

Review

Psychology and socioculture affect injury risk, response, and recovery in high-intensity athletes: a consensus statement

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This consensus statement summarizes key contemporary research themes relevant to understanding the psychology and socioculture of sport injury. Special consideration is given toward high-intensity sport in which elite athlete training and performance efforts are characterized by explosive physical speed and strength, mental fortitude to push physical limits, and maximum effort and commitment to highly challenging goals associated with achieving exceptional performance. Sport injury occurrence in high-intensity sport is an adverse and stressful health event associated with a complex multitude of risks, consequences and outcomes. A biopsychosocial (Engel, 1980) view is advocated which contextualizes an understanding of the

psychological aspects of sport injury in light of influential sociocultural, ethical, and biomedical issues. Outcomes related to athlete health and performance excellence are of equal importance in considering how psychological scholarship, expertise and services can be used to improve efforts focused on the prevention and management of sport injury among high-intensity athletes. The consensus view is that psychology and socioculture do affect sport injury risk, response and recovery in high-intensity athletes, and that continued efforts in psychological research and professional practice are needed to protect athlete physical and mental health and contribute toward performance excellence and career longevity.

Multidisciplinary efforts to understand sport injury risk, response, and recovery are at the forefront of those concerned with the health of high-intensity athletes. The unique demands of short duration high-intensity sport – such as heavy training volume, tedious and repetitious exercise, high pain tolerance, intermittent or continuous bursts of all-out effort, and contact with opponents or exposure to other physical hazards – are associated with sport injury and inter-related health risks like overtraining, burnout, and disordered eating. Scholarship blending the biological, behavioral, and social sciences – a biopsychosocial approach – advances our understanding of the complex etiology associated with sport injury, and the multitude of variables affecting response, recovery, and prevention. This paper overviews current literature outlining ways in which sport psychology and socioculture influence injury occurrence and response in high-intensity athletes contextualized within a broad biopsychosocial framework. Sport psychology is defined as the cognitions, affects, and behaviors of sport participants, and sport socioculture as the social and cultural structures, climates and processes influencing sport participants. In line with the ethic of elite sport organizations (e.g., International Olympic Committee, 2009), high-intensity athlete (a) health and (b)

sport training and performance are both central outcomes of concern in assessing the roles of psychology and socioculture in sport injury.

Definition and surveillance considerations

Understanding the public health nature of the problem of sport injury involves definition and documentation. Although significant variability exists among definitions used for sport injury investigations, among their most common elements are that: (a) the injury was incurred while training for or competing in a sport, (b) medical care was sought, and (c) time loss from practice, training and/or competition occurred (Hootman et al., 2007). Current efforts advocate for broader, more inclusive definitions of sport injury that not only encompass time-loss based injuries, but also “transient” injuries that do not involve time loss (Hodgson et al., 2007). These injuries may not (a) result in time loss because of the normative culture of sport that expects athletes to “carry on” and train and compete even when injured, (b) be reported by athletes for fear of being denied a chance by medical professionals or coaches to train or compete, and/or (c) be intrusive enough in and of themselves to prevent participation,

but nonetheless still have undesirable consequences for health, performance, and further injury vulnerability.

Causes and types of sport injury most broadly reflect a spectrum ranging from microtrauma (overuse, cumulative trauma over time) to macrotrauma (acute, specific traumatic event), and along with the structural damage common to both there may be a chronicity (unremitting or recurring) outcome being potentially characteristic of either (e.g., chronic tendinitis, chronic ankle sprains). These aspects of sport injury also have psychosocial underpinnings. For example, along with the exponential growth in numbers of intensely training youth athletes has come significant increases in microtrauma or overuse injuries; evidence suggests that youth athletes would otherwise rarely sustain these injuries if not being “trained” or “pressured,” often to excess, by someone such as a parent or coach. Current trends toward early and demanding sport specialization, overtraining and burnout, supervision by ill-trained coaches, and inadequate recovery intervals become normative experiences for many young athletes, and hold consequences for sport injury susceptibility and the associated health and performance outcomes.

The power and team sport nature of many high-intensity exercise sports also puts athletes at significant risk for macrotrauma orthopedic and brain injuries. Many of these injuries are artifacts of psychological and sociocultural processes that engrain a normative sport culture of ignoring pain and injury in quests for impression management (e.g., displaying toughness or earning respect) and performance success (e.g., a willingness to do whatever it takes to win, including sacrificing health). But the extent, severity, and lifespan health consequences of orthopedic damage, brain injury, and physiological excess exact an often heavy price for adherence to this normative socioculture. Chronicity outcomes have psychosocial implications for short-term impacts on such aspects as anxiety, confidence, and interpersonal relationships during the training and competing years, as well as post-career lifespan implications for factors such as quality of life and functional autonomy.

From a surveillance standpoint, in order to obtain accurate estimations of sport injury incidence and associated psychosocial causes and consequences a three element definition is suggested (Hodgson et al., 2007): sport injury incidence as (a) risk (number of athletes at risk to injured athlete ratio), (b) rate (incidence vs exposure), and (c) treatments (seeking medical care). The roles of psychology and socioculture are apparent in all of these, such as for (a) risk, which could be related to the nature of the sport chosen and the type of athlete personality that chooses it (e.g., high sensation seeking athletes and more risky sport choices and training behaviors), (b) rate, which is related to higher exposures associated

with increased levels of training intensity and competitive play (e.g., a child athlete transitioning from a lower to a more intense talent development stage), and (c) treatments, which is related to the normative sport culture of athletes downplaying injury reporting so as to “stay in the game” (e.g., failing to report a concussion).

