Psychological Factors Associated with Injuries in Badminton

David P. Broadbent[1], N. Viktor Gredin[1], David B. Alder[2] and Noel P. Kinrade[3]

[1]Brunel University London, [2]Leeds Beckett University, [3]Nottingham Trent University

Contact: David Broadbent (david.broadbent@brunel.ac.uk)

Introduction

Given the cost of injuries, including the detraining associated with time away from the sport, injury prevention is a priority area of research. Specific to badminton, research of 44 elite level badminton players, found that the incidence of injuries for senior athletes was 7.4 per 1,000 hours of play (Yung et al., 2007). Badminton-related injuries are also common in recreational and beginner players. Fahlström et al. (1998) conducted a five-year review of emergency department records in Sweden and found that 90.7% of badminton-related cases were recreational/beginner players. Despite badminton being one of the most widely played sports in the world, there is a clear disparity in relation to the amount of attention it has received with regard to sports injury. Research from other domains has highlighted that internal factors, which influence the vulnerability to injury, include physiological and psychological factors (see Williams & Andersen, 2007). The psychological factors associated with injury is an area still lacking in substantial evidence and one that could play an important role in attempts to understand, prevent, and rehabilitate, injuries in badminton.

One of the most recognised models that establishes a connection between psychological factors and sport injuries is the Stress–Injury model (Williams and Andersen, 1998). The model, which centres on stress, highlights three main categories of risk factors for injury: 1) History of stressors, 2) Coping resources, and 3) Personality.

The first category, history of stressors, includes negative life stress, daily hassles and past injury. Injury history data is usually collected by self-report surveys (Gabbe et al., 2003) and previous research has shown that past injury history is particularly related to injury outcome (Yung et al., 2007).

The second category, coping resources, concerns relaxation, stress management, self-confidence, and arousal control, which can be measured using one of several different questionnaires including the Athletic Coping Skill Inventory (ACSI-28; Smith et al, 1995). Using a modified version of this questionnaire, Hanson et al. (1992) found that coping resources were the best discriminator for number of injuries across various sports. Athletes with a high number of coping resources are less exposed to injury risks, and show greater recovery from injuries, in comparison to athletes with fewer coping resources (Rogers & Landers, 2005).

The final category, personality, affects an individual's perception of stressful states (Petrie, 1993). Most notable is the positive relationship found between a sport injury and trait anxiety (Maddison & Prapavessis, 2005). The intensity of anxiety, which can be measured using questionnaires such as the State Trait Anxiety Inventory (STAI; Spielberger et al., 1983) and Sport Anxiety Scale (SAS; Smith et al., 1990), is a crucial factor in determining how athletes perceive and perform on a task. Kerr and Fowler (1988) found that athletes with high levels of trait anxiety reported narrow concentration and attention problems, while Andersen and Williams (1999) found a positive relationship between sport injuries and both anxiety and peripheral narrowing. It appears that in sport, situations deemed as stressful or threatening cause increases in anxiety, eliciting a variety of changes in focus of attention and muscle tension (e.g. distraction and tightening up). As such, personality traits closely related to *movement control*, could be crucial, but are not currently detailed in the Stress-Injury model.

The psychomotor aspects of movement control have been conceptualised through *reinvestment* (Masters & Maxwell, 2008). The theory of reinvestment states that consciously observing, monitoring, or controlling movements can hinder the automatic execution of already highly trained movements. Studying people's thoughts or expectations regarding their own movements has been used to explain error-prone movements in a range of populations (e.g. elderly population; Wong et al., 2008). Research suggests that the adoption of stiffening strategies, whereby individuals attempt to consciously control their movements, results in error prone movements, most often in the lower body (Staab et al., 2013). Research in badminton has shown that lower extremity injuries are the most common including Achilles tendon ruptures, knee injuries and ankle sprain/fractures (Fahlström et al., 1998). The propensity to consciously reinvest on one's own movements resulting in error-prone movements may be related to prevalence of injuries in badminton but this has yet to be examined.

Johnson and Ivarsson (2011) used the Stress-Injury model to examine a variety of psychological predictors of sport injuries among junior soccer players. They found that life event stress, somatic trait anxiety, mistrust, and ineffective coping resources were significant predictors and could be used to predict 67.4% of the cases successfully. In other words, approximately two out of three athletes in the study were sorted correctly into either the injured or the non-injured group based on these psychological factors. The authors used these findings to develop an empirical model of injury risk factors, specifically for junior soccer players, based on the Stress-Injury Model (Williams & Andersen, 1998). Such a study has not been completed in badminton resulting in a lack of understanding of the psychological factors associated with injury in the sport. Moreover, it is essential to investigate additional psychological factors, such as the propensity to reinvest, and their relation to increased injury risk, to advance current models. The development of a model bespoke to badminton has the advantage of summarizing empirical findings, facilitating a systematic understanding of factors influencing injuries in badminton and allowing for recommendations to be made to sport medicine teams and coaches to aid the prevention and rehabilitation of injuries in the sport.

Accordingly, the nature of this study is explorative, with three main aims. Firstly, to examine the differences in psychological factors, specifically personality traits and coping resources, between badminton players of all skill levels who had experienced an injury in the last 24 months and those that had not been injured. Secondly, to investigate the relationship between number of injuries sustained and psychological factors. Finally, we aimed to see whether the psychological factors were moderated by the types and causes of injuries. This project is based around the Stress-Injury model (Williams & Andersen, 1998) and attempts to provide a start point for the development of a badminton-specific model of psychological factors associated with injury.

Hypotheses:

- Players who have had an injury in the last 24 months will have increased trait anxiety (STAI and SAS scores), increased propensity to reinvest (MSRS scores), decreased risk-taking behaviour (RPS scores), and less coping resources (ACSI-28 scores) compared to players with no previous injuries.
- Number of injuries will have a positive relationship with trait anxiety (STAI and SAS scores), and propensity to reinvest (MSRS scores), but a negative relationship with coping resources (ACSI-28 scores) and risk-taking behaviour (RPS scores).
- Skill level, type of injury, cause of injury, and body region injured, will all be moderating factors in the above predictions.

