

A Model of Stress and Athletic Injury: Prediction and Prevention

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A theoretical model of stress and athletic injury is presented. The purpose of this paper is to propose a framework for the prediction and prevention of stress-related injuries that includes cognitive, physiological, attentional, behavioral, intrapersonal, social, and stress history variables. Development of the model grew from a synthesis of the stress-illness, stress-accident, and stress-injury literatures. The model and its resulting hypotheses offer a framework for many avenues of research into the nature of injury and reduction of injury risk. Other advantages of the model are that it addresses possible mechanisms behind the stress-injury relationship and suggests several specific interventions that may help diminish the likelihood of injury. The model also has the potential of being applied to the investigation of injury and accident occurrence in general.

In the U.S. in 1981 over 70,000,000 injuries were incurred that either required medical attention or at least a day of restricted activity. In sports and recreation alone it is conservatively estimated that 3 to 5 million injuries occur each year (Kraus & Conroy, 1984). This alarming information underscores the need for research that delves into the nature of injury and the mechanisms behind its occurrence. The results of such research could be used to identify individuals at high risk of injury and to design intervention programs aimed at reducing the risk of injury.

There are myriad factors that may contribute to injury, many of which are primarily physical (e.g., overtraining, equipment failures, poor field conditions, weather, the nature of the sport). Many psychological and social factors may also influence injury occurrence. This paper will address the interconnections of psychosocial factors and stress and their impact on injury outcome. First a brief review of the research conducted on psychosocial and stress factors in injury will be presented, followed by a detailed explication of a model for stress and the prediction and prevention of athletic injury.

Early studies of psychological factors and athletic injury stemmed from clinical or coaching experiences (e.g., Ogilvie, 1966). More recently, better con-

trolled studies on personality and athletic injury have been conducted, but unfortunately the results have been inconsistent. Jackson et al. (1978) found that Factor I (tough-minded vs. tender-minded) of Cattell's Sixteen Personality Factor Questionnaire (16 PF) discriminated injured from noninjured football players, with the tender-minded players being more likely to incur injury than the tough-minded ones. Valiant (1981) obtained similar results with runners. Irvin (1975), however, found no differences between injured and noninjured football players on Factor I but did find differences on Factor A. Injured players were more reserved (vs. outgoing) than noninjured players. Brown (1971), on the other hand, using the California Psychological Inventory, found no differences between injured and noninjured football players on any personality variable. The above trait approaches to studying behavior have been criticized for rigidity, over-simplification, and low explanatory value. See Fischer (1984) for a critique of the trait approach and an appeal for an interactional (Person \times Situation) model of sport behavior.

The personality and athletic injury research recently has been overshadowed somewhat by stress-injury research, the results of which appear to be more consistent, at least for football. Much of the stress and athletic injury research has centered on the influence of stressful life events. Life events are major changes in an individual's life (e.g., marriage, death of a close friend, change in financial status). Initial interest in life events stems from the work of Holmes and Rahe (1967), who developed the Social Readjustment Rating Scale (SRRS) to measure stressful life events. Using the SRRS, they found that individuals with high life stress seemed generally to be at greater risk of disease than those with low life stress. Later a similar relationship was found for accident occurrence (e.g., Selzer & Vinokur, 1974; Stuart & Brown, 1981).

From the evidence supporting a relationship of life stress with illness and accidents, it was reasoned that life stress might influence another form of "disease," that is, athletic injury. An early and rarely cited study (Holmes, 1970) using the SRRS found that football players who experienced high life stress were more likely to incur injury than players who were rated low on life stress. Later, Bramwell, Masuda, Wagner, and Holmes (1975) modified the SRRS to better fit an athletic population by deleting some items and adding items relevant to athletics (e.g., troubles with head coach, difficulties with eligibility, being dropped from team). The new tool was called the Social and Athletic Readjustment Rating Scale (SARRS). Bramwell et al.'s results were consistent with the previous Holmes (1970) study. Coddington and Troxell (1980) and Cryan and Alles (1983) also found greater incidence of injury in high stress high school and college football players compared to low stress players.

