DOI:10.2478/v10237-011-0062-3

Psychological Predictors of Injury among Professional Soccer Players

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Objectives: Numerous empirical studies suggest that specific psychological factors influence the frequency and severity of sport injuries. The main purpose of the present study is to outline the psychological factors, which predict increased injury vulnerability among professional male soccer players in Denmark. Based on the Stress-Injury Model by Williams & Anderson (1998) it is hypothesized that low coping resources, high competitive trait anxiety, and history of previous injuries would be positively related to an increased risk of injury occurrence and severity. **Methods**: The soccer players (N = 87) were asked to report history of previous injuries within the last 12 months. Furthermore, 2 questionnaires were used; Competitive Trait Anxiety Test, and Athletic Coping Skills Inventory – 28 (ACSI-28). Injuries were prospectively recorded throughout a period of approximately 3 months by the team's medical staff (doctors and physiotherapists). **Results**: Study findings clearly suggest that history of previous injury and coping with adversity are the best predictors of injury occurrence. These factors explained between 7 % and 11 % of the total variance of injury occurrence and days lost due to injury respectively. Furthermore, the same variables were found very successful in prediction injury occurrence. **Conclusions**: The findings support the suggestions that psychological factors can be utilized as a predictive measurement to sport injuries, which should be considered by coaches and medical staff in order to reduce vulnerability to injury.

Keywords: Injury Prediction; Competitive Trait Anxiety; Coping Resources; Previous Injury; Professional Soccer

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Introduction

Background. Played by millions of people around the world, association soccer is the world's most popular sport. Worldwide more than 270 million people are actively involved in soccer (www.fifa.com). In Denmark (2010), there are approximately 255.000 male and 67.000 female registered football players (www.dbu.dk). Needless to say, elite soccer players are exposed to many hours of training and competition every week, and thus are under enormous physical and psychological pressure. Consequently, injury rates are considerably high and vary widely in magnitude as well as duration of impact: Among male elite soccer players between 65% and 91% are estimated to sustain at least one performance-limiting injury throughout a season (Lewin, 1989; Engström et al., 1990; Lüthje et al., 1996; Waldén, Hägglund, & Ekstrand, 2005; Constantinou, 2010). Other studies demonstrated injury incidence between 1,8-7,6 injuries per 1000 training hours and as high as 34,8 injuries per 1000 match hours (Andersen et al., 2004; Árnason et al., 2004a; Hawkins & Fuller, 1999; Waldén, Hägglund, & Ekstrand, 2005). During national soccer matches, injury frequency are even bigger: FIFA reported an average injury occurrence of respectively 2,3 and 2,0 injuries per match during the FIFA World Cup Germany 2006 and FIFA World Cup 2010 (www.fifa.com).

Definition of a injury. The field of psychological research operates with various definitions of sport injuries. Some researchers use the "*medical-assistance*" definition, (when the athlete is treated in a hospital) whereas others use a "tissue injury" definition (Fuller, Smidt, & Junge, 2004; Morgan & Oberlander, 2001; Junge & Dvorak, 2000). However, most recent studies related to soccer injuries have used the "*time loss*" definition of an injury, thereby recording injuries only when it causes absence from match and/or training participation (Hawkins et al., 2001; Árnason et al., 2004a; Ekstrand, Waldén, & Hägglund, 2004; Junge, Chomiak, & Dvorak, 2000). However injury is defined, it is important to acknowledge these various definitions of injuries when evaluating sport injury studies, and comparison of different studies must be handled with care.

The present study used the *time-loss* definition which is in agreement with the UEFA Medical Committee: *Injury is defined as any physical damage that occurred during football (soccer ed.) activities (scheduled matches or training sessions) and resulted in the player being unable to participate fully in future training sessions or matches* (www.uefa.com; Ekstrand, 2009). Injuries that interrupted training or matches are also included, regardless of whether the player missed scheduled soccer activities or not. The *time-loss* definition is highly dependent on the frequency of training sessions and matches. However, this study deals exclusively with elite soccer players from

the same league, and it is therefore expected that the amount of training and matches are approximately the same for all participants.

Furthermore, injuries will be classified as: slight (1-3 days absence), minor (4-7 days), moderate (8-28 days), and severe (>28 days). These cut-off points are chosen in accordance to UEFA consensus and in order to make the present study comparable to previous research (Árnason et al., 2004b; Hawkins & Fuller, 1999; Hawkins et al., 2001; Ekstrand, Waldén, & Hägglund, 2004; Hägglund et al., 2005; Waldén, Hägglund, & Ekstrand, 2005).

Research about psychological predictors of sport injuries. For many years, the science of sport injuries were perceived merely through the lenses of physiological and medical research, largely ignoring the (imperative) role of psychological factors. However, Holmes (1970) was the pioneer to this approach and especially throughout the last two decades, a substantial body of research has investigated the role of psychological antecedents of sport injuries (Smidt et al., 1997; Williams, 2001; Maddison & Prapavessis, 2005; Galambos et al., 2005; Johnson, Ekengren, & Andersen, 2005; Stephan et al., 2009; Johnson & Ivarson; 2010). Most findings support the assumption that psychological factors are strongly related to the vulnerability to sport injuries. Thus, psychological factors play a substantial role in a comprehensive understanding of sport injuries. The foundation of this theoretical approach is proposed by Andersen and Williams' stress-injury model (1988) (revised by Williams & Andersen, 1998) (Figure 1).

Stress-injury model. The stress-injury model (Williams & Andersen, 1998) provides a comprehensive, interactional model explaining the psychological antecedents of sport injuries. Despite difficulties to test the entire model, this complex stress-injury model has created a feasible theoretical framework examining the relationship of injuries and psychological risk factors.