Method

Participants

To take part in the study, participants had to currently play badminton, but the skill level of the individual did not matter as we wanted a variety of badminton players. Moreover we recruited participants who had, and who had not, experienced a badminton-specific injury in the last 24 months. Approximately 70 badminton organisations and clubs were contacted and asked to promote participation in this study through emails and posters. 148 participants began the questionnaire with 94 fully completing it, resulting in a 36% internal dropout. Incomplete questionnaires were not included in the data analysis. Of the 94 participants to complete the questionnaire, 53 were male and 41 were female, with the ages ranging from 18 years old to 68 years old (M = 32.3, SD = 16.2). The participants current playing level was categorised in to six groupings; recreational (n = 17), local club (n = 50), county (n = 18), regional (n = 2), national (n = 3), and international (n = 4). The average start age in badminton was 14.6 years (SD = 7.4), and the participants played an average of 4.4 hours (SD = 2.6) of badminton per week. All participants gave their written informed consent before they took part in the study. The study was approved by the Research Ethics Committee of Brunel University London and conformed to the recommendations of the Declaration of Helsinki.

Procedure

Once a participant decided to take part, then the full procedure was completed online using Qualtrics, a computer software that produces online surveys. Participants were required to read the participant information sheet and then sign a consent form. Following this the participants completed a demographics questionnaire, an injury history questionnaire, the Sport Anxiety Scale (SAS), the State Trait Anxiety Inventory (STAI), Movement Specific Reinvestment Scale (MSRS), the Athletics Coping Skills Inventory (ACSI-28), and the Risk Propensity Scale (RPS). On average the participants took approximately 15minutes to complete the questionnaires in full.

Measurements

Demographic Questionnaire. Participant’s age, gender and skill level (i.e. recreational, local club, county, regional, national, international) was collected, as was how many years they have played badminton and the hours per week currently spent playing the sport.

Injury History Questionnaire. The injury history questionnaire contained the following questions for participants to answer based on the last 24 months; have you sustained an injury, if yes then what type of injury was it, what body region was injured, what the cause of the injury was, and how severe the injury was (severe, moderate, minor). A severe injury was defined as an injury which required hospitalisation, a moderate injury was defined as an injury which received other healthcare attention such as from a physiotherapist, and a minor injury was defined as an injury that was self-treated. These questions and definitions were adapted from multiple research papers outlining self-recall of sports injuries (Clarsen et al., 2012; Gabbe et al., 2003; Valuri et al., 2018).

Athletic Coping Skills Inventory-28 (ACSI-28; Smith et al., 1995). ACSI-28 has 28 items, classified in seven categories, which measure an athlete’s general coping skills. The categories are coping with adversity, peaking under pressure, goal setting, concentration, freedom of worry, confidence and coachability. Questions were answered on a four graded Likert scale, ranging from 0 (not at all) to 3 (very much so). The ACSI has a good test–retest reliability of 0.87 (Smith et al., 1995).

State Trait Anxiety Inventory (STAI; Spielberger et al., 1983). STAI has 40-items (20 state and 20 trait) used to measure current state and trait anxiety. Only the items related to trait anxiety were included in the current project. The trait items described the participants' general anxiety level. Questions were answered on a four-graded Likert scale, ranging from 1 (not at all) to 4 (very much so). The STAI has good test–retest coefficients ranging from 0.73 to 0.86 for trait items (Spielberger et al., 1983).

Sport Anxiety Scale (SAS; Smith et al., 1990). SAS has 20 items, classified in three categories, which measure an athlete's anxiety level. The categories are somatic anxiety (nine items), worry (seven items) and concentration disrupters (five items). Questions were answered on a four-graded Likert scale, ranging from 1 (not at all) to 4 (very much so). SAS has a good test–retest reliability of 0.85 (Smith et al., 1990).

Movement-Specific Reinvestment Scale (MSRS; Masters & Maxwell, 2005). The MSRS is a 10-item scale that contains five items assessing movement self-consciousness and five items assessing conscious motor processing. Participant responded to using a five-graded Likert scale from 0 (extremely uncharacteristic) to 4 (extremely characteristic). The MSRS has good test-retest reliability for both the movement self-consciousness ($r = .67$, $p < .05$) and conscious motor processing ($r = .76$, $p < .05$) factors (Masters & Maxwell, 2005).

The Risk Prosperity Scale (RPS; Meertens & Lion, 2008). The RPS is a 7-question form used to determine general risk-taking tendencies and categorise the participants as high or low risk-takers. The form was slightly modified to be badminton specific and the statements were answered using a 7-point Likert scale ranging from 1 (totally disagree) and 7 (totally agree).

Data Analysis

Descriptive statistics were used to describe the injury history profile of the participants, detailing the number of participants who had experienced any injury in the last 24 months, the type of injury, the body region injured, and the cause of the injury. Once participants with a previous injury, and those that had not sustained any previous injuries, had been identified a one-way analysis of variance (ANOVA) was used for comparing the psychological questionnaire data between the groups. Further analysis of this data was conducted through additional ANOVA analyses on the data split by skill level (i.e. recreational, local club, county, national, international). Correlations were used to examine the relationship between the psychological factors and the number of injuries. Finally, the descriptive injury data, such as the injury region, cause and type, was transformed in to a binary yes or no response to allow for follow up logistic regressions to further scrutinise the psychological factors associated with specific types of injuries. For the region of the injury, the body parts were grouped in to three categories; upper limb (i.e. shoulder, elbow, wrist, hands/fingers), lower limb (i.e. hip/groin, pelvis/buttock, thigh, knee, lower leg, ankle, foot/toes), and trunk and head (i.e. head/face, neck, lumbar spine, abdomen).