Socioculture influences

The normative culture of high-intensity sport is such that athletes learn through socialization experiences into the normative ethos of sport that the expectation is for them be “tough” and play through pain and injury. Writings on the ethics of sport and sports medicine question whether participation and risk in sport as related to injury and other negative health outcomes is voluntary or coerced through social pressure mechanisms (Murphy & Waddington, 2007) such as organizational stress (Fletcher & Hanton, 2003), and raise issues related to the often incongruous ethics of health and sport performance (Mathias, 2005). The willingness to sacrifice ethics, health, or common sense in pursuit of high achievement in sport is highly visible through many actions of athletes such as willingness to use drugs to mask pain (e.g., Tricker, 2000). Playing through pain and injury has been the subject of study in a variety of high-intensity sports (e.g., gymnastics, see Nippert, 2005; rowing, see Pike & Maguire, 2003). Others have considered influences of sociodemographic factors such as gender (e.g., Charlesworth & Young, 2006) and age (e.g., Wiese-Bjornstal, 2003) on the willingness to train and compete while in pain or injured, physical activity risk taking and injury incidence (e.g., Kontos, 2004), response to sport injury (e.g., Henert, 2000), and differential incidence of injury (e.g., Renstrom et al., 2008).

Relevant also are examinations of the social norms of accepted behavior when participants sustain injury, such as the common practice of using bodies or other coverage to shield an injured player from spectator view, kicking the ball out of bounds in football/soccer so as to allow an injured athlete to receive medical attention (Hardman, 2009), or the demonstration of sportsmanship evident in the story of collegiate softball players carrying an anterior cruciate ligament (ACL)-injured opponent around the bases thus enabling her to score the winning run for her team (Lake, 2009). The counterpart socioculture and acceptability of aggressive and/or illegal behavior also relates to sport injury risk and response, with a significant number of athlete injuries related to illegal behavior (e.g., Collins et al., 2008), and athletes injured as a result of illegal behavior perhaps more likely to evidence certain emotional responses such as anger. Cross-sport and cross-cultural considerations have

received relatively minimal research attention, although anecdotal evidence and intuition would lead to the conclusion that the socioculture of different sports, countries and among varying ethnicities and philosophic traditions is influential in athlete injury; for example, the harsh and abusive training methods tolerated and used by coaches in certain sports and countries are physically and psychologically harmful to many athletes. The hopes and dreams of not only an athlete but an entire nation or culture can be dashed by an injury, such as the Achilles tendon injury that forced the withdrawal of national track and field hero Liu Xiang of the host Chinese team from the 2008 Beijing Olympics. These examples illustrate that a consideration of socioculture is central to understanding the chronology of sport injury psychology risks, consequences, and recoveries.

Pre-injury etiology, risks, and protections

A number of pre-injury conceptual models and frameworks continue to provide grounding for sport injury scholarship efforts including biomedically based models (Meeuwisse et al., 2007), psychology-specific models derived from the behavioral medicine literature (Andersen & Williams, 1988), and biopsychosocial views on a Sport Injury Risk Profile (Wiese-Bjornstal, 2009, see Fig. 1). Factors associated with risk, causality, and etiology of adverse health events like sport injury include the interaction of intrinsic biological and psychological characteristics and actions of the athlete with the extrinsic physical and sociocultural characteristics and events

of the sport environments, and the associated implications for athlete behavior and risk vulnerability based on the resultant exposures, choices, and hazards. Actual injury occurs as a result of some proximate cause or “inciting event” (Meeuwisse et al., 2007) based on controllable behaviors and uncontrollable risks inherent in sport training and competition and the specific risk vulnerabilities of the involved athlete. In a continued quest to understand the etiology of sport injury and its prevention, not only should researchers consider the risk factors and the mechanisms of injury, but also the protective factors and “mechanism of no injury” (Meeuwisse, 2009); the “protections” likely include psychological and sociocultural protective factors (such as “proactive coping,” developing coping skills and resources as preventers of or buffers to life event stress) as well as biological and environmental ones.

With respect to specific psychosocial vulnerabilities to sport injury, one of the most consistent findings in the pre-injury (Williams & Andersen, 1998) literature surrounds life event stress. In line with the theoretical predictions of Andersen and Williams’ (1988) Model of Stress and Athletic Injury, major life event stress (defined as the perceived strain associated with major life event stressors such as starting at a new school or death of a family member), and in particular negative life event stress (the self-rated negative impact of these major events or stressors on personal strain levels), in most studies to date is predictive of sport injury occurrence (e.g., among female youth football/soccer players, see Steffen et al., 2009). This seems particularly apparent among those high major life event stress athletes who simultaneously self-report few coping skills or social resources to deal with the stress. Minor life event stress, studied under constructs such as daily hassles and everyday problems, has also been implicated in the relationship between accumulative small stressors and sport injury incidence, although it has received lesser research attention.

Other psychological factors have shown some research-based indication of their pre-injury influences on risk. Mood state is one example, with evidence relating pre-injury negative mood to increased injury incidence (e.g., Smith et al., 1997; Heniff, 1998), particularly with respect to high fatigue or lack of vigor. Personality (e.g., Deroche et al., 2007), risk behaviors (e.g., Brovard, 2008), and physiological indicators of allostatic load (e.g., Galambos et al., 2005) or excessive training behaviors (such as may be associated with perfectionistic, high achieving personalities common to high-intensity sport) are evidenced as injury risk factors. Clinical psychological issues such as eating disorders are risk factors for specific sport injuries like stress fractures (American College of Sports Medicine, 2007). Neurocognitive function,