In another study on football injuries, Passer and Seese (1983) adapted Sarason, Johnson, and Siegel's (1978) Life Experiences Survey (LES) to athletics, creating the Athletic Life Experiences Survey (ALES). The original LES was designed to separate positive and negative life events and test the influence of each on illness. Holmes and Rahe (1967) assumed that any major change, whether positive or negative, would be stressful and deleterious to health, but evidence from Vinokur and Selzer (1975) indicated that only negative events were associated with negative outcome.

Passer and Seese (1983) also broadened the scope of the research on stressful life events and injury by including three possible moderator variables of the life events-injury relationship (i.e., trait anxiety, competitive trait anxiety, and

locus of control). The life events–injury relationship was again demonstrated, only for negative events, but Passer and Seese failed to detect any influence from the moderator variables. However, a recent study found that the moderator variable of social support contributed directly to the likelihood of injury. Subjects with low social support were more likely to become injured than those with high social support, regardless of life stress levels (Hardy, Prentice, Kirsanoff, Richman, & Rosenfeld, 1987).

All of the initial research that identified a life stress and athletic injury relationship was conducted on football players. In recent studies of collegiate volleyball players (Williams, Tonymon, & Wadsworth, 1986) and basketball and cross-country athletes (Williams, Haggert, Tonymon, & Wadsworth, 1986), a subject's score on a life events scale had no relationship to injury occurrence. In the study with basketball and cross-country athletes, too small of a sample size may have influenced the results; similar problems did not occur in the volleyball study. In another study with nonfootball athletes, high life stress physical education students involved in a variety of sports were more likely to experience an acute injury than low life stress physical education students (Lysens, Auweele, & Ostyn, 1986). These inconsistent results illustrate the need for theory development and refinement in methodology and measurement.

Most of the research on stress and athletic injury has been conducted on a narrow scope, minimally considering the complexity of stress and the broad array of factors that might moderate stress and injury outcome. Also, much of this research has been conducted without the benefit of an adequate framework to explain the relationships between psychosocial factors and injury. The purpose of the present paper is to propose an interactional theoretical model of injury and the cognitive, physiological, attentional, behavioral, intrapersonal, social, and stress history variables that may influence injury occurrence and prevention. The model and its resulting hypotheses offer a framework for many avenues of research into the identification of the injury-prone athlete and the reduction of injury risk. This model of stress and athletic injury was proposed recently (Williams & Andersen, 1986) and has since had minor modifications. The model (see Figure 1) includes not only stressful life events but other aspects of stress as well as psychosocial factors that may influence injury occurrence. Other advantages of the model are that it addresses possible mechanisms behind the stress–injury relationship and suggests several specific interventions that may help diminish the likelihood of injury.

The general model and its conceptual foundation will be briefly described, followed by a closer examination of the model's subcomponents and the rationale for their inclusion. An initial perusal of the model reveals four major components in the central portion: The potentially stressful athletic situation, the cognitive appraisal of various aspects of that situation, the physiological and attentional responses, and the potential injury outcome. This conceptual foundation for the model was derived from Smith's (1980) mediational model of stress. Smith's model addresses the external situation, the bidirectionally connected core of cognitive appraisal and emotional (physiological) response, and the outcome behavior. Smith's model also proposes interventions aimed at the stress response core. Similar models may be found in health (e.g., Allen, 1983; Pelletier, 1977) and in other areas of sport psychology (see Martens' 1975 model of the competition process). Thus the model presented here is not unique.