Results

Of the 94 participants, 56% had sustained a badminton-specific injury in the last 24 months. Figure 1 shows the breakdown of the body regions where the reported injuries occurred. The majority of injuries reported occurred in either the ankle, shoulder, or knee, with either a muscle or tendon sprain or a joint or ligament sprain accounting for the nature of the injury (Table 1). The causes most often cited were overuse, twist or change of direction, and overstretch (Figure 2). The majority of injuries were minor and self-treated (*n* = 31) or moderate and required healthcare attention by individuals such as physiotherapists (*n* = 17), while very few of the injuries were severe and involved professional medical attention from a doctor or surgeon (*n* = 5). The reported injury-induced time out of the sport ranged from a few days to over a year and varied across participants (1-7 days [*n* = 16], 8-21 days [*n* = 13], over 22 days [*n* = 21]).

Table 1. The number of participants who reported each different type of injury

	Fracture	Joint or Ligament sprain	Joint or Ligament tear/rupture	Muscle or Tendon Strain	Dislocation	Other
Number of Participants	1	22	4	38	1	7

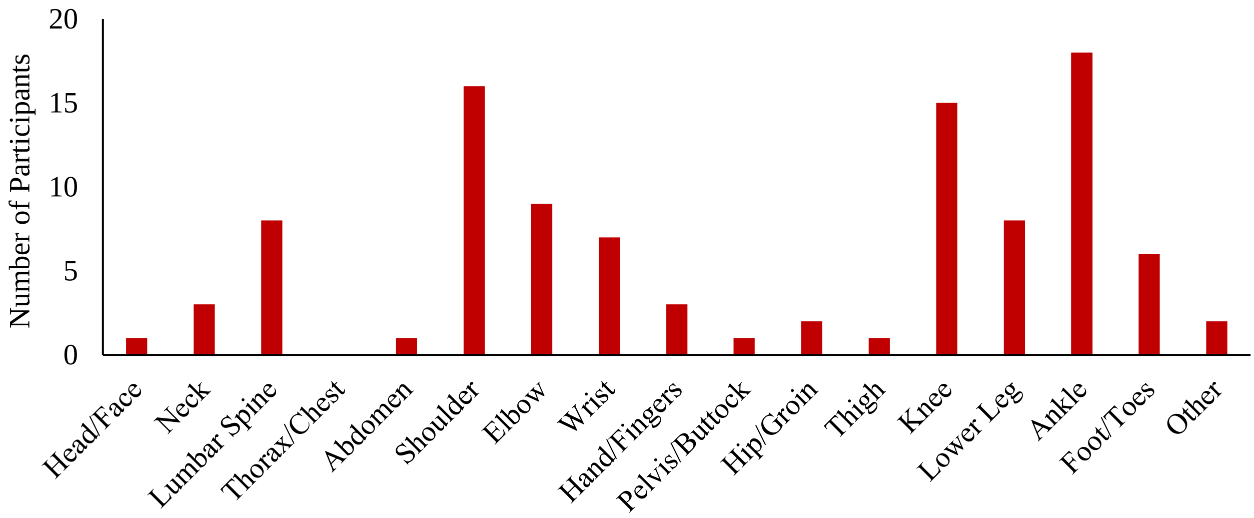

Figure 1. The different body regions where the reported injuries occurred and the number of participants who reported each region

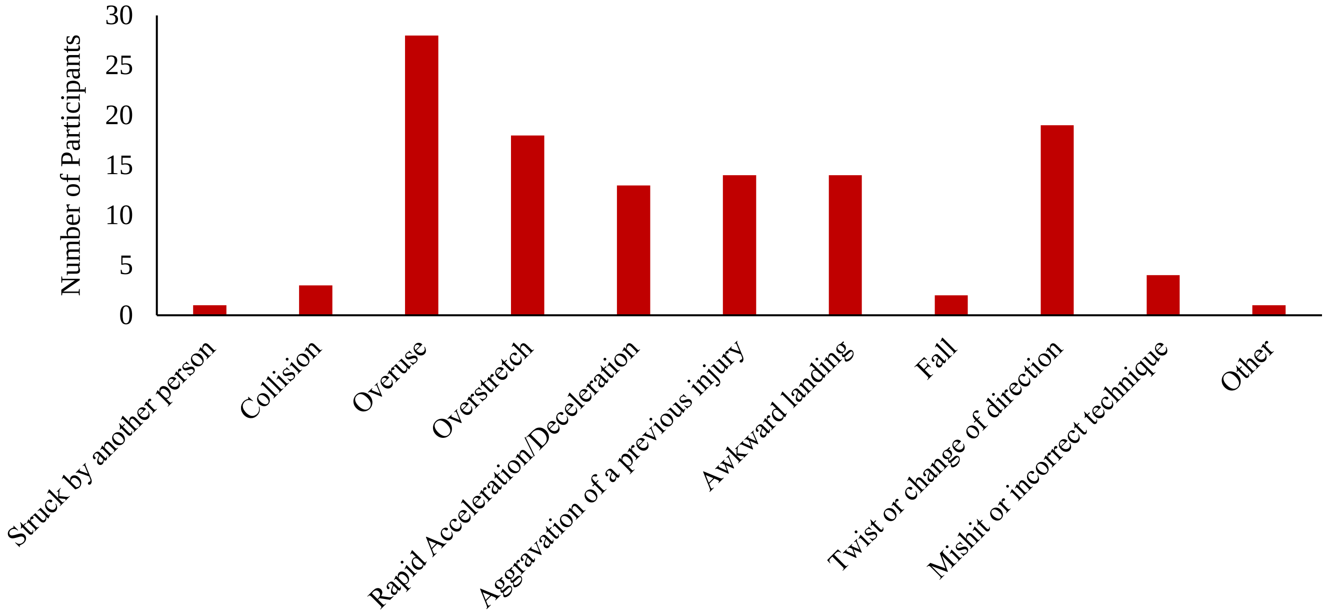

Figure 2. The different causes of injuries reported and the percentage of participants who reported each cause

One-way ANOVA revealed that participants who reported having an injury in the last 24 months had significantly higher trait anxiety scores (*M* = 42.81, *SD* = 9.17) on the STAI compared to participants who had not sustained an injury (*M* = 36.90, *SD* = 8.24), F (1, 93) = 10.47, p = .002 (see Figure 3). Moreover, responses on the ACSI-28 revealed that those with a previous injury had significantly lower scores on the coping subcategory (*M* = 9.68, *SD* = 2.35) compared to those that had not sustained a previous injury (*M* = 10.71, *SD* = 2.66), F (1, 93) = 3.94, p = .05. No other psychological factors were significantly different.