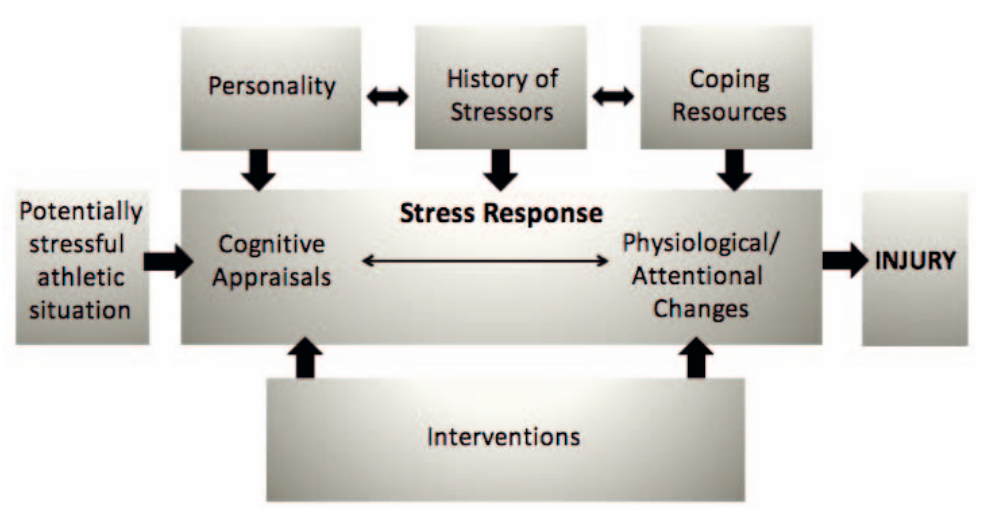

Figure 1. Revised version of the stress-injury model. Adapted from Williams and Andersen (1998). The original model (Andersen & Williams, 1988 p.297) did not have bi-directional arrows between personality, history of stressors, and coping resources.

The core of this model is the *stress response*; an interactional relationship between athletes' cognitive appraisals of demands, consequences, and sport related resources and their physiological and attentional responses (e.g. increased muscle tension, high/low arousal, visual narrowing) (Williams & Andersen, 1998). In the context of sport, athletes create cognitive appraisals of: (a) the demands of a forthcoming event, (b) own competences to meet those demands, and (c) consequences (success or failure) in meeting those demands. Williams and Andersen (2007) argue that athletes, who appraise situations as fun, exciting, and challenging, will utilize a positive stress response (eustress), which may help the athlete to stay focused and concentrated. On the other hand, athletes who see competitions as anxiety enhancing or ego-threatening may experience negative stress response (distress) leading to greater risk of injury. Hence, the stress-injury model hypothesizes that increased negative stress response (distress) are believed to enlarge vulnerability to sport injuries by disturbing athletes' coordination (increased muscle tension) as well as interfering with attentional focus, and narrowing of peripheral vision.

In addition to stress response, the *stress-injury model* also consists of three main factors: *personality traits, history of stressors, and coping resources*.

Personality traits: This factor is defined as context-dependent, psychological attributes characterizing the athlete. The personality can potentially affect if an athlete assesses situations as stressful or not. For example, athletes with high trait anxiety may appraise more situations as stressful as well as exacerbating their responses to potentially stressful situations, hence resulting in an increased risk of injury (Patterson et at., 1998; Maddison & Prapavessis, 2005).

Initially Andersen and Williams (1988) included *hardiness, sense of coherence, achievement motivation, sensation seeking, locus of control*, and *trait anxiety* as personality traits. However, most research on sport injury has focused on *locus of control* and especially *competitive trait anxiety* when investigating the relationship between personality traits and sport injury. The overall body of research is far from consistent. Conversely, positive relationships are often found between increased vulnerability sport injury and *competitive trait anxiety* (Lavallee & Flint, 1996, Petrie, 1993, Johnson & Ivarsson, 2010), *locus of control* (Kolt & Kirkby, 1996; Pargman & Lunt, 1989), and *low self-confidence* (Kolt & Roberts, 1998).

History of stressors: This moderator embraces variables as: *daily hassles, life events,* and *previous injuries*.

- *Life events*. This term refers to any event resulting in major changes in the life of the athletes (e.g. marriage, divorce, illness in the family). It is hypothesized that major life events lead to elevated demands for adaption, and thus, cause an increased level of stress and ultimately increase the risk of injury (Andersen & Williams, 2007). A relatively rich body of empirical research consistently supports the relationship between increased risk of injuries and high life stress (e.g. Hardy & Riehl, 1988; Petrie, 1993; Patterson, Smith, & Everett, 1998, Johnson & Ivarsson 2010). This argument is supported by a systematic review by Williams and Andersen (2007) that found correlations between life event stress and injuries in approximately 85% of literature about life events and injuries. Williams and Roepke (1993) also proved a two to five times higher probability to sustain injuries for athletes with high life stress than athletes with low life stress.

- *Daily hassles*. This term refers to everyday problems, irritations, and/or changes that potentially can contribute to enlarge life stress level. Research about the correlation of daily hassles and injury are far from consistent (e.g. Hanson et al., 1992; Smidt, Smoll, & Ptacek, 1990; Van Mechelen et al., 1996). However, a well-conducted study by Fawker, McMurray, and Summer (1999) found that injured players had a significant increase in daily hassles prior to injury-occurrence, while no significant changes were found among non-injured players. The authors concluded that a relationship between daily hassles and injury occurrence exists.

- *Previous injuries*: Williams and Anderson (1998) argue that previous injuries might enlarge vulnerability to athletic injuries caused by: (a) negative cognitive appraisals thereby potentially leading to increased stress response, if the athlete returns to sport before being psychologically ready, and/or (b) an increased risk of being reinjured if not fully physically recovered. This hypothesis is somewhat supported by research (Junge et al., 2000; Dvorak & Junge, 2000; Dvorak et al., 2000; Williams, Hogan, & Andersen, 1993; Lysens et al., 1984; Maddison & Prapavesis, 2005). However, only little empirical research has investigated the direct relationship of previous injuries and vulnerability to injury, and findings are inconsistent (Søderman et al., 2001; Hanson et al., 1992; Van Mechelen, Twisk, Molendijk, et al., 1996).

Accordingly, *history of stressors* should be considered as an indirect predictor of injuries, as higher life stress might affect concentration and focus during training and competition, and thus, increase the risk of injury.

Coping resources: According to Williams and Andersen (1998) coping resources refer not only to various coping skills but also to the amount of received social support. Numerous studies suggest a close relationship between injury outcome and coping resources (Williams, Tonymon, & Wadsworth, 1986; Hanson, et al., 1992; Maddison & Prapavessis, 2005). Studies on the relationship of social support and injury occurrence are not consistent. However, Smidt, Smoll, and Ptacek (1990) found a positive connection between negative life events and injury incidents only for athletes low in both coping skills and social support. Moreover, Petrie (1992) found that athletes with low social support and high negative life events were more likely to get injured, suggesting that low social support enlarge athletes' vulnerability to injury while high social support seems to reduce the risk of injury.

To summarize; the stress-injury model hypothesizes that the three psychosocial moderators (*personality traits, history of stressors*, and *coping skills*) directly affect how well athletes respond to stressful situations, hence indirectly influencing the risk of injuries, both in matter of occurrence and gravity of injuries. The variables may operate in isolation as well as in combination to influence the stress response. For example, athletes high on life stressors, with few coping resources, and high competitive anxiety show, when placed in a stressful situation, show a greater stress response (e.g. increased muscle tension and lack of concentration), and thus leading to higher susceptibility to injuries (Williams & Andersen, 1998). These athletes are stated as high-risk profile.