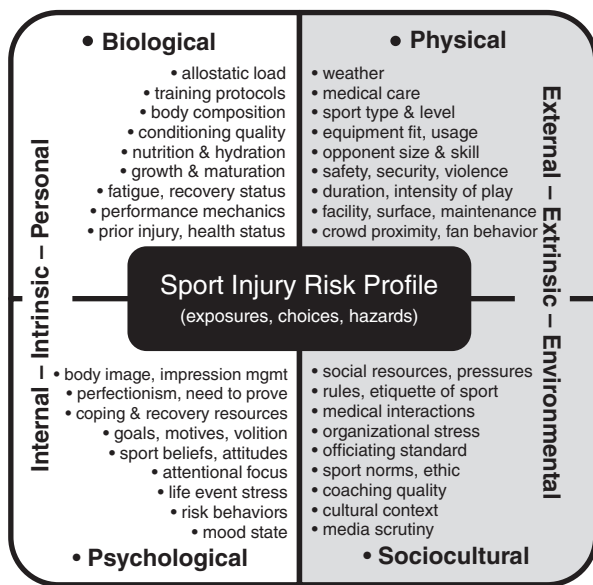


Fig. 1. Biopsychosocial sport injury risk profile (adapted from Wiese-Bjornstal 2009).

such as is compromised by concussions and other brain injury (Jantzen et al., 2008), is another psychological factor with research evidence beginning to show connection to further sport injury through the resulting deficits in cognitive and motor function, neuromuscular control and coordination (e.g., as associated with non-contact ACL injury in Swanik et al., 2007).

Post-injury response and outcome processes

Post-injury response and outcome entails themes of stressors, coping, and adjustment, and of psychological and physical rehabilitation and return-to-play. Cognitive appraisal and stress process conceptual models such as the Integrated Model of Psychological Response to the Sport Injury and Rehabilitation Process (Wiese-Bjornstal et al., 1998) have consistent research support (e.g., Albinson & Petrie, 2003); the injury itself now becomes another stressor in the athlete’s life leading to process cycles of thoughts, feelings, and actions. Affecting these are moderators and mediators of response (Wiese-Bjornstal et al., 1995) including a variety of interacting personal and social factors such as age and gender (e.g., Wiese-Bjornstal, 2003), personality and individual differences (e.g., Brewer et al., 2007), injury history, and interactions with medical professionals (e.g., Bone & Fry, 2006).

Components of the post-injury psychological response process surround cognition, affect, and behavior; all are inter-related, cyclic, spiraling, dynamic, and recursive in their influences on each other and on

short- and long-term outcomes through biopsychosocial pathways (see Fig. 2). Cognitive appraisal encompasses the many conscious assessments athletes make post-injury, such as about senses of self (e.g., Smith et al., 1993), identity, loss, optimism, challenge, or burnout (e.g., Cresswell & Eklund, 2006), and influence affect-related psychological responses of emotion and behavior, as well as physical recoveries. Cognitions such as attributions relate to rehabilitation and adherence behaviors (e.g., Brewer et al., 2000). Pain assessments and perceptions affect wound healing (e.g., McGuire et al., 2006) and are associated with speed of return (e.g., Berlin, 2001). Maladaptive catastrophizing of pain (e.g., Campbell & Edwards, 2009) is related to greater fear, anxiety and reports of pain and can hinder effective mental and physical recoveries. Baseline neuropsychological testing as an indicator of cognitive processing is used with increasing frequency as a proactive strategy for effective concussion management (Lovell, 2009).

Emotional or affective responses include mood disturbances such as depression (e.g., Appaneal et al., 2009), anxiety, low vigor, fatigue, grief (e.g., Evans & Hardy, 1995), and burnout. Fears of re-injury are common (e.g., Heijne et al., 2008), as are fears of pain and movement (“kinesiophobia”). Perceptions and emotions associated with stress, such as depression and anger (e.g., Gouin et al., 2008), negatively affect wound healing through psychoneuroimmunological pathways (e.g., Kiecolt-Glaser et al., 1998; Christian et al., 2006). Adding to the complexity, different types of injuries may

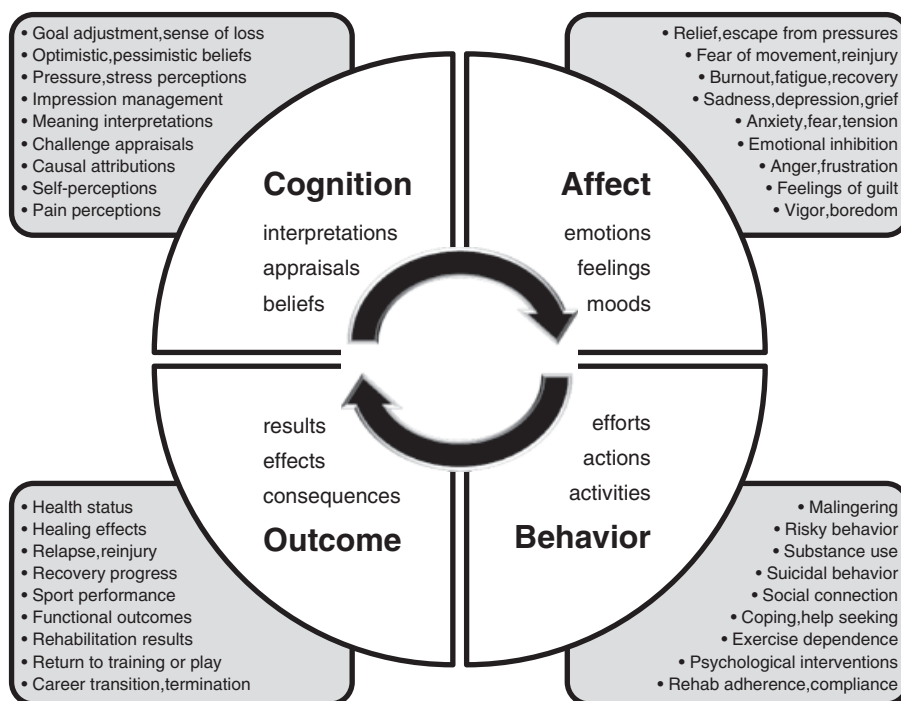


Fig. 2. Dynamic biopsychosocial cycles of post-sport injury response and recovery (reprinted by permission of the author).

elicit different emotional responses (e.g., Henert, 2000; Hutchison et al., 2009). With certain injuries such as traumatic brain injury, it is difficult to separate the psychological consequences associated with the injury physiology from interpretive emotional responses of athletes which are based more on cognitive appraisal and meaning (Putukian & Echemendia, 2003). Characteristics of the injury, like chronicity, are often tied to short- and long-term affective responses, such as in the case of recurrent concussions and long-term risk of depression (e.g., Guskiewicz et al., 2007). Emotional inhibition (Mankad et al., 2009) evidenced by some athletes is not surprising given the effects of socioculture on impression management and demonstrating toughness.