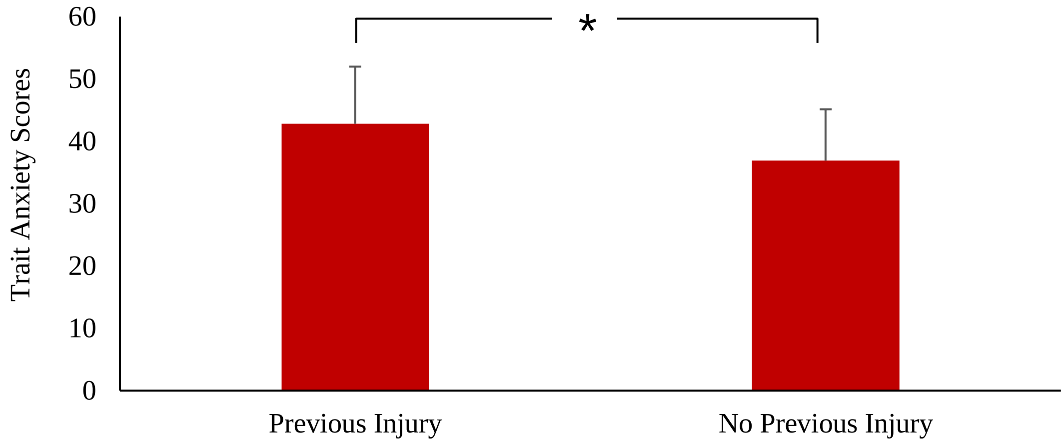

Figure 3. The mean (SD) trait anxiety scores on the STAI for participants who had experienced a badminton injury in the last 24 months (i.e. Previous Injury) and those that had not (i.e. No Previous Injury)

Correlational analysis supported the ANOVA findings, as trait anxiety, from the STAI scores, had a significant positive relationship with the number of injuries experienced, *r* = .24, *p* = .02. Similarly, SAS scores were significantly correlated with the number of injuries, *r* = .24, *p* = .02, although this was driven by the significant positive relationship between the somatic anxiety scores and the number of injuries, *r* = .32, *p* = .001. Finally, a significant negative relationship was found between the scores on the coping subcategory of the ACSI-28 and the number of injuries, as the number of injuries increased the coping scores on the ACSI-28 decreased, *r* = -.21, *p* = .04. Table 2 provides all the correlational data for the number of injuries and the scores on the questionnaires.

To interrogate the findings further, the data was split by skill level (recreational, local club, county, regional, national, international) and then separate ANOVAs were performed to compare psychological factors at each skill level. Given the low number of participants in some skill levels, this data should be viewed with caution and is only included to generate discussion for future research. It seems that the differences found in the overall data is mainly driven by the participants at Local Club level (*n* = 50; injured = 32, non-injured = 18) as this was the largest group of participants. For the Local Club players, STAI scores, *F* (1, 93) = 10.47, *p* = .002, and ACSI-Coping scores, *F* (1, 93) = 10.47, *p* = .002, were found to be significantly different between participants who had previous injuries and those who did not. Moreover, SAS-Somatic scores were significantly different for the Local Club players, as the participants with previous injuries reported significantly higher somatic anxiety scores (*M* = 9.31, *SD* = 3.87) compared to the participants with no previous injuries (*M* = 7.17, *SD* = 2.36), *F* (1, 49) = 4.55, *p* = .04. For the recreational players (*n* = 17; injured = 7, non-injured = 10), the only significant difference was found on the RPS with the previously injured participants having significantly lower risk-taking scores (*M* = 21.43, *SD* = 4.58) compared to those with no previous injuries (*M* = 29.00, *SD* = 6.98), *F* (1, 16) = 6.28, *p* = .02. No significant differences were found on any of the questionnaires for the County players (*n* = 18; injured = 10, non-injured = 8) and analysis was not conducted on the regional players given the low numbers (*n* = 2). Finally, due to the low numbers, the National and International participants were joined together (*n* = 7; injured = 4, non-injured = 3). The findings revealed that for national and international participants, the SAS scores were significantly different, *F* (1, 6) = 8.45, *p* = .03, and this was driven specifically by the fact that the participants who had sustained a previous injury had significantly higher scores on the SAS-Worry subcategory (*M* = 16.00, *SD* = 3.27) compared to the participants with no previous injuries (*M* = 8.67, *SD* = 2.31), *F* (1, 6) = 10.80, *p* = .02. Moreover, unlike the other skill levels, the elite players who had sustained previous injuries had significantly greater scores relating to Movement Self-Consciousness on the MSRS (*M* = 16.00, *SD* = 2.16) compared to elite players with no previous injuries (*M* = 7.67, *SD* = 3.79), *F* (1, 6) = 13.95, *p* = .01.