The last segment of the model is *interventions*. This component refers to intervention strategies to lessen the stress response in stressful events in order to

reduce injury vulnerability. Williams and Andersen (1998) argue for two different intervention approaches: 1) modify athletes' cognitive appraisals of potentially stressful situations, and 2) alter athletes' physiological and attentional characteristics of the stress response. This approach has found solid empirical support; May and Brown (1989) reported reduced number of injuries among U.S. Alpine skiers after an intervention program using mental skills training, teambuilding, and communication; Johnson, Ekengren, and Andersen (2005) applied a 5-month intervention program (e.g. relaxation, stress management, and coping skills training) and reported significant fewer injuries for the intervention group. Other studies showed similar results (e.g. Kerr & Goss, 1996; Parna et al., 2003; Maddison & Prapavessis, 2007; Rogers & Landers, 2005).

Summary. The stress-injury model proposed by Williams and Andersen (1998) has manifested itself as a feasible foundation for the psychology of sport injury risk. A substantial body of research supports this approach indicating a close relationship between injury susceptibility and a large number of different psychological factors. However, much research is conducted in different sports environments and levels (amateur, elite, professional) and results are far from comprehensive. Thus, more research is required in order to single out those specific psychological risk factors targeting the many different groups of athletes.

Aim of study

Accordingly, the main purpose of the present study is to single out those significant psychological factors that could lead to an increased risk of injury frequency and injury severity among professional soccer players in Denmark. An additional purpose is to examine the relationships between competitive trait anxiety, history of previous injury, coping resources, and injury occurrence and injury severity. Thus, four hypotheses are given:

1: It is hypothesized that athletes with a history of previous injuries would report higher level of competitive trait anxiety.

2: It is hypothesized that high level of competitive trait anxiety, incidents of previous injuries, and low coping resources would contribute to increased vulnerability to injury.

3: It is hypothesized that coping resources, history of previous injuries, and specific personality traits contribute significantly to the prediction of injury occurrence and days lost due to injury.

4: It is hypothesized that coping resources, history of previous injuries, and specific personality traits can predict injury incidents and injury severity.

Materials and methods

Participants

Elite male soccer players from five competing teams in the Danish Superliga and First Division League were contacted for participation in the study. In total, eighty-seven players from these teams completed the questionnaires successfully at measuring point 1 (N = 87, drop-out rate = 39 %). At measuring point two, sixty-six respondents provided complete injury data (N = 66, drop-out rate = 24 %). Their ages were between 18 and 34 years old (N = 66: M = 24.61, SD = 4.15).

All participants are professional soccer players and participate in Danish as well as international competitions. The nationalities of the participants are mainly Danish (N = 52) but also international (N = 14). Anonymity throughout the whole study was assured at all times, hence each team was offered to use codes instead of names.

Measurements

Competitive Trait Anxiety Test. The Competitive Trait Anxiety Test (Brand, Graf, & Ehrlenspiel, 2005; Danish version: Elbe & Øhrgaard, 2008) is designed to investigate athletes' disposition to perceive competitive situations as threatening while measuring the athletes' competitive trait anxiety. The test contains twelve questions each divided into the following three subscales:

- *Somatic anxiety*: measures the athlete's predisposition to experience somatic anxiety in competitive situations (e.g. racing heart beat, wet hand palms).

- *Worry*: measures the athlete's predisposition to worry in competitive situations (e.g. self doubts and negative expectations).

- *Concentration disturbance*: measures the athlete's predisposition to concentrate and stay focused in competitive situations.

Questions were answered in a four-point likert scale with the following labels: *0 = not at all; 1= somewhat; 2 = moderate so; 3 = very much so*. Elbe and Øhrgaard (2008) reported internal consistency with Cronbach's α = .70 for the *somatic anxiety* subscale, α = .81 for the *worry* subscale, and α = .54 for the *concentration disturbance* subscale.

Athletic Coping Skills Inventory – 28 (ACSI-28). The ACSI-28 survey (Smith, Schutz, Smoll, & Ptacek, 1995) is a sport-specific instrument used to measure athletes' personal coping resources. Each question can be classified in one of the following seven subscales:

- *Coping with adversity*: measures how well athletes remain positive and enthusiastic when facing adversity; how well to remain calm and controlled; how well to recover from errors and obstacles.

- *Coachability*: measures how well athletes are open to and learn from instructions; how well to accept constructive criticism without becoming upset.

- *Concentration*: measures how well athletes can stay focused on the task at hand and how easily they get distracted; how well athletes maintain these abilities even when adverse and unexpected situations occur.

- *Goal-setting & Mental Preparation*: measures how well athletes are able to set and work towards specific performance goals (i.e. goals not related to performance outcome); how well to plan and mentally prepare for performance and has clearly identified 'game plans' for specific situations.

- *Peaking under Pressure*: measures how well athletes perceive pressure situations as challenging rather than threatening; how well to perform under pressure; how well to respond to high-risk ventures.

- *Confidence & Motivation*: measures how well athletes are confident and positively motivated; how much effort athletes put into practice and to improve their skills.

- *Freedom from Worry*: measures how much pressure athletes put on themselves by worrying about performing badly and making mistakes; how much athletes are concerned about what other people think about them; whether athletes focus on what they *want* to happen rather than on what they *do not want* to happen (Smith & Christensen, 1995).

The survey contains 28 statements arranged in a four-point scale with the following labels: *0 = almost never; 1 = sometimes; 2 = often; 3 = almost always*. The internal consistency for ACSI-28 was .84 for males and .88 for females, and the test-retest reliability for each subscale was between .47 and .87 (Smith, Schutz, Smoll, & Ptacek, 1995).

History of stressors. Proposed by Williams and Andersen (1998), possible *history of stressors* includes: Daily hassles, previous injuries, and major life events.

The present study includes history of previous injuries. The participants were asked to report the amount of injury incidents in the preceding 12 months.

A copy of the Danish and English version of the complete questionnaire can be found in Appendix VIII and XI.

Translation validation. In order to diminish omission and mistranslation both questionnaires were translated using methods of back-translation (Brislin, 1970) and then proof-read by a fluent English and Danish speaking. Optimally, the translated versions should be subjected to further analysis or pilot-studies to confirm its validity (Su & Parham, 2002; Douglas & Craig, 2007).