Cognitions and emotions influence behaviors (e.g., Haggart et al., 2005), such as attendance at rehabilitation, rehabilitation adherence (e.g., Pizzari et al., 2002), exercise dependence, suicidal behavior (e.g., Baum, 2005), NSAID and nutritional supplement use (e.g., Tricker, 2000; Gorsline & Kaeding, 2005), and steroid use (e.g., National Collegiate Athletic Association, 2001). Social support seeking behavior (e.g., Rees et al., 2003) and use of social support networks are demonstrated by some athletes, although factors such as perceptions of availability and comfort with help seeking (e.g., Hoar & Flint, 2008) influence the effectiveness of the behaviors in ameliorating distress and aiding recovery. Emotions can interfere with such behaviors; for example, depression is a risk factor for noncompliance with rehabilitation (e.g., DiMatteo et al., 2000).

Temporal aspects of post-injury psychological sequelae are variable and dynamic (e.g., LaMott, 1994; Morrey et al., 1999; Wiese-Bjornstal, 2004) (see Fig. 3). Stage or phase approaches are often used as a general rubric to understand changes over time in the components of cognition, affect, and behavior (Quinn & Fallon, 1999), while recognizing that thoughts, feelings, and actions (e.g., Schwenz, 2001; Tracey, 2003) and emotion representations (Haggart et al., 2005) are in fact quite dynamic over time. Mental models and itineraries are tied to successful outcomes and the restoration of healthy self-concepts over the course of the injury lifespan (Vergeer, 2006). Insight into specific phases (such as the return to sport phase,

Podlog & Eklund, 2006) and social influences (such as coaches, Podlog & Eklund, 2007) informs sport practitioners about key aspects of phase transitions and return to sport processes.

Psychological interventions

Matching psychological intervention strategies to the specific needs of individual athletes (Smith et al., 1990), and integrating psychological recovery interventions with physical rehabilitation efforts and landmarks (Flint, 2007) provide logical and systematic conceptual orienting frameworks for future research and practice. Research evidence supports the effectiveness of a variety of psychological interventions both pre- and post-injury on outcomes of athlete health and performance. Pre-injury, prophylactic stress management programs have been associated with reduced sport injury incidences when used with global athlete groups (e.g., Perna et al., 2003) and with high-injury risk players specifically (e.g., Johnson et al., 2005; Maddison & Prapavessis, 2005). Post-injury, a variety of individual psychological interventions such as imagery (e.g., Driediger et al., 2006), relaxation (e.g., Johnson, 2000), and goal setting (e.g., Evans & Hardy, 2002) have been advocated and supported as of benefit to athlete recoveries through outcomes like improved rehabilitation adherence and efficacy. Interventions often-times involve multiple components in combination or sequence, generally to good effect.

Interpersonal interventions such as solution-focused brief counseling (e.g., Gutkind, 2004) and social support (e.g., Bianco, 2001; Bianco & Eklund, 2001) from coaches (e.g., Malinauskas, 2008) and teammates (e.g., Corbillon et al., 2008) also appear efficacious in their use within sport injury contexts. The positive health effects of social contact are well-supported in many contexts, particularly in stressful circumstances. An understanding of biopsychosocial interactions reveals that the stress system is a hormone-based system, and biological variables such as hormones affect neurocognitive function and human social behavior. Recent evidence on hormones and behavior would support that hormones involved in bonding, such as social bonding through support, are associated with reductions in stress and anxiety (e.g., Brown et al., 2009) and as such one would expect similar benefits in sport injury contexts.

Psychoeducational prevention and management efforts

An understanding of the evidence bases and real-world implications of sport injury prevention measures and strategies are fundamental to their

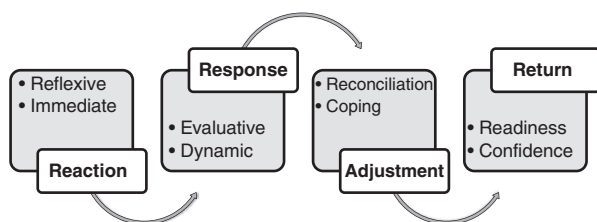


Fig. 3. Temporal flow of psychological response to sport injury lifespan (reprinted from Wiese-Bjornstal 2009).

effectiveness (Finch & Donaldson, 2009). Comprehensive conceptual models of sport injury prevention (e.g., van Tiggelen et al., 2008) have incorporated an understanding of factors such as attitudes, behaviors, motives, and culture into their approaches to preventions based on evidence suggesting that such efforts rely on psychology and socioculture for their effectiveness and implementation. Psychosocial educational efforts lay at the forefront of advocating for behavior change, through the psychology of behavior modification (e.g., Dvorak, 2009) in changing risk-taking behaviors and improving compliance with prevention protocols, and broader integrated and multidisciplinary efforts (e.g., Timpka et al., 2007).