Table 2. Correlation data between the number of injuries and the scores on the psychological questionnaires. STAI = State Trait Anxiety Inventory; MSRS (Total) = Movement Specific Reinvestment Scale; MSRS (MSC) = Movement Self-Consciousness; MSRS (CMP) = Conscious Motor Processing; SAS (Total) = Sport Anxiety Scale; SAS (Som) = Somatic Anxiety; SAS (Wor) = Worry; SAS (Conc) = Concentration; ACSI (Total) = Athletic Coping Skills Inventory; ACSI (Cop) = Coping with Adversity; ACSI (Coa) = Coachability; ACSI (Conc) = Concentration; ACSI (Conf) = Confidence; ACSI (GS) = Goal Setting; ACSI (PUP) = Peaking Under Pressure; ACSI (FFW) = Freedom From Worry; RPS = Risk Prosperity Scale.

	No. of Injuries	STAI	MSRS (Total)	MSRS (MSC)	MSRS (CMP)	SAS (Total)	SAS (Som)	SAS (Wor)	SAS (Conc)	ACSI (Total)	ACSI (Cop)	ACSI (Coa)	ACSI (Conc)	ACSI (Conf)	ACSI (GS)	ACSI (PUP)	ACSI (FFW)	RPS
No. of Injuries		.238*	.052	.005	.093	.236*	.324**	.102	.165	-.099	-.212*	-.037	-.122	-.060	.082	-.023	-.100	-.043
STAI	.238*		.337**	.343**	.254*	.526**	.395**	.407**	.499**	-.585**	-.533**	-.381**	-.397**	-.504**	-.203*	-.298**	-.429**	-.214*
MSRS (Total)	.052	.337**		.906**	.881**	.394**	.179	.439**	.301**	-.031	-.052	-.157	.112	.080	.092	.233*	-.444**	-.021
MSRS (MSC)	.005	.343**	.906**		.598**	.350**	.086	.438**	.282**	-.230*	-.188	-.302**	-.059	-.110	-.138	.102	-.394**	-.101
MSRS (CMP)	.093	.254*	.881**	.598**		.355**	.243*	.341**	.255*	.197	.112	.039	.278**	.273**	.328**	.327**	-.400**	.074
SAS (Total)	.236*	.526**	.394**	.350**	.355**		.790**	.865**	.741**	-.411**	-.354**	-.159	-.246*	-.304**	.018	-.096	-.734**	-.095
SAS (Som)	.324**	.395**	.179	.086	.243*	.790**		.474**	.442**	-.200	-.200	-.059	-.151	-.203*	.099	-.009	-.403**	-.043
SAS (Wor)	.102	.407**	.439**	.438**	.341**	.865**	.474**		.488**	-.393**	-.316**	-.210*	-.147	-.196	.008	-.071	-.833**	-.047

*****$p < .05$ **$p < .01$

Table 2 (Continued)

	No. of Injuries	STAI	MSRS (Total)	MSRS (MSC)	MSRS (CMP)	SAS (Total)	SAS (Som)	SAS (Wor)	SAS (Conc)	ACSI (Total)	ACSI (Cop)	ACSI (Coa)	ACSI (Conc)	ACSI (Conf)	ACSI (GS)	ACSI (PUP)	ACSI (FFW)	RPS
SAS (Conc)	.165	.499**	.301**	.282**	.255*	.741**	.442**	.488**		-.406**	-.350**	-.082	-.352**	-.389**	-.087	-.180	-.442**	-.175
ACSI (Total)	-.099	-.585**	-.031	-.230*	.197	-.411**	-.200	-.393**	-.406**		.850**	.655**	.777**	.781**	.603**	.659**	.370**	.301**
ACSI (Cop)	-.212*	-.533**	-.052	-.188	.112	-.354**	-.200	-.316**	-.350**	.850**		.533**	.705**	.666**	.432**	.463**	.234*	.152
ACSI (Coa)	-.037	-.381**	-.157	-.302**	.039	-.159	-.059	-.210*	-.082	.655**	.533**		.439**	.465**	.305**	.240*	.192	.282**
ACSI (Conc)	-.122	-.397**	.112	-.059	.278**	-.246*	-.151	-.147	-.352**	.777**	.705**	.439**		.607**	.322**	.515**	.103	.198
ACSI (Conf)	-.060	-.504**	.080	-.110	.273**	-.304**	-.203*	-.196	-.389**	.781**	.666**	.465**	.607**		.497**	.359**	.168	.193
ACSI (GS)	.082	-.203*	.092	-.138	.328**	.018	.099	.008	-.087	.603**	.432**	.305**	.322**	.497**		.371**	-.086	.055
ACSI (PUP)	-.023	-.298**	.233*	.102	.327**	-.096	-.009	-.071	-.180	.659**	.463**	.240*	.515**	.359**	.371**		.024	.353**
ACSI (FFW)	-.100	-.429**	-.444**	-.394**	-.400**	-.734**	-.403**	-.833**	-.442**	.370**	.234*	.192	.103	.168	-.086	.024		.148
RPS	-.043	-.214*	-.021	-.101	.074	-.095	-.043	-.047	-.175	.301**	.152	.282**	.198	.193	.055	.353**	.148	

*****$p < .05$ **$p < .01$

While scores on the MSRS did not correlate with number of injuries for all the participants (see table 2), further exploration in to the correlational data regarding the potential role of movement self-consciousness with regards to other psychological factors revealed that the total score for the MSRS, and both the subcategories (movement self-consciousness and conscious motor processing), showed a significant positive correlation with the STAI and the SAS (driven mainly by the Worry subcategory), demonstrating the positive relationship between reinvestment and anxiety (see Table 2). Anxiety scores from both the STAI and SAS also significantly correlated with the scores from the ACSI-28, demonstrating that the more coping resources an individual has the lower the levels of anxiety (see Table 2).