Procedure

At the beginning of December 2009, coaches from the Danish Superliga and First Division League were contacted to seek their participation in the present study. Contact was established by email and phone and was followed by a cover letter informing the coaches and the club's medical staff about the procedure of data sampling and full information about the study. This letter also emphasized that participation was voluntary and that confidentiality and anonymity were guaranteed at all times. The sampling of data for this longitudinal study took place from 15th March to 15th of June 2010. The club's medical staff and/or coaches distributed the questionnaires to each player who completed the questionnaire individually. Subsequently, the completed questionnaires were returned to the researcher.

Throughout the time of research, injury record was continuously collected. In order to objectively determine if an injury had happened or not, all potential injuries were assessed by the team's medical staff (based on present study's definition of an injury) and then collected in a standard report form. The form included information about date of injury and the severity of the injury measured in days. The researcher subsequently transcribed the completed questionnaires and injury reports.

Dropout

Initially, 143 players were invited to participate in the present study. In total, 87 players completed the questionnaires successfully (measuring point 1) result-

ing in a dropout rate of 39 %. At the second test event (measuring point 2) one team failed to provide injury data resulting in a total of sixty-six remaining participants (drop-out rate = 24 %).

Statistical analysis

All information obtained from the questionnaire and the injury report form were manually captured and entered into IBM® SPSS® Statistics. This file included the player's age, previous injuries (last 12 months), total time of injury, and name/identification number, as well as the two questionnaires. All of the study populations are professional soccer players, so it was important to maintain total anonymity and confidentially in order to protect the clubs and the players. Therefore each player was matched with their own identification number only known to the club's coaches and medical staff and to the researcher.

One-way Analysis of Variance (ANOVA) and correlation analysis using Pearson's correlation coefficient (*r*) was conducted in order to compare data between the injured and non-injured players. In order to find injury predictors, linear regression analysis was conducted using injury as dependent variable. However, to adjust for conjunctive patterns among the predictors, linear regression analysis, backward elimination, was chosen to outline the most significant moderators. Furthermore, logistic regression analysis, backward LR (likelihood ratio) was conducted to demonstrate if injury occurrence and severity successfully could be predicted. A significance level of .05 was accepted at all times. The results of each analysis are presented in the *Results* chapter. The original output can be examined more thorough in the complementary Appendix if needed.

Output from logistic regression must be handled with care: R^2-output from logistic regression model is considered as a "pseudo R^2" and the normal "goodness-of-fit" do not apply. Thus, it is recommended not to publish this output (Hosmer & Lemeshow, 2000).

Logistic transformation: All regression models were tested for violation of the essential assumptions of linear regression; nonlinearity, serial correlation, heteroscedasticity, and/or non-normality distribution. Some models failed to meet these requirements, and thus, logistic transformation (log transform) was conducted. In order to perform the log transformation it was a necessity that no data was valued zero. Thus, according to conventional research, a constant of 0.5 was added to the dependent variable count (McDonald, 2009). Furthermore, the log transform enables the unit-based interpretations of outcome and is replaced by percentage-based interpretations (McDonald 2009).

Results

Injury Occurrence and Time-loss. Of the 66 participating players, 40 (60.6 %) players experienced at least one injury during the 3 months of research. In total, 56 injuries were reported resulting in a total of 717 days of missed practice or training sessions caused by injury. The days missed due to injury ranged from 1 to 83 days, and the average duration of injury was 18 days (*SD* = 22.0).

Instrument reliability. Table 1 and 2 present the internal reliabilities for each subscale in the Competitive Trait Anxiety Questionnaire and the ACSI-28 respectively. Reliability for all instruments was based on the sample at measuring point 1 (N = 87).

Table 1. Reliability for each subscale in the Competitive Trait Anxiety Questionnaire

	Cronbach' s Alpha
Somatic anxiety	.54
Worry	.64
Concentration disturbance	.46

Table 2. Reliability for the ACSI-28

	Cronbach' s Alpha
Coping with adversity	.60
Coachability	.49
Concentration	.37
Goal setting & Mental preparation	.73
Peaking under pressure	.68
Confidence & motivation	.54
Freedom from worry	.67

It is suggested that measures must be internal consistent with .70 as a minimum criterion value (Tenenbaum, Kamata, & Hayashi, 2007). However, the present study operates with a reliability score at minimum 0.5, and thus the

variables *concentration disturbance*, *coachability*, and *concentration* are excluded from all subsequent statistical analyses in the present study.

Descriptive Statistics

Hypothesis 1: Previous injuries and competitive trait anxiety. One-way ANOVA and regression analysis was conducted in order to examine competitive trait anxiety between players with previous injuries and those players without previous injuries. Results are presented in Table 3 (Appendix I). The group of players without previous injuries show significant lower level of *somatic anxiety* (F = 4.888, r = .233, P = .030). In regards to worry, no significant difference was found between the groups of players.

Table 3. Descriptive statistics between players with no previous injuries (N = 24) and players with previous injuries (N = 63).

Variables		Mean	SD	F	Effect size r	P	95% Confidence Interval	
Somatic anxiety	No prev. injuries	5.13	1.329	4.888	.233	.030*	4.564	5.686
	Previous injuries	5.84	1.358				5.499	6.183
Worry	No prev. injuries	5.29	1.488	1.912	.148	.170	4.663	5.920
	Previous injuries	5.83	1.651				5.410	6.241

Note. Effect size (r) reflects the mean of the players with previous injuries, i.e. a positive r indicates higher means for players with previous injuries. * Indicates significant relationship

Hypothesis 2: Correlations between injured and non-injured players. One-way ANOVA and correlation analysis was conducted to investigate the differences between the injured and the non-injured players measuring different psychological variables and their history of previous injuries (Table 4; Appendix II). Injured players reported significant lower score of coping with adversity (F = 5.384, r = -.279, P = .024) and had significant more previous injuries (F = 5.505, r = .281 P = .022) than the non-injured group of players. Between the two groups, no other significant differences were found.