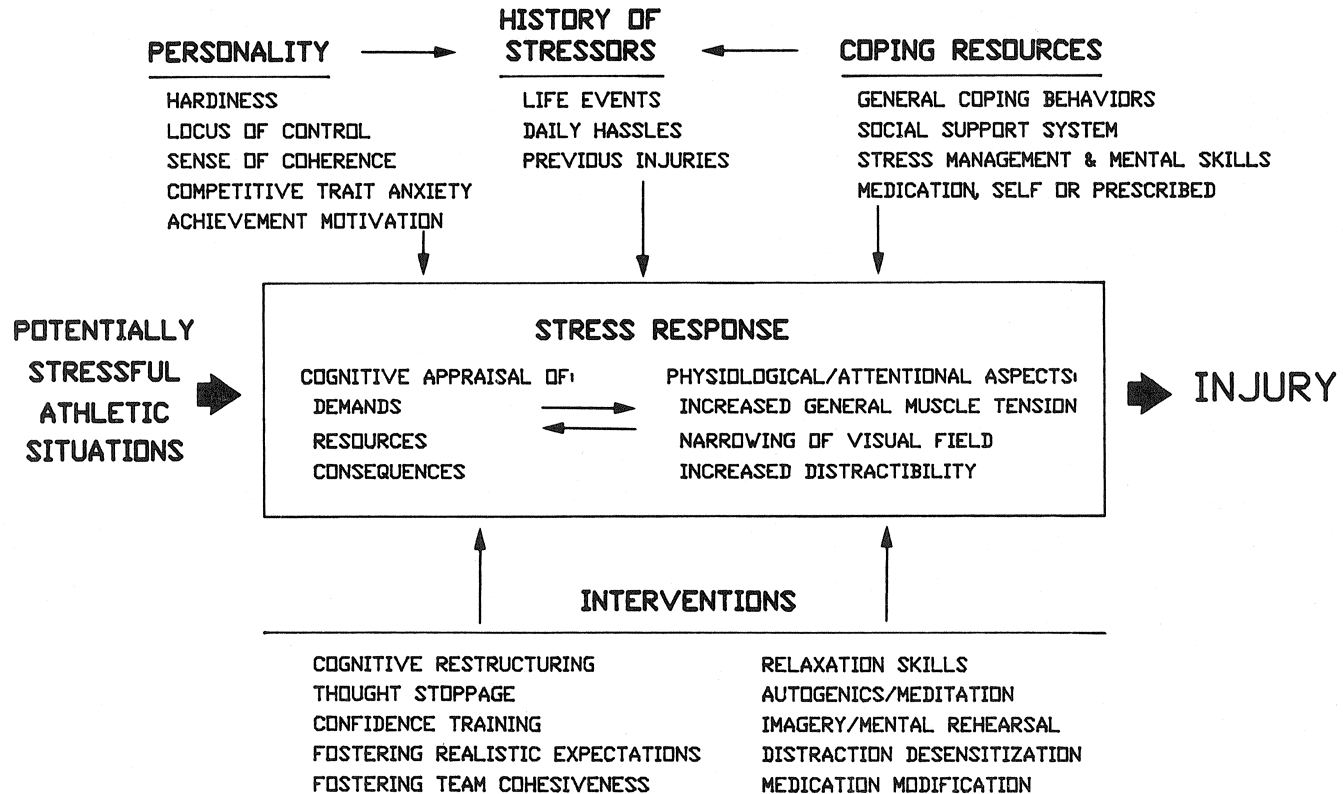


Figure 1 — A model of stress and athletic injury.

Above the stress response core of the model are three major areas (i.e., personality factors, the history of stressors, and coping resources). It is hypothesized that one's stress history contributes directly to the stress response while personality factors and coping resources may act on the stress response either directly or through the effects of the history of stressors. Most of the health literature has viewed these moderator variables as merely buffering the effects of life stress. But such a view may be too narrow in that personality factors and coping resources may moderate the stress response regardless of the levels of life stress or daily hassles.

The model is predicated on the assumption that the two basic mechanisms behind the stress-injury relationship are increases in general muscle tension and deficits in attention during stress. It is hypothesized that individuals with a lot of stress in their lives who have personality traits that tend to exacerbate the stress response and few coping resources will, in a stressful situation, be more likely to appraise the situation as stressful, exhibit greater muscle tension and attentional changes, and thus be at greater risk of injury compared to individuals who have the opposite profile.