Multiple examples of such are evident in the research literature. Engaging athletes in neuromuscular interventions for injury prevention such as ACL (e.g., Hewett et al., 2006) or ankle sprain (e.g., Hrysomallis, 2007) involves education and cognitive-emotional “convincing” of athletes, coaches, and trainers of their efficacy and worthiness as a use of valued practice time. Convincing athletes to wear protective gear such as that documented to reduce injury risk (e.g., eyewear in squash, Eime et al., 2004; protective headgear in junior cricketers, Shaw & Finch, 2008) poses similar challenges in areas of changing attitudes, behaviors, and microcultures. Mandating protective equipment and other preventive measures, however, raises considerations of “risk compensation” (Hagel & Meeuwisse, 2004), in which reducing one set of risks merely creates another (such as high sensation seeking children’s tendency to engage in more risky physical activity behavior when wearing safety gear than when not, Morrioniello & Lasenby-Lessard, 2007); the equipment disrupts the risk “homeostatis” (van Tiggelen et al., 2008) thereby contributing to risks of another kind.

Coach interventions, such as reducing advocacy for or limiting tolerance of excessively risky behaviors, overtraining, overestimations of ability, and improper mechanics (e.g., Rebella et al., 2008) are central to prevention efforts (e.g., Juhn et al., 2002). Monitoring stress and recovery variables and encompassing psychometric data (e.g., Mäestu et al., 2005) along with biochemical and performance parameters as indicators of overtraining and burnout are other examples of prevention efforts under investigation. Careful consideration of the advisability of early sport specialization, intensive training and excessive focus on early talent development, multi-sport/season competition, and limited rest or recovery time, by parents, coaches, and athletes has the potential to contribute to injury prevention efforts among developing young competitors.

Post-injury, management efforts, and the prevention of psychological complications associated with sport injury would benefit from mental health resource availability (e.g., Wiese-Bjornstal, 2009). In-

jury is among the most common “presenting problems” when athletes seek help and utilize team assistance programs (e.g., McDuff et al., 2005). Considering that for many athletes the most difficult step is admitting that they need help, research evidence would justify having psychological assistance proactively ready and available to injured athletes seeking help. Philosophical interventions (e.g., Shaffer & Wiese-Bjornstal, 1999) strive to prevent injury or aggravation of existing injury through modifications in the prevailing ethos and norms of expected sport attitudes and behaviors.

Perspectives

High-intensity sport injuries are stress and trauma-related; in addition to the more common causality attributions to mechanical and physiological stressors and traumas, there is significant evidence to demonstrate that psychological and sociocultural stressors and traumas are implicated in their etiology as well. Inherent in evaluating the high-intensity sport physical stressors (such as repetitive microtrauma, growth tissue compromises, and risky exposures) are psychological stressors (such as life event stress, burnout, and under-recovery) resulting in less than optimal attention and physiology manifested in injury risk factors such as tunnel vision, mental fatigue, and muscle tension, and social and ethical stressors that lead athletes toward misuse, abuse or overuse of their bodies and minds. Once sport injury occurs, it becomes yet another stressor that athletes must manage during their recovery, rehabilitation and return efforts: efforts also affected by psychology and socioculture through such mechanisms as cognitive, emotional, and behavioral response cycles and the normative attitudes, pressures and expectations for athletes to continue to train and compete when injured. Examining literature from sports medicine, psychology, and sport science with a biopsychosocial view leads to a better understanding of the integrated nature of the mental and physical health of injured high-intensity athletes and best practices for psychological intervention, prevention and management efforts, effective recoveries, successful sport performance, and healthy futures.

Key words: sport injury psychology, sports medicine, biopsychosocial, athlete health, rehabilitation, vulnerability, cognitive appraisal, emotion.

