

Incidence of Injury, Psychological Correlates, and Injury Prevention Strategies for Elite Sport

Sandor A. Galambos (sandor.galambos@srq.qld.gov.au)

Centre of Excellence for Applied Sport Science Research
Queensland Academy of Sport, PO Box 956, Sunnybank QLD 4109 Australia

Peter C. Terry (terryp@usq.edu.au)

Department of Psychology
University of Southern Queensland, Toowoomba QLD 4350 Australia

Gene M. Moyle (gene.moyle@srq.qld.gov.au)

Centre of Excellence for Applied Sport Science Research
Queensland Academy of Sport, PO Box 956, Sunnybank QLD 4109 Australia

Abstract

Research has highlighted the high incidence of injuries among elite athletes. The present investigation established the incidence and psychological correlates of injury at the Queensland Academy of Sport (QAS) prior to implementing an injury prevention strategy. In Study 1, 845 scholarship athletes (433 females and 412 males) from 20 sports completed, over a three-year period (2002 – 2004), the QAS Health Screening Questionnaire, which included measures of life stress and mood, plus questions about general health, history of injury and psychological disorders, and current injury status. Athlete norms for the psychological scales using a “past month” response timeframe were established. Overall, 67% of participating athletes had been injured during the previous 12 months, and 18% were injured at the time of the survey. Most common injury sites were knee/leg/thigh (29%), ankle/foot (21%) and neck/spine/torso (19%). Injury status was predicted from life stress and mood scores with 60% accuracy. In Study 2, a cognitive-behavioral stress management program was designed and implemented with QAS athletes over a 12-week period, which included proprioceptive awareness training, relaxation techniques, cognitive restructuring, and imagery training. Measures of salivary cortisol and a range of psychological indicators were taken weekly.

Introduction

The typology and incidence of injuries in competitive sport and the psychological factors impacting upon injury risk are well documented (Van Mechelen, Hlobil, & Kemper, 1992; Williams, 2001). Many risk factors are physical in nature, such as anatomical predispositions, suboptimal playing equipment or surface and biomechanical faults, which combine with rare or random events during competition or practice to cause acute injury. Such events are somewhat inevitable in sport, making injuries an occupational hazard, although athletes often have some forewarning of

impending danger, allowing time for selecting and implementing corrective action to avoid or mitigate injury outcomes. However, perceptual narrowing due to concurrent psychological and physical stressors and the resulting high allostatic load, may interfere with the timely recognition of, and appropriate responses to, situational danger signals (McEwen, 2003; Williams & Andersen, 1998), although proprioceptive training using balance mats and wobble boards to simulate emergency motor patterns has recently been shown to be effective in reducing serious knee injury rates among elite handball players (e.g., Myklebust et al., 2003).

The most influential stress and sport injury model was originally proposed by Andersen and Williams (1988) and has been extended recently by Petrie and Perna (2004). The model posits that psychological risk factors are mediated by the cumulative effects of acute and/or chronic physiological stress responses, a proposal supported in more than 30 studies (Williams, 2001). In particular, cortisol, as an index of cumulative physiological stress, has been shown to be linked to negative affect in recovery-oriented research and investigations in psychoneuroendocrinology (see Davis, Botterill, & MacNeill, 2002; McEwen, 2003).

The effect of psychological interventions on injury is the least-researched aspect of the model. Only six published studies were found (see Table 1) that have evaluated psychological interventions to reduce injuries (Davis, 1991; Kerr & Goss, 1996; Maddison & Prapavessis, 1005; Perna et al., 2003; Schomer, 1990; May & Brown, 1989) and only two have been published since a comprehensive review of this aspect of the model by Durso-Cupal (1998). Interventions typically include techniques such as breathing control, muscular relaxation, imagery, and cognitive restructuring, and despite using different methodologies, definitional frameworks, and sport contexts, all these studies point to substantial potential for reducing injury rates and associated lost time.

Table 1: Injury prevention intervention studies.