Below the stress response are two groups of interventions that are hypothesized to lessen the stress response by addressing either the cognitive appraisal or the physiological/attentional aspects. In addition, these interventions and others may be used to directly influence the moderator variables of coping resources and personality factors. A closer examination of the model's subcomponents will follow.

The Stress Response

The present model and its components was developed primarily from an examination of the stress-illness, stress-accident, and stress-injury literatures (e.g., Passer & Seese, 1983; Smith, 1980; Stuart & Brown, 1981). Other factors are included not because of empirical evidence that they influence accident, illness, or injury outcome but because of demonstrated moderating effects on the stress response.

Cognitive Appraisal

Cognitive appraisal and the potentially stressful athletic situation may be logically, but not experientially, separable. As athletic situations develop, and the process may take weeks or months, there is a continual appraisal and reappraisal. In response to stressful situations (e.g., competition, practice, selection to first or second strings), the athlete appraises the demands of the situation and his or her ability to meet those demands (resources). If the athlete perceives his or her resources as exceeding demands, the stress response to the situation may be minimal. On the other hand, if perceived demands exceed perceived resources, the stress response to the situation may be pronounced. Also, appraisal of the consequences of the event may influence the stress response. If the consequences, whether actual or perceived, are crucial to the athlete's career or self-esteem, the stress response may be extreme.

Whether or not one's cognitive appraisal of potentially stressful situations reflects reality is of little importance in generating a stress response. The cognitive portion of the model owes much to Ellis' (1962) work concerning the in-

fluence of perceptions, attributions, and irrational beliefs on the generation of inappropriate or maladaptive emotional responses. These responses, if extreme, may predispose an individual to be at risk of injury because of the attentional and physiological changes that accompany negative cognitive appraisals.

Physiological/Attentional Aspects

The cognitive appraisal of demands, resources, and consequences is connected bidirectionally to physiological and attentional aspects of the stress response. Just as cognitive appraisal of a situation can influence attention and physiological arousal, arousal and attentional patterns can act as feedback information for the continual appraisal and reappraisal of the external situation and one's performance.

Many physiological changes occur during stress, but increases in generalized muscle tension (bracing) may be one of the mechanisms behind the stress-injury relationship (Nideffer, 1983). Generalized muscle tension can disturb motor coordination and reduce flexibility, thus contributing to strains, sprains, and other musculoskeletal injuries. A research issue that needs to be addressed is whether certain individuals will, under stress, exhibit greater increases in generalized muscle tension than others (e.g., high life stress vs. low life stress subjects), and whether these "tenser" persons are more likely to become injured.

The most frequently cited culprit in the stress-injury relationship, however, is change in attention (e.g., Bramwell et al., 1975; Cryan & Alles, 1983; Williams, Tonymon, & Wadsworth, 1986). During stress, narrowing of the visual field may occur, leading to a failure to pick up vital cues in the periphery and thus increasing the likelihood of injury (e.g., getting blind-sided). Also, attention may become scattered under stress, causing the athlete to attend to stimuli not relevant to the task at hand and thus failing to detect vital cues. Research has addressed attentional changes during stress (see Hancock, 1984, for a review), but studies are needed of those attentional changes as they relate to sport and the variables that may influence attentional processes (see below).

If the core of the stress response (i.e., cognitive appraisals and attentional and physiological changes) can be positively modified during a potentially stressful situation, then the likelihood of injury may also be lowered. The literature is replete with studies of variables that may moderate the responses to and consequences of stress. Three broad areas that may influence the response to specific stressful situations, either directly or through interactions with other factors, are presented below.

History of Stressors

An individual's history of stressors (i.e., major life events, chronic daily problems, and previous injuries) should have a substantial impact on the stress response, and thus on injury risk. A thorough assessment of the stressors in an athlete's life may give the coach, trainer, or sport psychologist a good estimate of how much at risk of injury that athlete is, at least from a history-of-stressors standpoint.