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References

- Albinson CB, Petrie TA. Cognitive appraisals, stress, and coping: pre-injury and post-injury factors influencing psychological adjustment to sport injury. *J Sport Rehab* 2003; 12: 306–322.
- American College of Sports Medicine. Position stand: the female athlete triad. *Med Sci Sports Exerc* 2007; 39: 1867–1882.
- Andersen MB, Williams JM. A model of stress and athletic injury: prediction and prevention. *J Sport Exerc Psychol* 1988; 10: 294–306.
- Appaneal RN, Levine BR, Perna FM, Roh JL. Measuring post-injury depression among male and female competitive athletes. *J Sport Exerc Psychol* 2009; 31: 60–76.
- Baum AL. Suicide in athletes: a review and commentary. *Clin Sports Med* 2005; 24: 853–869.
- Berlin TL. The relationships among pain perception, pain coping and speed of recovery in male intercollegiate athletes. Unpublished masters' thesis, University of Minnesota, 2001, Available TC Wilson Library Thesis MnU-M01-93.
- Bianco T. Social support and recovery from sport injury: elite skiers share their experiences. *Res Quar Exerc Sport* 2001; 72: 376–388.
- Bianco T, Eklund RC. Conceptual considerations for social support research in sport and exercise settings: the case of sport injury. *J Sport Exerc Psychol* 2001; 23: 85–107.
- Bone J, Fry M. The influence of injured athletes' perceptions of social support from ATCs on their beliefs about rehabilitation. *J Sport Rehab* 2006; 15(2): 156–167.
- Brewer BW, Cornelius AE, Sklar JH, Van Raalte JL, Tennen H, Armeli S, Corsetti JR, Brickner JC. Pain and negative mood during rehabilitation after anterior cruciate ligament reconstruction: a daily process analysis. *Scand J Med Sci Sports* 2007; 17: 520–529.
- Brewer BW, Cornelius AE, Van Raalte JL, Petitpas AJ, Sklar JH, Pohlman MH, Krushel RJ, Ditmar TD. Attributions for recovery and adherence to rehabilitation following anterior cruciate ligament reconstruction: a prospective analysis. *Psychol Health* 2000; 15: 283–292.
- Brovard RS. Risk behaviors in high school and college sport. *Curr Sports Med Reports* 2008; 7(6): 359–366.
- Brown SL, Fredrickson BL, Wirth MW, Poulin MJ, Meier EA, Heaphy ED, Cohen MD, Schultheiss OC. Social closeness increases salivary progesterone in humans. *Hormon Behav* 2009; 56(1): 108–111.
- Campbell CM., Edwards RR. Mind-body interactions in pain: the neurophysiology of anxious and catastrophic pain-related thoughts. *Transl Res* 2009; 153(3): 97–101.
- Charlesworth H, Young K. Injured female athletes: experiential accounts from England and Canada. In: Loland S, Skirstad B, Waddington I, eds. *Pain and injury in sport: social and ethical analysis*. New York: Routledge, 2006: 89–106.
- Christian LM, Graham JE, Padgett DA, Glaser R, Kiecolt-Glaser JK. Stress and wound healing. *Neuroimmunomodulation* 2006; 13(5–6): 337–346.
- Collins CL, Field SK, Comstock RD. When the rules of the game are broken: what proportion of high school sports-related injuries are related to illegal activity? *Inj Prev* 2008; 14: 34–38.
- Corbillon F, Crossman J, Jamieson J. Injured athletes' perceptions of the social support provided by their coaches and teammates during rehabilitation. *J Sport Behav* 2008; 31(2): 93–107.
- Cresswell SL, Eklund RC. Nature of player burnout in rugby: key characteristics and attributions. *J App Sport Psychol* 2006; 18: 219–239.
- Deroche T, Stephan Y, Brewer BW, Scanff CL. Predictors of perceived susceptibility to sport-related injury. *Pers Indiv Diff* 2007; 43: 2218–2228.
- DiMatteo MR, Lepper HS, Croghan TW. Depression is a risk factor for noncompliance with medical treatment: meta-analysis of the effects of anxiety and depression on patient adherence. *Arch Intern Med* 2000; 160: 2101–2107.
- Driediger M, Hall C, Callow N. Imagery use by injured athletes: a qualitative analysis. *J Sports Sci* 2006; 24: 261–271.
- Dvorak J. Give Hippocrates a jersey. Promoting health through football/sport. *Br J Sports Med* 2009; 43: 317–322.
- Eime R, Owen N, Finch C. Protective eyewear promotion: applying principles of behaviour change in the design of a squash injury prevention programme. *Sports Med* 2004; 34(10): 629–638.
- Engel GL. The clinical application of the biopsychosocial model. *Am J Psychiatry* 1980; 137: 535–544.
- Evans L, Hardy L. Sport injury and grief responses: a review. *J Sport Exerc Psychol* 1995; 17: 227–245.
- Evans L, Hardy L. Injury rehabilitation: goal-setting intervention study. *Res Quar Exercise Sport* 2002; 73: 310–319.
- Finch CF, Donaldson A. A sports setting matrix for understanding the implementation context for community sport. *Br J Sports Med* 2009. Available at <http://bjsm.bmj.com> (accessed April 6, 2009).
- Fletcher D, Hanton S. Sources of organizational stress in elite sports performers. *Sport Psychol* 2003; 17: 175–195.
- Flint FA. Matching psychological strategies with physical rehabilitation: integrated rehabilitation. In: Pargman D, ed. *Psychological bases of sport injuries*, 3rd edn. Morgantown, WV: Fitness Information Technology, 2007: 319–334.
- Galambos SA, Terry PC, Moyle GM, Locke SA. Psychological predictors of injury among elite athletes. *Br J Sports Med* 2005; 39: 351–354.
- Gorsline RT, Kaeding CC. The use of NSAIDs and nutritional supplements in athletes with osteoarthritis: prevalence, benefits, and consequences. *Clin Sports Med* 2005; 24: 71–82.
- Gouin JP, Kiecolt-Glaser JK, Malarkey WB, Glaser R. The influence of anger expression on wound healing. *Brain Behav Immun* 2008; 22: 699–708.
- Guskiewicz KM, Marshall SW, Bailes J, McCrea M, Harding HP, Mathews A, Mihalik JR, Cantu RC. Recurrent concussion and risk of depression in retired football players. *Med Sci Sports Exerc* 2007; 39: 903–909.
- Gutkind SM. Using solution-focused brief counseling to provide injury support. *Sport Psychol* 2004; 18(1): 75–88.
- Hagel B, Meeuwisse W. Risk compensation a “side effect” of sport injury prevention? *Clin J Sport Med* 2004; 14(4): 193–196.