Study	N	Participants	Intervention(s)	Intervention effects
May and Brown (1989)	18	Olympic alpine skiers	Complex	Reduced number of injuries, increased self-control and self-confidence
Schomer (1990)	10	Marathon runners	Cognitive strategy training (attentional strategies)	Heavy training without overuse injuries
Davis (1991)	25	Collegiate swimmers and football players	Stress management, sport specific imagery	52% and 28-33% reduction in swimming and severe football injuries, respectively
Kerr and Goss (1996)	24	Elite gymnasts	Stress management	Reduced injury incidence (not significant statistically) and stress levels
Perna et al. (2003)	34	Varsity and junior varsity collegiate rowers	Cognitive-behavioral stress management in stress inoculation training (SIT) format	Reduced days missed through injury and illness (by about two-thirds) and fewer health services visits (by about half)
Maddison and Prapavessis (2005)	470	Rugby union and rugby league players	Cognitive-behavioral stress management in SIT format	Injury rate reduced by 47% (not significant statistically) and time lost by 40% in treatment condition

In a typical year, the Queensland Academy of Sport (QAS) supports approximately 700 athletes across more than 20 sports. Given the cost of injuries, in terms of time out of sport with consequent detraining, the expense of rehabilitation, and adverse social and economic effects (see Van Mechelen et al., 1992), comprehensive injury prevention and management is a priority research area at the QAS Centre of Excellence for Applied Sport Science Research. The potential for developing cost-effective, preventative, psychological interventions clearly warrants further concurrent examination of the psychological and physiological predictors of injury in larger mixed samples of elite athletes. To begin to address this challenge, Study 1 established baseline injury indices and examined links between measures of mood and life stress with indices of general health, history of injury, psychological disorder, and current injury status in a mixed elite athlete population — scholarship athletes at the QAS.

Study 2 focused on developing an athlete-friendly and effective cognitive-behavioral stress management (CBSM) program. Except for the Maddison and Prapavessis (2005) study, it was not possible to obtain detailed intervention protocols used in previous studies. This necessitated in-house development of a CBSM program specifically designed for QAS athletes.

Rigorous evaluation of the program is ongoing at the time of writing and involves weekly measures of salivary cortisol as a physiological indicator of cumulative stress and a range of psychological stress indicators over a 12-week period to evaluate program effects on injury indices and lost time. However, given the general lack of available psychological intervention protocols directed toward injury *prevention* rather than effective rehabilitation, the authors felt it worthwhile to

detail the theoretical and practical considerations involved in developing a theory-consistent and effective CBSM program and the preliminary qualitative evaluations available.

Study 1 - Method

Participants

Data from 845 scholarship athletes (433 females and 412 males) at the Queensland Academy of Sport in Brisbane, Australia, who completed the QAS Health Screening Questionnaire between 2002 and 2004, were used to establish baseline injury incidence. A subset of 233 athletes (116 females and 117 males) who were uninjured or completely recovered from injury was utilised to investigate prospectively the effectiveness of psychological measures to predict injury. The whole sample was used in establishing psychometric norms. The sample represented 20 sports.

Measures

The QAS Health Screening Questionnaire was used to collect the data. This 374-item questionnaire is divided into sections such as demographic, general medical and orthopaedic history, injury-related time loss, nutrition, psychological health, etc.

Injury. Injury was operationalized as all medically-attended, sport-related damage to the body (Finch, 1997). The orthopaedic history section has 108 questions recording acute traumatic and chronic overuse type of orthopaedic incidents by 12 body regions (e.g., neck, shoulder, upper arm, thigh, knee, toes, etc.). Ninety-six questions cover common sport-

related injuries (e.g., traumatic fracture, stress fracture, dislocation, bursitis, etc.) by body region. Athletes identify specific incidents in time categories: *never*, *within one year*, or *more than 12 months ago*.

Time loss. Injury-related time loss was recorded in four categories (*nil*, *1-7 days*, *8-14 days* and *>14 days*) for 10 common typologies summarising the region-by-region orthopaedic history (i.e., traumatic fractures, stress fractures, tendonitis or tendon injury, joint injury or tear, etc.).