Table 4. Descriptive statistics for the group of injured (N = 40) and non-injured (N = 26) players

Variables		Mean	SD	F	Effect size r	P	95% Confidence Interval	
Previous injuries	Injured	1.43	1.174	5.505	.281	.022*	1.05	1.80
	Non-injured	.81	0.081				0.48	1.13
Somatic anxiety	Injured	5.65	1.545	.401	.079	.529	5.156	6.144
	Non-injured	5.42	1.205				4.936	5.910
Worry	Injured	5.63	1.764	.234	.060	.630	5.061	6.189
	Non-injured	5.42	1.474				4.828	6.019
Coping with Adversity	Injured	7.08	2.368	5.384	-.279	.024*	6.318	7.833
	Non-injured	8.35	1.832				7.606	9.086
Goal-setting & Mental Preparation	Injured	6.48	2.961	.001	-.004	.973	5.528	7.422
	Non-injured	6.50	2.943				5.311	7.689
Peaking under Pressure	Injured	8.45	2.012	.307	-.069	.581	7.807	9.094
	Non-injured	8.77	2.658				7.696	9.843
Confidence & Motivation	Injured	8.93	1.873	2.416	-.191	.125	8.326	9.524
	Non-injured	9.62	1.577				8.979	10.252
Freedom from Worry	Injured	7.45	2.873	1.263	-.139	.265	6.531	8.369
	Non-injured	8.19	2.173				7.315	9.070

Note. Effect size (r) reflects the mean of the injured players, i.e. a positive r indicates higher means for the injured group. * Indicates significant relationship.

Regression analysis

The regression analyses were adjusted for the potential influence from age; however, age was not proved as significant confounding variable for the prediction of injury.

It was hypothesized by the author, that the psychological variables predicting injury occurrence might not be the same as those variables correlated with injury severity measured in days (time-loss). So, in order to make results more nuanced and descriptive, injury was analysed as a dichotomous variable (0 = no injury, 1 = injured) as well as on a scale (time-loss caused by injury).

Hypothesis 3: Coping resources, history of previous injuries, and specific personality traits as predictors of injury. Linear regression analysis with backward elimination was conducted with all potential predictors using injury occurrence as dependent variable.

The analysis showed that the two predictors, *previous injuries* and *coping with adversity*, explain 7.4 % of the total variance of injury incidents (R^2_{Adj} = .074, R = .321, F = 3.612, p = .033) (Table 5; Appendix III). Both predictors were close to significant; *previous injuries* (B = .175, ß = .228, p = .060) and *coping with adversity* (B = -.086, ß = -.233 p = .056).

Table 5. Linear regression analysis of injury predictors

Independent variables	M	SD	B	Beta (ß)	P	95% Confidence Interval	
Previous injuries	1.24	1.19	.175	.228	.060	-.008	.358
Coping with adversity	7.22	2.25	-.086	-.233	.056	-.174	.002

Note. Dependent variable is injury occurrence.

Linear regression analysis with backward elimination was conducted with all potential predictors using time loss due to injury as dependent variable.

The variables were not accepted as normally distributed and linearity was not found, and thus, unable to meet the requirements of linear regression analysis. Therefore, time-loss data was subjected to logarithmic transformation in order to diminish potential spurious influence of extreme scores (Hopkins, 2000; Osbourne & Waters, 2010).

After log transform of injury time-loss, the assumptions for regression analysis were satisfied. The analysis revealed that the two predictors, *previous injuries* and *coping with adversity*, explain 10.9 % of the total variance of days lost due to injury (R^2_{Adj} = .109, R = 0.369, F = 49.75, P = .010) (Table 6; Appendix IV). Both predictors were significant; *previous injuries* (B_{log} = .172 → ratio (B_{Adj}) = 1.4859, ß = .248, p = .038) and *coping with adversity* (B_{log} = -.094 → ratio (B_{Adj}) = .8053, ß = -.282, p = .019).

Table 6. Regression analysis of injury predictors. Dependent variable is injury days log transformed

Independent variables	M	SD	B_{log}	Ratio ($B_{Log.adj}$)	Beta (ß)	P	95% C.I.$_{LogAdj}$ (ratio)	
Previous injuries	1.24	1.19	.172	1.486	-.254	.038	1.021	2.280
Coping with adversity	7.22	2.25	-.095	.804	.221	.019	.673	.964

Note. The present regression model is significant (R2Adj = .109, R = 0.369, P = .010).

Logistic Regression

Hypothesis 4: Prediction of injury. A logistic regression analysis was conducted with injury occurrence as dichotomous dependent variable (0 = no injuries, 1 = one or more injuries) using all potential predictors as independent variables. Not surprisingly, *previous injuries* and *coping with adversity* were found to be significant predictors (Table 7; Appendix V). A total of 87 cases were analyzed (Chi^2 = 12.241, df = 2, *P* = 0.002) predicting 82.5 % of the injured and 57.7 % of the non-injured. In total, 72.7 % of all predictions were accurate.

Table 7. Logistic regression analysis (N = 66)

Predictors	B	S.E.	df	Sig (P)	Exp (B)	95% C.I. for Exp (B)	
Previous injuries	.783	.340	1	.021	2.189	1.123	4.264
Coping with adversity	-.313	.133	1	.019	.731	.563	.949

Note. Dependent variable: Injury occurrence, yes (N = 40) or no (N = 26).

In order to conduct logistic regression, the dependent variable must be binary, and thus, the injury time-loss definition cannot be used. Instead injury time-loss is transformed to injury severity (see definition in *Introduction*). In the present analysis the cut-point for injury severity was placed between minor injuries (no injury to 7 days) and moderate injuries (more than 8 days). Logistic regression analysis using all potential predictors and injury severity as independent

variables revealed that *somatic anxiety* and *coping with adversity* where the two best predictors ($Chi^2 = 6.592$, df = 2, $P = 0.037$), however not significant (Table 8: Appendix VI). The model successfully predicted 91.1 % of all incidents with no injury incidents or injury incidents leading to less than eight days of absence. 23.8 % of all moderate and severe injuries were successfully predicted. In total, 69.7 % of all predictions were correct.

Table 8. Logistic regression analysis (N = 66)

Predictors	**B**	**S.E.**	**df**	**Sig (P)**	**Exp (B)**	**95% C.I. for Exp (B)**	
Somatic anxiety	.356	.200	1	.075	1.428	.964	2.114
Coping with adversity	-.220	.133	1	.098	.802	.618	1.042

Note. Dependent variable: Injury severity (0 = no injury or less than 8 days absence (N = 45), 1 = injuries leading to 8 days or more of absence (N = 21)).

In order to adjust for *previous injuries*, two similar logistic regression analyses were conducted using the same two dependent variables again. Obviously, it did not change output in the latter model, while previous injuries was proved insignificant contributor in predicting injury severity. However, using injury occurrence as dichotomous dependent variable, and excluding *previous injuries* from the other independent variables, the output changed: *Coping with adversity* was found significantly as the best predictor ($Chi^2 = 5.270$, df = 1, $P = 0.022$) (Table 9; Appendix VII). In this sample, 23.1 % of the non-injured players and 80.0 % of the injured players were predicted successfully. In total, 57,6 % of all predictions were accurate.