- Hagggar MS, Chatzisarantis ND, Griffin M, Thatcher J. Injury representations, coping, emotions, and functional outcomes in athletes with sports-related injuries: a test of self-regulation theory. *J App Soc Psychol* 2005; 35(11): 2345–2374.
- Hardman A. Sport, moral interpretivism, and football's voluntary suspension of play norm. *Sport, Ethics Philos* 2009; 3(1): 49–65.
- Heijne A, Axelsson K, Werner S, Biguet G. Rehabilitation and recovery after anterior cruciate ligament reconstruction: patients' experiences. *Scand J Med Sci Sports* 2008; 18(3): 325–335.
- Henert SE. Exploring injured athletes' ratings of social support and use of coping strategies as a function of injury type and gender over the course of rehabilitation, PhD dissertation. University of Minnesota, Minnesota, USA, 2000. Available at <http://www.proquest.com/>. Publication Number: AAT 9966232.
- Heniff CB. A comparison of life event stress, weekly hassles, and mood disturbance between injured and uninjured female university athletes. Unpublished masters' thesis, University of Minnesota, 1998, Available TC Wilson Library Theses MnU-M98-89.
- Hewett TE, Ford KR, Myer GD. Anterior cruciate ligament injuries in female athletes: Part 2, a meta-analysis of neuromuscular interventions aimed at injury prevention. *Am J Sports Med* 2006; 34: 490–498.
- Hoar SD, Flint F. Determinants of help-seeking intentions in the context of athletic injury recovery. *Int J Sport Exerc Psychol* 2008; 6(2): 157–175.
- Hodgson L, Gissane C, Gabbett TJ, King DA. For debate: consensus injury definitions in team sports should focus on encompassing all injuries. *Clin J Sports Med* 2007; 17(3): 188–191.
- Hootman JM, Dick R, Agel J. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. *J Ath Train* 2007; 42(2): 311–319.
- Hrysomallis C. Relationship between balance ability, training and sports injury risk. *Sports Med* 2007; 37(6): 547–556.
- Hutchison M, Mainwaring LM, Comper P, Richards DW, Bisschop SM. Differential emotional responses of varsity athletes to concussion and musculoskeletal injuries. *Clin J Sport Med* 2009; 19(1): 13–19.
- International Olympic Committee, 2009 Olympic movement medical code. Available at http://www.olympic.org/PageFiles/61597/Olympic_Movement_Medical_Code_eng.pdf (accessed on October 16, 2009).
- Jantzen KJ, Oullier O, Kelso JAS. Neuroimaging coordination dynamics in the sport sciences. *Methods* 2008; 45: 325–335.
- Johnson U. Short-term psychological intervention: a study of long-term-injured competitive athletes. *J Sport Rehab* 2000; 9(3): 207–218.
- Johnson U, Ekengren J, Andersen MB. Injury prevention in Sweden: helping soccer players at risk. *J Sport Exerc Psychol* 2005; 27(1): 32–38.
- Juhn MS, Broolin PG, Duffey T, Stockard A, Vangelos ZA, Emaus E, Maddox M, Boyajian L, Henehan M. Position Statement. Violence and injury in ice hockey. American Osteopathic Academy of Sports Medicine (AOASM). *Clin J Sport Med* 2002; 12(1): 46–51.
- Kiecolt-Glaser JK, Page GG, Marucha PT, MacCallum RC, Glaser R. Psychological influences on surgical recovery: perspectives from psychoneuroimmunology. *Am Psychol* 1998; 53: 1209–1218.
- Kontos AP. Perceived risk, risk taking, estimation of ability and injury among adolescent sport participants. *J Pediatr Psychol* 2004; 29(6): 447–455.
- Lake T. The way it should be. *Sports Illustrated* 2009; 110(26): 56–64.
- LaMott EE. The anterior cruciate ligament injured athlete: The psychological process, Ph.D. dissertation. University of Minnesota, Minnesota, USA, 1994. Available at <http://www.proquest.com/>, Publication Number: AAT 9501110.
- Lovell M. The management of sports-related concussion: current status and future trends. *Clin Sports Med* 2009; 28: 95–111.
- Maddison R, Prapavessis H. A psychological approach to the prediction and prevention of athletic injury. *J Sport Exerc Psychol* 2005; 27: 289–310.
- Mäestu J, Jürimäe J, Jürimäe T. Monitoring of performance and training in rowing. *Sports Med* 2005; 35(7): 597–617.
- Malinauskas R. College athletes' perceptions of social support provided by their coach before injury and after it. *J Sports Med Phys Fitness* 2008; 48(1): 107–112.
- Mankad A, Gordon S, Wallman K. Perceptions of emotional climate among injured athletes. *J Clin Sport Psychol* 2009; 3(1): 1–14.
- Mathias MB. The competing demands of sport and health: an essay on the history of ethics in sports medicine. *Clin Sports Med* 2005; 23: 195–214.
- McDuff DR, Morse ED, White RK. Professional and collegiate team assistance programs: services and utilization patterns. *Clin Sports Med* 2005; 24: 943–948.
- McGuire L, Heffner K, Glaser R, Needleman B, Malarkey W, Dickinson S, Lemeshow S, Cook C, Muscarella P, Melvin WS, Ellison EC, Kiecolt-Glaser J. Medicine, pain and wound healing in surgical patients. *Ann Behav Med* 2006; 31(2): 165–172.
- Meeuwisse WH. What is the mechanism of no injury (MONI)? *Clin J Sport Med* 2009; 19: 1–2.
- Meeuwisse WH, Tyreman H, Hagel B, Emery C. A dynamic model of etiology in sport injury: the recursive nature of risk and causation. *Clin J Sport Med* 2007; 17(3): 215–219.
- Morrey MA, Stuart MJ, Smith AM, Wiese-Bjornstal DM. A longitudinal examination of athletes' emotional and cognitive response to anterior cruciate ligament injury. *Clin J Sport Med* 1999; 9(2): 63–69.
- Morrongiello BA, Lasenby-Lessard J. Psychological determinants of risk taking by children: an integrative model and implications for interventions. *Inj Prev* 2007; 13: 20–25.
- Murphy P, Waddington I. Are elite athletes exploited? *Sport Soc* 2007; 10(2): 239–255.
- National Collegiate Athletic Association, 2001. NCAA study of substance use habits of college student-athletes. Available at <http://www.ncaa.org/research/> (accessed on March 4, 2006).
- Nippert AH. "I have four months to compete, eight months to heal": Playing through pain and injuries in girls' interscholastic gymnastics, Ph.D. dissertation. University of Minnesota, Minnesota, USA, 2005. Available at <http://www.proquest.com/>, Publication Number: AAT 3167684.
- Perna F, Antoni M, Baum A, Gordon P, Schneiderman N. Cognitive behavioral stress management effects on injury and illness among competitive athletes: a randomized clinical trial. *Ann Behav Med* 2003; 25(1): 66–73.
- Pike E, Maguire J. Injury in women's sport: classifying key elements of "risk encounters". *Soc Sport J* 2003; 20(3): 232–251.
- Pizzari T, McBurney H, Taylor NF, Feller JS. Adherence to anterior cruciate ligament rehabilitation: a qualitative analysis. *J Sport Rehab* 2002; 11: 90–102.
- Podlog L, Eklund RC. A longitudinal investigation of competitive athletes' return to sport following serious injury. *J Appl Sport Psychol* 2006; 18(1): 44–68.
- Podlog L, Eklund RC. Professional coaches' perspectives on the return to sport following serious injury. *J Appl Sport Psychol* 2007; 19(2): 207–225.