Finally, logistic regression partly supported the ANOVA and correlational data by showing that the only significant predictor of participants with a previous injury versus no previous injury (R^2 = .14 Hosmer & Lemeshow, .17 Cox & Snell, .23 Negelkerke, $X^2(8) = 7.59$, P = .47) was the STAI total (b = .11, SE = .04, P = .008). With regards to what participants attributed previous injuries to, overuse injuries (*n* = 28; R^2 = .20 Hosmer & Lemeshow, .22 Cox & Snell, .31 Negelkerke, $X^2(8) = 4.99$, P = .69) were also significantly predicted by STAI total scores (b = .09, SE = .04, P = .045), whilst overstretch injuries (*n* = 18; R^2 = .19 Hosmer & Lemeshow, .17 Cox & Snell, .27 Negelkerke, $X^2(8) = 5.60$, P = .76) were significantly predicted by ACSI Coping scores (b = -.60, SE = .29, P = .04). There were no significant predictors for acceleration/deceleration (*n* = 14), aggravate previous injury (*n* = 14), awkward landing (*n* = 14) or twisting injuries (*n* = 19). Examination by area that was previously injured revealed upper limb injuries (*n* = 30; R^2 = .14 Hosmer & Lemeshow, .16 Cox & Snell, .22 Negelkerke, $X^2(8) = 5.36$, P = .72) were predicted by ACSI Concentration (b = -.60, SE = .29, P = .04), lower limb injuries (*n* = 36; R^2 = .22 Hosmer & Lemeshow, .26 Cox & Snell, .35 Negelkerke, $X^2(8) = 7.75$, P = .46) were predicted by STAI total (b = .09, SE = .04, P = .041) and SAS Somatic scores (b = .42, SE = .21, P = .045), whilst injuries to the trunk and head (*n* = 10) revealed no significant predictors. Finally, closer inspection by examining injury type independently revealed that whilst muscle or tendon strain injuries (*n* = 38; R^2 = .20 Hosmer & Lemeshow, .23 Cox & Snell, .32 Negelkerke, $X^2(8) = 5.61$, P = .69) were predicted by STAI total (b = .09, SE = .04, P = .02) and ACSI coping scores (b = -.48, SE = .23, P = .04), joint or ligament sprain (*n* = 22) revealed no significant predictors.

Discussion

The overarching aim of this explorative study was to develop a preliminary model of psychological factors associated with injuries in badminton. In order to achieve this, a large sample of badminton players from a range of skill levels were recruited and tasked with completing an online form. This form involved a history of injury questionnaire and multiple psychological questionnaires to measure personality traits, including anxiety, reinvestment and risk propensity, and also the coping resources that the individual had. We examined differences in these psychological factors between players that had sustained previous badminton injuries and those who had not. Furthermore we investigated the relationships between the psychological factors and the number of injuries sustained. Finally, we investigated what psychological factors were most associated with specific types of injuries.

The injury history data was in line with previous research in badminton as we found that lower limb injuries were the most common, with the majority of these being either an ankle or knee injury (Fahlström et al., 1998; Goh et al., 2013; Shariff et al., 2009). However, similar to the study by Muttalib et al. (2009), we also found that shoulder injuries were very common. With regards to the type and cause of injury, findings support those reported by Reeves et al. (2015), as a large proportion of injuries were ligament sprains/tears in the lower limb and as a result of movements involving turning and/or changes of direction. However, the most frequent type of injury cited in the current study was a muscle or tendon strain, and the highest cause of injury was through overuse. While the study by Reeves et al. (2015) mainly focused on recreational and local club players, previous research with elite badminton teams showed that 74% of injuries were caused by overuse injuries (Jørgensen et al., 1987). Given the range of skill levels recruited in the current study, it is no surprise that there was a diverse range of injuries, and that we show support for a range of previous research. Overall though, the current study aligns with previous work by demonstrating that badminton-specific injuries are prevalent in players regardless of skill level, with 56% of the participants in the current study having sustained an injury in the last 24 months. This provides a strong rationale for research to be conducted on identifying risk factors associated with injuries.

While most of the previous research examining injury risk factors has focused on physiological factors, such as training load (Fahlström et al., 2002), or biomechanical factors, such as kinematic positioning (Kimura et al., 2011), the current study focused on psychological factors, which is an area with comparatively little research. In the current study, when comparing psychological factors between badminton players who had experienced an injury in the last 24 months, with those that had not sustained a previous injury, a number of significant differences were found. Firstly, players who had experienced a previous injury had significantly higher trait anxiety scores compared to players with no previous injuries. Moreover, as trait anxiety scores increased so too did the number of previous injuries that the participants had sustained. This supports previous research that demonstrates a positive relationship between sport injuries and trait anxiety (Maddison & Prapavessis, 2005). However, due to the design of the current study (i.e. psychological data collected retrospectively after injuries) it cannot be concluded with confidence whether the personality trait of anxiety is a risk factor for injuries or an outcome from experiencing an injury. This important question requires future research in badminton and could follow a similar design to previous research in other sports (i.e. Johnson & Ivarsson, 2011). Despite this limitation, the current study did identify that anxiety scores from the SAS also positively correlated with the number of injuries and that this was driven by the somatic anxiety scores specifically. This supports the study by Johnson & Ivarsson (2011) who demonstrated that somatic trait anxiety was a significant injury risk factor in football players. This suggests that the findings of the current study are in line with previous research on injury risk factors as well as outcome factors following an injury.

The current study also revealed that participants who had sustained a previous injury had significantly lower scores related to coping resources compared to participants with no previous injuries, and that there was a negative relationship between the number of injuries and the number of coping resources. This supports previous research that showed a lack of coping resources resulted in a greater number of injuries (Hanson et al., 1992) and that athletes with a high number of coping resources are less exposed to injury risks (Rogers & Landers, 2005). This finding points to the possible use of an intervention to enhance an individual's coping resources in an attempt to reduce the chance of an injury. Johnson et al. (2005) investigated the possibility of preventing sport injuries using psychological skills training among elite soccer players. Participants who received a brief cognitive intervention (e.g., relaxation and stress management), reported significantly fewer injuries after the 5-month intervention than players who did not receive the intervention. Similarly, Maddison and Prapavessis (2007) demonstrated that it was possible to prevent sport injuries by improving the athletes' coping skills, through stress management and self-confidence training (see also Perna et al., 2003). Future research is required to examine if interventions of this type can also be used to reduce the likelihood of injuries in badminton.