Table 9. Logistic regression analysis (N = 66). Dependent variable: Injury occurrence, yes or no (0 = no injury, 1 = one or more injuries), *previous injuries* excluded from independent variables.

Predictors	**B**	**S.E.**	**df**	**Sig (P)**	**Exp (B)**	**95% C.I. for Exp (B)**	
Coping with adversity	-.271	.124	1	.028	.762	.598	.971

Discussion

The primary purpose of the present study was to identify potential predictors of injuries among male professional soccer players in Denmark. The results showed, that *coping with adversity* and *previous injuries* were significant predictors of injury duration and near significant predictors of injury occurrence. Furthermore, the present study examined the probability to predict injury occurrence and severity. Finally, it was investigated, if previous injuries might be related to increased competitive trait anxiety, and hence leading to enlarged susceptibility to injury. These results and their relationships will be subjects to the following discussion with respect to Williams and Andersen's (1998) stress-injury model (Figure 1).

Hypothesis 1: Previous injuries and competitive trait anxiety. It was hypothesized that athletes with previous injuries would report higher level of competitive trait anxiety. Proposed by Williams and Andersen (1998) and supported by a great body of empirical research, it was hypothesized that competitive trait anxiety was positively related to sport injuries. The results indicate that players with a history of previous injury demonstrated significant higher level of somatic anxiety compared to players without previous injuries (Table 3). Although significantly related, the correlation coefficient is rather low ($r = .233$), indicating a relatively weak relationship between the two variables. Additionally, the same group of players reported an increased level of worry compared to the players without previous injuries, however not significant. These results denote that players with a history of previous injuries experience more competitive trait anxiety than players not previously injured, which is somewhat consistent with existing literature (Petrie, 1993; Lavallee & Flint, 1996; Johnson & Ivarsson, 2010).

The explanation for these results might be found when taken a closer look to the measurements. The Competitive Trait Anxiety Questionnaire obviously measures athletes' disposition to perceive competitive situations as frightening. The risk of injury is remarkably higher in competition situations compared to training settings (Andersen et al., 2004; Árnason et al., 2004; Hawkins & Fuller, 1999; Waldén, Hägglund, & Ekstrand 2005). Taken this fact into consideration, it could be speculated that trait anxiety is elevated during competition because previous experiences with injuries have changed the players' perception of competition, and hence exacerbating their stress responses. This cascade of responses could explain the significantly higher somatic anxiety among the players with previous injuries!

The above results show that players with previous injuries report higher level of somatic anxiety, indicating that injuries lead to increasing somatic

anxiety. Existing research argue that elevated competitive trait anxiety might act as a predictor to increased risk of injuries (Petrie, 1993; Lavallee & Flint, 1996; Johnson & Ivarsson, 2010). However, no such predictive relationship was found in the current study. Possible explanations of this result will be elaborated in subsequent discussions and compared with other results from the present study

Hypothesis 2: Correlations between injured and non-injured players. It was hypothesized that high level of competitive trait anxiety, incidents of previous injuries, and low coping resources would contribute to increased vulnerability to injury. In order to avoid confusion it is emphasized, that high scores in the Competitive Trait Anxiety Questionnaire are hypothesized to increase injury vulnerability, whereas high scores in ACSI-28 indicates high coping skills, and hence assumed to reduce the risk of injury occurrence and injury duration. The results showed, that athletes without a history of previous injuries and who cope well with adversity are less prone to injury.

Coping skills. Only one of the five subscales measuring coping skills was found significantly related to injuries, thus no clear relationship between general coping resources and injuries can be proved. Compared to previous studies (Lavallee & Flint, 1996; Van Mechelen et al., 1996, Johnson & Ivarsson, 2010), these results are not surprising, while no direct relationship between injury occurrence and coping resources was found. However, other studies (Smith, Smoll, & Ptacek, 1990; Hanson et al., 1992; Petrie, 1993; Noh et al., 2005; Maddison & Prapavessis, 2005) found positive relationships between low coping resources and the frequency of injuries. These opposing results can be explained because of studies using to small study populations, or/and in the many different instruments measuring coping skills (e.g. ACSI-28, COPE, Coping Resources Questionnaire). Another valid explanation, and perhaps the most imperative in regards of research, is the statistical analyses. Stressed by Williams and Andersen (1998), the three psychosocial variables (*personality traits, history of stressors,* and *coping skills*) are all interrelated and thus, they cannot be analysed isolated. This theoretical skeleton should be mirrored in the statistical procedures. When the statistical analyses are simplified (e.g. direct relationships and/or simple correlation analysis; Lavallee & Flint, 1996), the potential influences from interactional relationships are ignored (Williams & Andersen, 2007).

As stated above, the current study found that injury occurrence was positively related to players with low *coping with adversity*. Explanations for this relationship are many, although one above all is evident: This subscale measure how well players cope with difficulties and obstacles, and especially how well players remain positive and bounce back from mistakes (Smith & Christensen, 1995). These coping strategies are directly related to a positive stress response (eus-

tress), which may help players stay focused and concentrated (Williams & Andersen, 2007), and therefore it is not unexpected, that it was the subscale, *coping with adversity*, that was found significant related to injury. Furthermore, it could be argued that these players' cognitive appraisals generally are more positive in regard to competitive situations, which also leads to eustress. Taken together, it seems prudent that players who cope well with adversity generally experience fewer injuries than those players who do not cope well with adversity. Along this string, it is supported by several empirical studies that negative life stress is positively related to injuries (Holmes, 1970; Petrie, 1993; Patterson, van Mechelen, 1996; McMurray, & Summer, 1998; Maddison & Prapavessis, 2005; Rogers & Landers, 2005). Consequently, players with good coping resources are better equipped to overcome obstacles and remain calm and controlled, and therefore less vulnerable to injury.

The current study did not screen for life stress, so a viable explanation of the present study's deviating results in the ACSI-28 might be found in the interactional relationship between general coping skills and life stress as potential predictors of injury. That is, when the interaction between coping skills and life stress is not analysed, results may not capture all facets of the complete explanation. This may also explain the relative low correlation coefficient ($r = -.279$). Recently, two studies support this hypothesis; Johnson and Ivarsson (2010) found that negative coping resources and high life stress were significant predictors of injury. Rogers and Landers (2005) showed that high levels of coping skills decrease the influence of negative life stress on injury. Although the present study did not measure life stress, it seems reasonable that life stress do influence injury.

Although it is previously mentioned, it must be stressed that the current study does not include social support in regards to coping skills. Findings from previous research on this relationship are somewhat inconsistent (Smith et al., 1990; Hardy, Richman, & Rosenfeld, 1991; Petrie, 1992). However, even though such a relationship might exist, it is not subject to the current investigation.