- Putukian M, Echemendia R. Psychological aspects of serious head injury in the competitive athlete. *Clin Sports Med* 2003; 22(3): 617–630.
- Quinn AM, Fallon BJ. The changes in psychological characteristics and reactions of elite athletes from injury onset until full recovery. *J Appl Sport Psychol* 1999; 11: 217–229.
- Rebella GS, Edwards JO, Greene JJ, Husen MT, Brousseau DC. A prospective study of injury patterns in high school pole vaulters. *Am J Sports Med* 2008; 36(5): 913–920.
- Rees T, Smith B, Sparks A. The influence of social support on the lived experiences of spinal cord injured sportsmen. *Sport Psychol* 2003; 17(2): 135–156.
- Renstrom P, Ljungqvist A, Arendt E, Beynon B, Fukubayashi T, Garrett W, Georgoulis T, Hewett TE, Johnson R, Krosshaug T, Mandelbaum B, Micheli L, Myklebust C, Roos E, Roos H, Schamasch P, Shultz S, Werner S, Wojtys E, Engebretsen L. Non-contact ACL injuries in female athletes: an International Olympic Committee current concepts statement. *Br J Sports Med* 2008; 42: 394–412.
- Schwenz SJ. Athletes' perceptions of rehabilitation and the use of biofeedback to enhance psychological recovery following anterior cruciate ligament reconstruction, Ph.D. dissertation. University of Minnesota, Minnesota, USA, 2001. Available at <http://www.proquest.com/>, Publication Number: AAT 3020612.
- Shaffer SM, Wiese-Bjornstal DM. Psychosocial intervention strategies in sports medicine. In: Ray R, Wiese-Bjornstal DM, eds. *Counseling in sports medicine*. Champaign, IL: Human Kinetics, 1999: 41–54.
- Shaw L, Finch CF. Injuries to junior club cricketers: the effect of helmet regulations. *Br J Sports Med* 2008; 42: 437–440.
- Smith AM, Scott SG, Wiese DM. The psychological effects of sports injuries: coping. *Sports Med* 1990; 9: 352–369.
- Smith AM, Stuart MJ, Wiese-Bjornstal DM, Gunnon C. Predictors of injury in ice hockey players: a multivariate, multidisciplinary approach. *Am J Sports Med* 1997; 25: 500–507.
- Smith AM, Stuart MJ, Wiese-Bjornstal DM, Milliner EK, O'Fallon WM, Crowson CS. Competitive athletes: pre-injury and post-injury mood state and self-esteem. *Mayo Clin Proc* 1993; 68: 939–947.
- Steffen K, Pensgaard A, Bahr R. Self-reported psychological characteristics as risk factors for injuries in female youth football. *Scand J Med Sci Sports* 2009; 19(3): 442–451.
- Swanik CB, Covassin T, Stearne DJ, Schatz P. The relationship between neurocognitive function and noncontact anterior cruciate ligament injuries. *Am J Sports Med* 2007; 35: 943–948.
- Timpka T, Risto O, Björmsjö M. Boys' soccer league injuries: a community-based study of time-loss from sports participation and long-term sequelae. *Eur J Public Health* 2007; 18(1): 19–24.
- Tracey J. The emotional response to the injury and rehabilitation process. *J Appl Sport Psychol* 2003; 15: 279–293.
- Tricker R. Painkilling drugs in collegiate athletics: Knowledge, attitudes, and use of student athletes. *J Drug Educ* 2000; 30(3): 313–324.
- van Tiggelen D, Wickes S, Stevens V, Roosen P, Witvrouw E. Effective prevention of sports injuries: a model integrating efficacy, efficiency, compliance and risk-taking. *Br J Sports Med* 2008; 42(8): 648–652.
- Vergeer I. Exploring the mental representation of athletic injury: a longitudinal case study. *Psychol Sport Exerc* 2006; 7: 99–114.
- Wiese-Bjornstal DM. From skinned knees and Pee Wees to menisci and masters: developmental sport injury psychology. In: Weiss MR, ed. *Developmental sport and exercise psychology: a lifespan perspective*. Morgantown, WV: Fitness Information Technology, 2003: 525–568.
- Wiese-Bjornstal DM. Psychological responses to injury and illness. In: Kolt GS, Andersen MB, eds. *Psychology in the physical and manual therapies*. Edinburgh: Churchill Livingstone, 2004: 21–38.
- Wiese-Bjornstal DM. Sport injury and college athlete health across the lifespan. *J Intercol Sport* 2009; 2: 64–80.
- Wiese-Bjornstal DM, Smith AM, LaMott EE. A model of psychologic response to athletic injury and rehabilitation. *Ath Train: Sports Health Care Pers* 1995; 1: 16–30.
- Wiese-Bjornstal DM, Smith AM, Shaffer SM, Morrey MA. An integrated model of response to sport injury: psychological and sociological dynamics. *J Appl Sport Psychol* 1998; 10: 46–69.
- Williams JM, Andersen MB. Psychosocial antecedents of sport injury: review and critique of the stress and injury model. *J Appl Sport Psychol* 1998; 10: 5–25.