Life Events

Although the stress-athletic injury literature is not as substantial as the stress-illness research, there is support for a life event/stress-injury relationship.

This relationship has been particularly well established for football but, as noted earlier, attempts to test the effects of life stress outside of football have been somewhat equivocal. Perhaps the nature of the sport is a major determinant of injury outcome. Football is a full-contact sport whereas basketball, volleyball, and cross-country running move, respectively, from moderate to minimal to almost no contact. Future research must determine whether the relationship between stress and injury is more likely to occur in sports that have a naturally higher incidence of injury due to physical contact.

Several measurement issues in the assessment of stressful life events (e.g., confounding nature of some items, time frames, item weighting schemes, positive vs. negative events, scales for special populations) also need to be addressed. Resolution of these issues and the refinement of stress scales may help elucidate the present inconsistencies in the stress-injury literature. For thorough reviews of major measurement issues, see Christensen (1981) and Creed (1985).

Daily Hassles

One weakness of earlier stress-injury studies is that they only examined stress within the framework of life events scales; a weakness of such scales is that they measure only major stressful events. Stress also may stem from the minor daily problems, irritations, or changes an individual encounters. These chronic daily stressors may have nothing to do with a major life event (e.g., job dissatisfaction, loneliness) or they may be a direct consequence of the adaptation required by major life events. For example, moving to a new city also involves a lot of daily problems such as getting used to a new school, new neighbors, new streets, new climate, and so forth.

Kanner, Coyne, Schaefer, and Lazarus (1981) developed the Daily Hassles Scale (DHS), which was designed to measure minor chronic stressors rather than major life events. The scale demonstrated an ability to predict illness as well as life events scales. In fact, in one study daily hassles were found to be better predictors of psychological distress than were major life events (Monroe, 1983). The relationship of daily hassles to athletic injury needs to be investigated, but it may be necessary to develop an athletic daily hassles scale since the generalizability of the DHS to athletes is probably questionable.

Previous Injury

An assessment of previous injuries (and their severity) incurred by an individual would seem crucial for the prediction of future injury. If the athlete has not recovered enough to return to the sport but does anyway, the probability of reinjury is high. Also, if the athlete is physically but not psychologically prepared to return to sport participation, problems may arise due to negative cognitive appraisals. Fear of reinjury may lead to a considerable stress response and may actually increase the probability of reinjury. The history of previous injuries, and the psychological and physical rehabilitation of the athlete, are extremely important as their role in reinjury may outweigh other contributing factors in the model.

Measurement of life events, daily hassles, and previous injuries may produce a more complete assessment of an individual's history of stressors. Future research will help determine which of these stress factors, or combination of factors, are the best predictors of injury. Also, the nature of each sport and its train-

ing procedures probably interacts with stress factors. Studies of stress and injury in many different sports are needed in order to test for generalizability and to provide potential theoretical explanations for differences in the stress-injury relationship between sports.

Personality

Any comprehensive model of the relationship of stress to athletic injury would not be complete without considering certain personality differences. The stress-illness literature has identified many personality and psychosocial factors for their roles in moderating the stress-illness relationship (see Garrity & Marx, 1985; Jenkins, 1979). These personality differences may make some individuals less likely to perceive situations and events as stressful or may predispose one to be less susceptible to the effects of stressors. The personality factors that follow have been shown to be such moderator variables, and some have been examined in the stress-injury literature. These factors do not constitute an exhaustive list and there is surely considerable overlap among the variables, but they are all presented here as suggestions for future research in identifying who is most at risk of injury. See Bergandi (1985), and Crossman (1985) for reviews of other psychological and personality factors related to athletic injury.