Contradictory to our hypotheses, the propensity to reinvest, as measured through the MSRS, or propensity to take risks, as measured through the RPS, did not differ significantly between participants who had sustained a previous injury and those that had not, and did not show any relationship with the number of injuries sustained. However, when the data was split by skill level it was found that the psychological factors associated with injury differed between groups, specifically with regards to the recreational players and the national/international players. For the recreational players, participants who had experienced a previous injury had significantly lower risk-taking scores compared to the participants with no previous injuries. It may be that individuals lower in skill level also lack confidence in how they play and thus will alter their behaviour to take less risks and subsequently reduce the likelihood of incurring another injury. Woodman et al., (2013) conceptualised risk taking as consisting of two contrasting factors ‘deliberate risk taking’ and ‘precautionary behaviours’. They found that ‘deliberate risk taking’ was positively correlated with both accidents and close calls in extreme sports and ‘precautionary behaviours’ was negatively related with these outcome measures. Future research is required to examine whether precautionary behaviours are undertaken by recreational badminton players that have experienced an injury and whether this positively effects the likelihood of another injury occurring.

For the national/international participants, the players with a previous injury had significantly greater scores relating to movement self-consciousness on the MSRS compared to the elite participants with no previous injuries. This supports recent findings in baseball, which showed that expert pitchers who had previously sustained an injury had an internal attentional focus resulting in poorer performance when compared with the expert players who had not been previously injured (Gray, 2015). The theory of reinvestment states that narrowing one’s attention to internally monitor or control movements can hinder the automatic execution of highly trained movements (Masters & Maxwell, 2008). Based on this explanation, the propensity to reinvest relies on the fact that the individual is in the autonomous stage of learning, which recreational and local club players may not necessarily be, and also that the individual has the knowledge about how to correctly complete the movements required, which again may not be the case for many beginners and intermediate players who have not had appropriate formal training. Based on reinvestment theory, it is suggested that novice performers rely on explicit knowledge, manipulated by working memory and processed in an 'online' step-by-step fashion, and therefore remains unaffected from pressure-induced attention. Beilock and Carr (2001) examined this with novice participants on a golf-putting task, where they tested putting performance under pressure both early and late in practice. Their results indicated that pressure actually facilitated execution in the early test trials. However, following prolonged practice, performance decrements under pressure were observed. It was concluded that the autonomous performances of skilled performers are disrupted by pressure, whereas novice skill execution, which requires online processing, remained unaffected. Based on the previous research findings, and the findings from the current study, it could be argued that the propensity to reinvest is a factor only associated with injuries for elite participants as they are the only skill level to experience motor execution impairment due to attentional changes. However, this suggestion requires further research, especially given the low sample size of elite participants in the current study, which means the findings should be viewed with caution.

While MSRS scores for all the participants did not correlate with number of injuries, the current study did show support for previous findings that high levels of trait anxiety often results in peripheral narrowing and attention problems (Kerr & Fowler, 1988). Scores on the MSRS had a positive correlation with trait anxiety scores on the STAI and the SAS. So, although an individual's propensity to reinvest may only be a factor directly associated with injury for high level badminton players, it appears that regardless of skill level, as trait anxiety increases so does the propensity to reinvest and consciously control ones' movements, ultimately resulting in detrimental effects on performance (Masters & Maxwell, 2008). Practitioners, coaches, and players should consider this when developing and conducting interventions that reduce a player's anxiety levels and propensity to reinvest, such as those discussed in a previous paragraph (Johnson et al., 2005; Maddison & Prapavessis, 2007; Perna et al., 2003). Additional support for this suggestion is also demonstrated in the current study as coping resources, as shown through the ACSI-28 scores, had a negative relationship with trait anxiety levels, as shown through the STAI and SAS. In other words the more coping resources an individual has the lower the levels of anxiety, which will ultimately impact the likelihood of sustaining an injury.

Finally, the findings from the logistic regressions revealed that the scores on the STAI was the only psychological factor that predicted whether an individual had sustained a previous injury or not, providing further confirmation that trait anxiety appears to be the strongest psychological factor associated with injury in badminton. Closer inspection of the injury data to see if the psychological factors changed according to the cause, area, and type of injury gave an interesting insight into moderating factors of the overarching findings. The two biggest causes of injuries were overuse and overstretching, and it appears that psychological factors associated with these are trait anxiety and coping resources, respectively. None of the other causes had any significant factors associated with them and this is most likely down to small *n* values. Examination of body region that was injured revealed lower limb injuries were associated with STAI and SAS Somatic scores, and upper limb injuries were associated with ACSI Concentration. This last finding is particularly interesting given this is the first finding in the study linked to concentration. The upper limbs are the area most commonly associated with movement of an additional external component, the racquet swing, and will therefore naturally involve additional attentional demands. When players hold the racquet and perform a shot, they are using muscular effort to overcome and control the object's inherent inertia. This type of muscular exertion, in combination with stimulation of mechanoreceptors in the skin and other tissues, has been termed kinaesthetic or dynamic touch. Whilst cross referencing of the answers generated in the study was not possible in the current design, it would be interesting, based on previous findings (Hove, Riley & Shockley, 2006), to examine whether injuries to this area were a result of impact/collision, as a result of an impairment to kinaesthetic touch that was moderated by concentration.

Analysis of injury type revealed that muscle or tendon strain injuries were predicted by STAI and ACSI coping scores. Reeves et al. (2015), examined claims related to badminton injuries reported by the national insurance company in New Zealand and found that the majority of injuries were ligament sprains/tears in the lower limb (i.e. knee), as a result of movements involving turning and/or changes of direction. The findings from this study builds on this to suggest that trait anxiety may be a significantly associated with lower limb injuries, overuse injuries, and muscle or tendon strain injuries. Overall, from the logistic regression data we tentatively suggest that there may be some relationship between an individual's personality trait, specifically anxiety levels, and the cause of injury, the body region effected, and the type of injury. However, the current study only provides preliminary explorative data in to this so the question requires further research with a more focused study rationale and design.