Previous injuries. The group of players who experienced injuries during the test period reported significant more previous injuries than the group of non-injured players. This relationship has not been investigated extensively, however, most findings support the results from the present study: Williams, Hogan, and Andersen (1993) also found a positive correlation between athletes with previous injuries and subsequent injuries. Lysens et al. (1984) and van Machelen (1996) found similar results, and a recent study by Maddison and Prapavessis (2005) showed that previous injuries are positive related to injury frequency, although as a conjunctive moderator. On the other hand, a study by Hanson et

al. (1992) found no relationship between previous injuries and subsequent injury frequency or severity. Like the present study, Hanson et al. (1992) also relied on self-reports from the athletes in regards to past injuries. However, this does not explain the deviation results compared to the findings of the current study: It is more likely that the explanation lies in the participating population. Hanson et al. (1992) addressed college student with a mean age of 20 years old (M = 19.9), which is a notable lower compared to the present study (24.6). Furthermore, this study found that 72 % of participants reported previous injury. Of the study population of Hanson et al. (1992) only 55 % reported previous injures. These fundamental differences are likely to explain, why Hanson et al (1992) did not find previous injuries as a significant predictor of injuries. The younger mean age may account for faster rehabilitation. It could also be speculated that professional athletes are under more pressure to perform compared to college student, and hence more likely to experience insufficient rehabilitation.

In general, the increased likelihood of injury caused by previous injuries can be explained from a psychological as well as from a physiological perspective: From a physiological point of view, it is suggested that inadequate rehabilitation is one of the most obvious explanations. The risk of re-injury is relatively high; between 22 % and 42 % of all injury incidents are recurrences (Hawkins & Fuller, 1999; Hägglund, Waldén, & Ekstrand, 2006). Thus, it must be recognized that a fair amount of injuries reported in this study are caused by insufficient recovery.

The psychological explanation denotes that injuries may lead to increased anxiety and negative cognitive appraisals (Williams & Andersen, 1988; 2007). These effects may lead to substantial negative stress responses, and accordingly increasing the risk of injury. The present study found that previous injury was associated to increased somatic anxiety (Table 3). However, unexpectedly no direct relationship was found between increased somatic anxiety and subsequent injury occurrence or time loss due to injury (Table 4). This result conflicts most research: Recently, Johnson and Ivarsson (2010) found that somatic anxiety and mistrust are significant predictors of injury and could explain 11 % of the variance of injury occurrence. These results replicate previous research findings (e.g. Petrie, 1993; Kolt & Kirkby, 1996; Williams & Andersen, 1998).

However, the explanation might be obvious; the players who reported high coping resources when coping with adversity also experienced fewer injuries than players with the opposite profile. Thus, it can be argued that the increased somatic anxiety caused by previous injuries do not influence injury occurrence because of the players relatively high coping resources. In other words, the influence from somatic anxiety might be insignificant because of the influence from coping with adversity. This explanation gains support from a study by

Rogers and Landers (2005). They found that various coping resources decrease not only life event stress, but also the influence from life stress on injury. Another rationalization is, that somatic anxiety actually do influence injuries vulnerability, but act as a conjunctive moderator in combination with previous injuries. However, if the influence from previous injuries on subsequent injuries are relative stronger than the influence from somatic anxiety, the effect from somatic anxiety can be underestimated. It is speculated by the author, that when adjusting for the influence from the interaction between somatic anxiety and previous injuries, the influence from somatic anxiety is significantly related to injuries. Although it is intuitive reasonable, these explanations are speculations and must be subjected to further statistical analyses before any conclusions can be made.

Hypothesis 3: Coping resources, history of previous injuries, and specific personality traits as predictors of injury. The third hypothesis anticipated that coping resources, history of previous injuries, and specific personality traits would contribute significantly to the prediction of injury occurrence and days lost due to injury. Consistent with the preceding findings of the current study, coping with adversity and previous injuries were found as the best predictors of injury occurrence, however not significant. Together, these predictors explain approximately 7 % of the total variance of injury occurrence (Table 6). Furthermore, the relational strength of this predictive model is considered weak ($R < 0.4$) (Andersen & Jakobsen, 2005). When examining analysis more closely some interesting information appears: For each incident of previous injury, it is predicted that injury incidents will increase with 0.175. In regards to coping with adversity, the opposite relationship is found, predicting that injury incidents decreases 0.86 for each point scored on the coping with adversity-subscale. Although these results might seem somewhat arbitrary, it indicates the magnitude influenced by the two variables. Despite of these relative weak results, it must be accredited, that coping with adversity and previous injuries yet again were related to injury occurrence.

This relationship is confirmed once again by the results from the other regression analysis (Table 7). Coping with adversity and previous injuries were found to be significant predictors explaining approximately 11 % of the variance of amount of days lost caused by injuries. This model indicates a stronger explanatory relationship than the first model. It must be emphasized that because of the logistic transformation of data, the regression parameter is expressed in ratio (B_{Adj}). It is predicted, that a one-unit increase on the coping with adversity-subscale, injury duration is decreased by the multiplicative factor of .81 (B_{Adj} = .8053). Thus, for each coping with adversity-unit, the days lost due to injury is reduced by almost 25 %. The influence from previous injuries is predicted to

increase subsequent injury duration with approximately 49 % for each previous injury (B_{Adj} = 1.4859). These results clearly show the magnitude that history of previous injuries and coping skills influence on the days lost due to injury. Furthermore, these results explain important information about which factors that are the most contributively variables. For example, the above results clarify how important sufficient rehabilitation is. Every previous injury accounts for approximately 50 % increase in subsequent injury duration measured in days!

Contrary to the current hypothesis, competitive trait anxiety was not found predictive of injury occurrence or injury duration. One obvious reason is analogue to the previous discussion in hypotheses 2; somatic anxiety and previous injuries are conjunctive moderators, meaning that the influence from trait anxiety are neglected in the statistical analysis because of a more powerful influence from previous injuries.

Hypothesis 4: Prediction of injury. It was hypothesized that coping resources, history of previous injuries, and specific personality traits can predict injury incidents and injury severity. The results from the logistic regression equations replicate the preceding findings of the current study. Previous injuries and coping with adversity were found significant predictors of injury occurrence. Impressive 72.7 % of all predictions were classified correctly, and impressive 82.5 % of all injury incidents were successfully predicted. In order to measure injury severity, a similar regression analysis was conducted. Injury severity was altered to a dichotomous variable, and thus moderate and severe injuries were pooled in one outcome (injury duration > 8 days). The categories no injury, slight injury, and minor injury were combined to create the other potential outcome. The analysis revealed that when predicting one of these two outcomes, somatic anxiety and coping with adversity classified 69.7 % of all predictions accurately. However, only 23.8 % of the moderate/severe injuries were successfully predicted, while 91.1 % of the sample being correctly classified in the group, no injury, slight injury, and minor injury.