Psychological measures. In addition to recording history of psychological disorders and disturbed eating behaviours, the QAS Health Screening Questionnaire includes the Brunel Mood Scale (BRUMS: Terry, Lane, & Fogarty, 2003; Terry, Lane, Lane, & Keohane, 1999) and the Perceived Stress Scale-10 (PSS-10: Cohen, Kamarck, & Mermelstein, 1983). The BRUMS is a 24-item, self-report measure with six subscales (anger, confusion, depression, fatigue, tension, vigour) of four items each. The standard response timeframe is "How you feel *right now*" although other timeframes can be used. For the purposes of QAS screening, the response timeframe used was "How you have felt during the *past month including today*". The PSS-10 is a 10-item, self-report inventory that assesses the degree to which respondents have found their lives stressful during the past month. The standard response timeframe is "In the last month how often have you felt that you were unable to control the important things in your life?"

Results

Since no gender differences were found on initial analyses, males and females were grouped together for further analysis. Overall, 67% of participating athletes had been injured during the previous 12 months, and 18% were injured at the time of participation. The most common injury sites were knee/leg/thigh (29%), ankle/foot (21%) and neck/spine/torso (19%).

Normative data for the mood and stress scales specific to the whole sample of QAS elite athletes were produced and are available on request. Compared with existing norms (Terry et al., 2003), mean BRUMS scores for anger, confusion, depression, fatigue, tension, and vigor fell at the 65th, 52nd, 57th, 61st, 46th, and 55th percentiles, respectively. Use of the "past month" response time frame compared with "right now" has been shown to generally inflate scores on mood scales and partially explains these differences (Winkelman, Knauper, & Schwarz, 1998). However, the lower tension scores run counter to this trend and mean scores for anger and fatigue, being respectively 1.5 and 1 standard deviations above the existing norms, suggest that QAS athletes typically report moods that may be uncharacteristic of general athletic populations, thereby justifying use of population-specific normative data in planned studies.

In the uninjured subset of athletes, BRUMS and PSS-10 scores collectively explained 9.6% of the variance in injury status [$F_{(7, 225)} = 3.43, p = .002$] and 9.9% of time lost [$F_{(7, 225)} = 3.52, p = .001$]. Unique contributions of 2.1% ($p = .02$) and 1.8% ($p = .04$) of variance for time lost were identified for BRUMS depression and vigour, respectively.

Discussion

Results have established baseline incidence of injury and time lost at the QAS, and have shown that the BRUMS and PSS-10, even when controlling for the potential confound of ongoing injury problems, are only moderately effective in explaining observed injury and time loss characteristics. Findings support a psychobiological orientation to injury prevention, as it seems unlikely that substantial advancement would be achieved through exclusive reliance on psychological predictors without monitoring cumulative physiological indicators of injury risk (e.g., free cortisol level) at the same time (Perna et al., 2003).

Study 2: Intervention Development

Theoretical considerations

Stress or allostasis is generally seen as the demand associated with resourcing all ongoing adjustments in the body related to its overall energy utilization and control of the processes involved (Selye, 1976). Psychological definitions of stress tend to emphasise the outcome of cognitive appraisals of excessive demand over available coping resources (Lazarus & Folkman, 1984) and therefore refer to perceived distress only. In essence, perceived distress is an internal cognitive stimulus in the brain that can initialize autonomous (neural and/or endocrine) stress responses or amplify those mounted in response to external stressor stimuli.

In view of the above, to truly qualify as cognitive behavioral stress management (CBSM), techniques should effectively prevent developing perceived stress states in the absence of external stimuli and/or prevent cognitive exaggerations of perceived stress states in response to objective stimuli. Hence, the effect of using such techniques should be reflected in both psychometric and biological correlates of stress.

Breathing control, muscular relaxation, imagery, and cognitive restructuring are effective and well researched stress management techniques in clinical settings and in the context of sport performance (see Jones & Hardy, 1990; Lehrer & Woolfolk, 1993). These techniques are also supported by contemporary functional neuro-anatomical and physiological understanding, are relatively cheap to implement, and have many different performance-related implementations; yet they appear to be generally underutilized in the sport domain. To maximise athlete compliance, identification of possible

reasons for the apparent underutilization was deemed to be important in the lead-up to our ongoing prospective investigation into the effectiveness of these techniques in injury prevention. Hence, in developing the intervention, it was important to give due consideration to both the authenticity (i.e., staying true to the underlying theory) and palatability (i.e., being comprehensible and appealing to athletes) of the techniques included.