The ultimate aim of this explorative project was to develop a badminton-specific model of the psychological factors associated with injuries based on the Stress-Injury model (Williams & Andersen, 1998). Figure 5 depicts a preliminary model that incorporates the key findings from the current study in an attempt to enhance the understanding of the interaction between psychological factors and injury in badminton, and offer directions for future research. As per the Stress-Injury model (Williams & Andersen, 1998), the two key tenants of the model are personality factors and coping resources. Two specific traits are linked to the personality factors, trait anxiety (i.e. somatic, cognitive) and attentional changes (i.e. reinvestment). From the current study the strongest factors associated with injuries was trait anxiety. Moreover, trait anxiety was positively correlated with the propensity to reinvest, and negatively correlated with the number of coping resources. Therefore trait anxiety is positioned centrally within the model as we view it as an integral psychological factor for injuries in badminton. While previous research using the STAI as a measure of general anxiety have shown no clear effect on sports injuries (Kerr & Minden, 1988; Lysens et al., 1991), the current study provides evidence that the STAI and SAS are suitable for measuring trait anxiety, and we therefore strongly encourage practitioners, coaches and players to use these tools to enhance their awareness and understanding of the potential impact of trait anxiety on performance and injury. With regards to coping resources the model depicts how the number coping resources that an individual has is directly associated with injury but also has an indirect link to injury through its relationship with trait anxiety. Attentional changes is shown to indirectly link to injury through trait anxiety except for the case of highly skilled badminton players where there may potentially be more of a direct association between the propensity to reinvest and injuries, although future research is required to examine this.

The model also provides recommendations for future research, where the focus should be on developing and testing psychological interventions, such as stress management, cognitive-behavioural therapy, and relaxation techniques, to increase the coping resources available to individuals in an attempt to reduce the levels of trait anxiety and therefore reduce the risk of injury. Moreover, future research should be conducted to develop coaching resources, which can be integrated in to coach accreditation schemes, to provide a resource to coaches of all skill levels that allows them to understand and implement simple psychological interventions in to their everyday practices with their athletes.

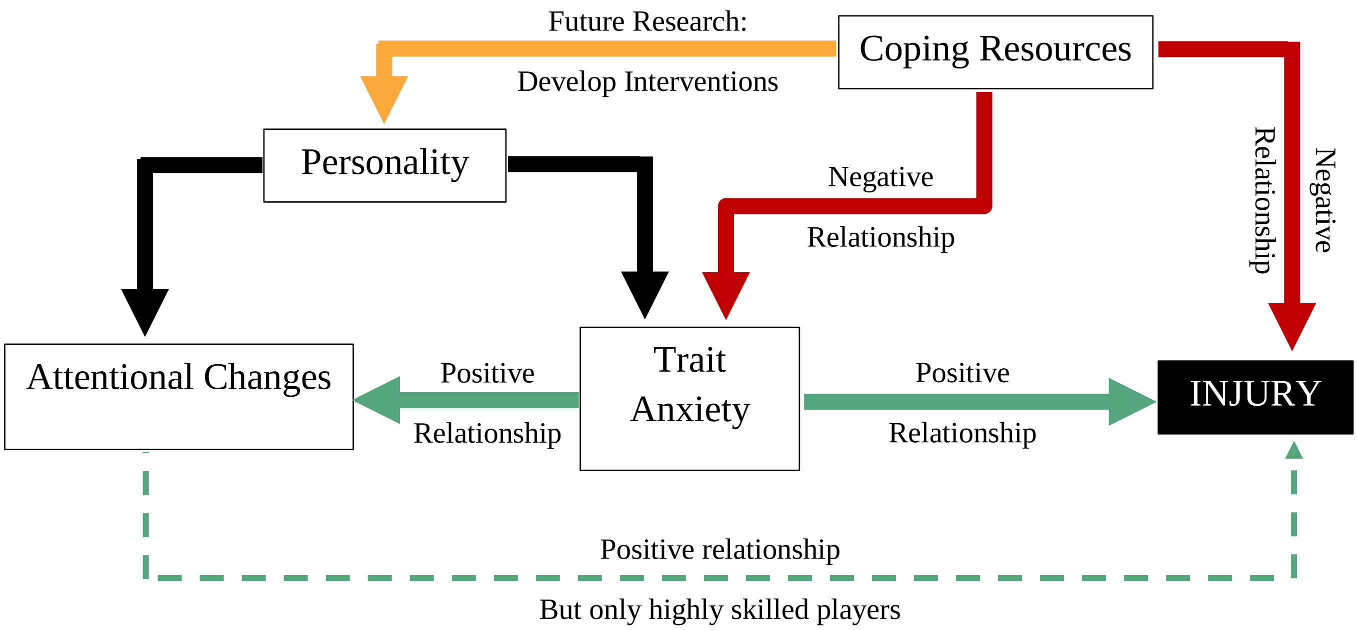

Figure 5. A preliminary badminton-specific model of psychological factors associated with injury, based on the Stress-Injury model (Williams & Andersen, 1998)

Conclusion

In conclusion, psychological factors appear to play a significant role in badminton injuries. Trait anxiety, coping resources and attentional changes (i.e. reinvestment) appear to have moderating effects on injury experiences. These findings offer further insight into precedents of sports injury and suggest that preventative psychological interventions to reduce badminton injuries should be developed and adopted by players and coaches. Whilst still early in its conceptualisation, the findings in this study have produced a vital first step in developing a model of psychological factors associated with injury in badminton and provide potential avenues for future research to aid in preventing and recovering from injuries.

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