The trait of psychological hardiness has been shown to moderate the stress-illness relationship in several studies (e.g., Kobasa, Maddi, & Puccetti, 1982). Psychological hardiness is really a constellation of characteristics such as curiosity, willingness to commit, seeing change as a challenge and stimulus to development, and having a sense of control over one's life (Kobasa, 1979). Recently the hardiness concept has come under close scrutiny (Hull, Van Treuren, & Virenelli, 1987) and some refinement is needed. Although the relationship between hardiness and injury has not been established, the Jackson et al. (1978) finding that tough-minded football players were less likely to be injured than tender-minded ones seems to be addressing issues very similar to hardiness.

Locus of control (Rotter, 1966) and Antonovsky's sense of coherence (1985) were included in the list of personality factors because of their resemblance to the hardiness concept and because both constructs have demonstrated their usefulness in stress-illness research. Other personality factors such as sensation seeking, achievement motivation, and competitive trait anxiety are included because they are variables common to the world of athletics and appear to be related to stress.

Research is needed to determine if these personality factors influence the stress response and injury rate directly. For example, do high sensation seekers see competition as challenging rather than anxiety provoking? Also, do individuals with a high need to avoid failure experience a greater stress response when in a potentially stressful athletic situation, thus placing themselves at greater risk of injury? Do personality factors interact with the history of stressors (e.g., high sense of coherence seems to buffer the deleterious effects of high life stress; Antonovsky, 1985), thus modifying stress through that pathway? Many of these factors could be used in longitudinal studies as predictor variables in regression equations to determine which personality variables are helpful in identifying the high-risk-of-injury athlete. Sport-specific instruments for measuring these variables may be necessary to best determine the usefulness of the variables in predicting injury (e.g., an athletic locus-of-control scale).

Coping Resources

Coping resources comprise a wide variety of behaviors and social networks that help the individual deal with the problems, joys, disappointments, and stresses of life. The role of coping resources in the stress-illness literature is extensive. See Billings and Moos (1981) for a review of the interactions of coping resources and life stress. What constitutes coping has long been debated and is surely multifaceted. The coping resources presented in the model probably do not comprise a complete list and must be considered only as suggestions for future research in the stress-injury field.

General coping behavior is a category containing several diverse behaviors that may influence an athlete's overall stress level. Their relationship to athletics and injury has not been clearly demonstrated and their inclusion here is only suggestive. This category might include the assessment of such coping behaviors as sleep patterns, nutritional habits, time management, general self-esteem and, if the athlete is a student, study skills. Lack of good general coping behaviors in this category may easily lead to higher stress and thus greater risk of injury. In the area of athletic injury, Williams, Tonymon, and Wadsworth (1986) found that general coping resources—measured by the Miller and Smith (1982) Vulnerability to Stress subscale of their Stress Audit Questionnaire—were directly related to injury. Athletes who had low coping resources were more likely to be injured than those with better coping resources.

In much of the stress and health literature, coping resources have been viewed as moderating the effects of life stress, and by that route influencing illness outcome. As stated earlier, this may be too narrow a view. Some coping factors may act on the stress response and injury rate directly. One major source of coping resources is the extent and kind of social support system an athlete has. Agreement on what constitutes social support and how to measure it has been lacking in the stress literature. Social support usually is considered to be the presence of others whom we know value and care for us and on whom we can rely (Sarason, Levine, Basham, & Sarason, 1983).

One study (Coddington & Troxell, 1980), although it did not specifically examine social support, found that football players who experienced family instabilities (e.g., separations, divorces, deaths) were more likely to become injured than those who did not. This could be interpreted as a disruption of the athlete's social support system.

Evidence for social support's role in athletic injury also comes from Williams, Tonymon, and Wadsworth (1986). Half of the items on their coping resource questionnaire dealt with social support and, as stated above, coping resources was the only variable related to athletic injury. Hardy et al. (1987) also found a direct influence of social support on injuries. Again, athletes with high levels of social support had a lower incidence of injury, but the notion that social support buffers the effect of life stress by serving as a mediating variable in the life stress-injury relationship was not supported.