Without questioning the statistical power and engaging a complex statistical discussion, it must be stressed, that although these results are statistically significant (or close to), the practical value is questionable. In order to trust these predictive values, it is required to include many more participants and/or to embrace more complex statistical designs (e.g. all interactions between potential predictors) (Rogers & Landers, 2005).

The results from the third logistic regression analysis support previous findings and hypotheses: The analysis is adjusted for the influence from previous injuries, and not surprisingly was coping with adversity singled out as the prima-

ry predictor of injury occurrence. However, the probability and its contributing effect size are remarkable lower compared to the first regression analysis. These findings clearly support the observations and rationalizations noted above: Due to the interactional contribution from previous injuries, seems coping with adversity to be at better predictor when including the influence from previous injuries. Thus, the contribution from previous injuries cannot be ignored in matter of predicting injury, and must be recognized as an important confounding variable.

Furthermore, this observation clarifies the obvious need of multivariate analyses, in order to produce valid and comprehensive results.

Methodological concerns. When the above-presented results are considered, one must also recognize the imperative variance explained by physical, environmental, and biomechanical factors. Williams and Andersen (2007) make a distinction between external and internal factors. The present study focuses on the internal factors (psychological and psychosocial factors). However, it is important to recognize that injury above all is a physical phenomenon. Injuries frequency and severity vary widely depending on the type of sport (soccer, ballet, rugby), gender, level of participation (amateur, professional), weather, training or competition and several other variables. As a result, only relatively little variance are left to be explained by the psychological factors. Thus, when comparing results from other studies it is evident to take these factors into consideration and not merely rely on the actual statistical values.

One limitation of the current study is the fact that it can be problematic to rely on only test occasion. Especially the Competitive Trait Anxiety Questionnaire is sensitive to the players' state of mind at the time of measuring. In order to report competitive trait anxiety, the players need to recall feelings associated with competition. Thus, recent experiences (good or bad) may influence the momentary recollections, however not truthfully reflecting the player's general level of anxiety. Repetitive tests would diminish this unreliability and strengthen the study. Similar concerns apply for the ACSI-28.

In opposition to most studies, the relationship between life stress/daily hassles and injuries was not investigated in the current study, although strong associations often are found. The main purpose of this study was to find psychological predictors of injuries. Life stress and daily hassles are dynamic and cannot be predicted or measured in the same way as psychological factors, and thus they were excluded from the research design. Instead, focus of the present study was the stable psychological attributes (personality traits and coping skills), which could be used to identify players at risk of injuries, in order to conduct future prevention interventions.

Despite support from existing research, history of previous injury was included as a potential predictor of injury. In light of the results of the current study this decision was obviously reasonable. However, the reliability of this information could be optimized: information about previous injuries was provided by the players themselves and not by a third-party person. Therefore, this data holds some uncertainties; e.g. did they recall the right amount of injuries within the preceding 12 months and how did the players define injuries. Correspondingly, some players might have failed to remember previous injuries, while others might have exacerbated their reports. These uncertainties are inevitable in all retrospective studies; however, they must be acknowledged as potential spurious of results and explanations of misleading results.

In matter of statistical procedures, it must be noted, that correlation analysis relies heavily on some rather rigid assumptions. If these assumptions are not met the analysis becomes unstable, and hence the influence from other potential significant variables can be underestimated (false negative). In spite of this, the current study sought to diminish these errors, by testing each linear regression for its assumptions to ensure the most valid results.

Conclusions

The main focus of this study was to outline significant predictors of injury occurrence and severity. Previous injuries and coping with adversity was found as the best predictors of injury frequency and severity. These two factors was could between explain 7 % and 11 % of the variance of injury occurrence. Furthermore, these variables successfully predicted 82.5 % of all injury incidents. In addition, somatic anxiety and coping with adversity was found as the best predictors of injury severity, however only 23.8 % of the moderate and severe injuries was predicted accurately. When adjusting for the influence from previous injuries, the influential effect from coping with adversity seems to decrease indicating a conjunctive relationship between previous injuries and coping with adversity.

Overall, the current study showed high internal consistency, repeatedly emphasizing previous injury and coping with adversity as main predictors of subsequent injury occurrence and time lost due to injury. It was also found that history of previous injuries might lead to increased somatic anxiety. These findings denote, that the influence from somatic anxiety becomes insignificant because of high coping resources, and hence, somatic anxiety does not directly lead to increased vulnerability to injury.

From a psychological perspective these findings are viable: players who cope well with adversity are less prone to the influence from somatic anxiety, and thus, they are able to remain positive and focused in potentially stressful situations. Moreover, the players are more likely to create positive appraisals, and therefore reducing risk of injury.

Conclusively, the present findings seem promising and have the potential to expand the understanding of the stress-injury relationship.

Perspectives and recommendations. The present study has established strong evidence for suggesting, that previous injuries is an important predictor of subsequent injury incidents and severity. However, only few studies have investigated this relationship, so it would be recommended, that any future research about injury antecedents also include history of previous injuries in their research design. The present study relied on the players' self-reports of previous injuries. However, more details and greater reliability can be obtained, if teams' medical staffs conduct the collection of previous injuries.

The findings of this study complement existing research by addressing how previous injuries in collaboration with coping resources and personality traits significantly influence subsequent injury vulnerability. In an applied perspective, this knowledge is evident for soccer coaches and medical staff in order to recognize the imperative role of psychological factors in regards to injury prevention. A comprehensive understanding of these relationships allow sport psychologist to target interventions more efficient. Existing research clearly indicates that specific intervention strategies have the potential to significantly reduce injury occurrence and severity (Johnson et al., 2005; Maddison & Prapavessis, 2005).

Acknowledgements

I would like to thank all players, coaches, and medical staff from Brøndby IF, Lyngby BK, Silkeborg IF, Randers FC, and Vejle Boldklub for their cooperation. Furthermore, I would like to thank Johan Wikman and particularly Glen Nielsen from University of Copenhagen for time and wisdom. Finally, I would also like to thank my supervisor Associate Professor Anne-Marie Elbe from University of Copenhagen for providing vulnerable feedback as well as showing great enthusiasm throughout the project.

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