In terms of authenticity, given the high physical stressor loads in sport and the increased probability of injury associated with acute depletion of physical resources, it was judged essential that the breathing optimization techniques to be included were focused on learning to identify very slight feelings of effort or internal discomfort and adjusting breathing mechanics back to optimum. Similarly, with relaxation training, authenticity demanded the focus be on attaining conscious control over automatic, inappropriate, stress-related tone patterns because it is typically these sorts of subliminal activations that reduce fluidity of motion, detrimentally affecting performance and increasing injury risk.

Intervention design

To assess palatability, four focus groups were recruited involving a total of 17 athletes. In addition to the interventions used by Maddison & Prapavessis (2005), relevant elements (breathing control, muscular relaxation, imagery, and cognitive restructuring) available in 16 clinical and sport-related training protocols (e.g., Hale, 1998; Winter & Martin, 1993) were qualitatively evaluated by the focus groups.

Different implementations of the relevant techniques were discussed, focusing on whether participants were able to understand what the techniques were, why they were relevant to performance and/or injury prevention, and how helpful the presented materials appeared to be. Our focus was on obtaining first-hand, practical suggestions from athletes on how to make presentations more useable and athlete-friendly. The techniques presented were generally regarded as straightforward and easy to understand. However, simplified but scientifically sound conceptualisations of techniques coupled with anatomical illustrations and/or activities allowing immediate feedback were consistently preferred and perceived as more credible than faith-based, authoritative and/or esoteric conceptualisations (e.g., simultaneously evaluating the effect of breathing control on pulse rate changes and mental state changes as opposed to an assertion that the technique improves focusing). Lack of “good” illustrations was a main issue raised about most of the evaluated print materials. Predominantly text-based materials were consistently deemed to be “very boring.”

Categorical distinctions such as body-to-mind as physical (e.g., breathing control or progressive relaxation) vs. mind-to-body as cognitive techniques

(e.g., cognitive restructuring) appear to hinder rather than facilitate recognition of common conceptual underpinnings of CBSM techniques such as improved awareness of internal sensory (e.g., proprioceptive) and/or cognitive stimuli (e.g., attitudes and related emotions) that enables intentional though indirect control of some of the autonomous stress responses.

Following feedback from the focus groups, a Stress Inoculation Training (SIT: Meichenbaum, 1985) format was chosen for the intervention. The essence of this approach is to utilise a three-phase approach of conceptualisation, skill acquisition, and application to introduce the various components of a CBSM intervention. The resultant program, which is currently under evaluation, included proprioceptive awareness training using breathing optimisation and muscular relaxation, plus modules on imagery and cognitive restructuring, presented over seven sessions, with a follow-up period of 12 weeks during which measures of salivary cortisol and self-reports of mood, perceived stress, and recovery were taken.

Discussion

Most of the theoretical bases of CBSM for injury prevention were established in the first half of the 20th century (e.g., Jacobson, 1938; Selye, 1936) yet psychological protocols consistently implementing known physiological and neuroanatomical principles are practically non-existent. In athlete populations, the major component of stress or allostatic load is physical in origin and related to sport itself. The magnitude of potential benefits of somatically-oriented CBSM protocols in injury prevention suggested by the small number of available studies (see Table 1) is consistent with a setting where physical stressors predominate.

The main psychological issue in CBSM is to increase awareness of “self operations control” at levels that can safely be ignored at low physical load conditions (Jacobson, 1964). The present qualitative evaluations suggest that a psychobiological approach to conceptualisations of stress management needs and techniques in sport and an instructional rather than suggestive or authoritative training style is the best fit for athletic populations. The general lack of CBSM protocols that fit this description points to the need to develop and standardise such protocols.

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