The presence of a supportive social network (family, friends, coach, sports medicine staff, and teammate support) may directly inoculate the athlete against injury or may attenuate the stressfulness of life events and daily hassles as well as the stressfulness of athletic participation. Although initial athletic injury research suggests only a direct influence, more research is needed before we can deter-

mine whether social support only directly influences the risk for injury or whether it also buffers the negative effects of stress, as suggested in the general health literature. Also, see Sarason, Sarason, and Johnson (1985) for a discussion of the myriad problems of assessing and defining social support.

The stress management techniques and other mental skills an athlete possesses may influence athletic performance and responses to stress. These techniques are not only coping resources but also interventions and will be discussed briefly in the next section.

Drug use is prevalent in athletics for legitimate as well as illegitimate reasons. An extensive pharmacopoeia is employed for performance enhancement, injury treatment, pain management, and recreation. Many of these substances have the ability to influence the stress response, perception, and performance, and thus the probability of injury. Assessment of an athlete's drug use other than those drugs that are prescribed is often difficult if not impossible, due to the clandestine nature of drug use. The health and welfare of the athlete needs to be of paramount importance to athletic directors, coaches, trainers, teammates, family, and health care professionals. Identification of substances used or abused by the athlete and programs for drug use modification should help not only in injury prevention but in most aspects of the athlete's life.

The above list of coping variables that may moderate stress and the stress response is surely incomplete and in some places redundant. The variables are offered here as a springboard for research that will lead to a better picture of the coping factors involved in athletic injury. Single variables mentioned above may not be very useful, but when combined with others and with personality and history-of-stressors variables, may prove to be moderately strong predictors of injury risk and outcome.

Interventions

Not only do we wish to identify the factors that may predispose an athlete to injury but also the potential interventions for preventing injury. Following Smith's (1980) suggestion, the stress response's two major components invite a two-pronged offensive (see Figure 1) directed at attenuating the negative cognitive and physiological/attentional aspects of the stress response.

Interventions for the cognitive appraisal side of the stress response include cognitive restructuring to eradicate thinking patterns that lead to maladaptive responses (see Heyman, 1984). Other techniques such as thought stoppage and confidence training may enhance an athlete's ability to appraise the athletic situation (see Bunker & Williams, 1986). Improving team cohesiveness (a way of manipulating social support) and fostering and communicating realistic expectations are the responsibilities of the coaches, trainers, sport psychologists, and sports medicine staff (see Carron, 1986). If the athlete feels the team is behind him or her and knows what is expected, then the athlete's cognitive reactions to stressful situations may be tempered.

Interventions for the attentional/physiological aspects of the stress response would be aimed at lowering arousal and enhancing concentration. Harris (1986) offers several techniques for lowering arousal levels (e.g., autogenics, progressive relaxation, meditation, breathing exercises). Concentration training can lead to lower distractibility and help keep the athlete on task (see Schmid & Pepper,

1986). Finally, modifying an athlete's use of drugs is an obvious step to improving the stress response and the quality of the athletic experience. All these interventions are aimed at reducing the stress response, either by modifying cognitions or lowering physiological arousal, and thus reducing the likelihood of injury.

Summary and Conclusions

Past research on injury and stress has been atheoretical and too narrow in scope, focusing on a limited conceptualization of stress and a restricted consideration of the interaction of personal and situational variables that may influence the stress response and, ultimately, injury. The present model provides a broad theoretical foundation for future investigations into the prediction and prevention of injury and the many psychosocial variables to be considered in the stress-injury relationship. The model also suggests some probable mechanisms behind the as yet unexplained correlation between stress and injury.

This paper has presented several research suggestions for specifically testing the hypotheses generated by the model. Also, it is highly likely the model could be applied to other areas of health research such as accident occurrence and prevention since the mechanisms behind the stress-accident relationship may be similar to those behind athletic injury. Future research should be directed at testing the model, refining it, and possibly expanding its applicability.

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