–67.
90. Noh YE, Morris T, Andersen MB. Psychosocial factors and ballet injuries. Int J Sport Exerc Psychol. 2005;3(1):79–90.
91. Osborn ZH, Blanton PD, Schwebel DC. Personality and injury risk among professional hockey players. J Inj Violence Res. 2009;1(1):15–9.
92. Passer M, Seese M. Life stress and athletic injury: examination of positive versus negative events and three moderator variables. J Hum Stress. 1983;9(4):11–6.
93. Patterson EL, Smith RE, Everett JJ, et al. Psychosocial factors as predictors of ballet injuries: Interactive effects of life stress and social support. J Sport Behav. 1998;21(1):101.
94. Quarrie KL, Alsop JC, Waller AE, et al. The New Zealand rugby injury and performance project. VI. A prospective cohort study of risk factors for injury in rugby union football. Br J Sports Med. 2001;35(3):157–66.
95. Steffen K, Pensgaard AM, Bahr R. Self-reported psychological characteristics as risk factors for injuries in female youth football. Scand J Med Sci Sports. 2009;19(3):442–51.
96. Horst N. Risk factors for recurrent injuries in male amateur soccer players: a prospective cohort study. [Master's thesis]: Utrecht University, Utrecht, Netherlands; 2012.
97. van Mechelen W, Twisk J, Molendijk A, et al. Subject-related risk factors for sports injuries: a 1-yr prospective study in young adults. Med Sci Sport Exerc. 1996;28(9):1171–9.
98. Vassos MV. An exploration of the psychometric properties of the Test of Attentional and Interpersonal Style 2 and its ability to predict athletic injury [Doctoral dissertation]: RMIT University; 2009.
99. Wadey R, Evans L, Hanton S, et al. An examination of hardiness throughout the sport injury process. Br J Health Psychol. 2012;17(1):103–28.
100. Wadey R, Evans L, Hanton S, et al. Effect of dispositional optimism before and after injury. Med Sci Sport Exerc. 2013;45(2):387–94.