©Journal of Sports Science and Medicine (2012) **11**, 331-338
http://www.jssm.org

Research article

Is a cognitive-behavioural biofeedback intervention useful to reduce injury risk in junior football players?

Arne Edvardsson ✉, Andreas Ivarsson and Urban Johnson
Centre for Research on Welfare, Health and Sport, Halmstad University, Halmstad, Sweden

Abstract
Athletes participating in sport are exposed to a relatively high injury risk. Previous research has suggested that it could be possible to reduce sports injuries through psychological skills training. The purpose of this study was to examine the extent to which a cognitive behavioural biofeedback intervention could reduce the number of sports injuries in a sample of players in Swedish elite football high schools. Participants from four elite football high schools (16–19 years old) were divided into one experiment (n = 13) and one control group (n = 14). Participants were asked to complete three questionnaires to assess anxiety level (Sport Anxiety Scale), history of stressors (Life Event Scale for Collegiate Athletes) and coping skills (Athletic Coping Skills Inventory – 28) in a baseline measure. Mann-Whitney U-tests showed no significant differences in pre-intervention scores based on the questionnaires. The experimental group participated in a nine-week intervention period consisting of seven sessions, including: somatic relaxation, thought stopping, emotions/problem focused coping, goal setting, biofeedback training as well as keeping a critical incident diary. A Mann-Whitney U test showed no significant difference between the control and experimental group U ($n1$ = 13, $n2$ = 14) = 51.00, p = 0.054. However, considering the small sample, the statistical power (0.05 for present study), to detect effects was low. The results of the study are discussed from a psychological perspective and proposals for future research are given.

Key words: Coping skills, elite sport, psychological injury prevention, psychological stress, soccer.

Introduction

It has recently been estimated that over eight million sports injuries are medically treated each year in Europe (Bauer and Steiner, 2009). Focusing on European elite football players, Ekstrand et al. (2011) found that, on average, players suffered two injuries per season. Drawer and Fuller (2002) proposed an injury cost framework based on English elite football clubs. They suggested that the cost impact for a club sustaining several injuries could not only be measured in medical expenses though injury rates, but also, it strongly correlated with team quality, team-performance, club-turnovers and club salaries, which, for the clubs, will mean a loss in income of millions of euros every year. In addition a wealth of evidence indicates that a sport injury can be an extremely stressful and disruptive event for elite athletes, particularly in cases where the injury is severe and the athlete is heavily invested in sport (Brewer, 2007). Therefore, it is important to find preventive actions, combining well-established psychological and physiological techniques.

Research that has examined the influences of psychological factors on injury risk has stated that athletes who experience high levels of stress are exposed to a greater risk of attaining a sport injury (Ivarsson and Johnson, 2010; Rogers and Landers, 2005). One of the most influential psychological models in this area is Williams and Andersen's theoretical "stress – injury model" (1998). The core of the model consists of three parts, where (1) a potential stressful event, which could originate from both inside and outside of the sport context, (2) might affect an athlete's stress response which, in turn, (3) could influence injury risk. An athlete's appraisal of the potential stressful event could be discussed as the mediating link that will decide the size of the stress response that might occur, which could lead to both behavioural and cognitive consequences (such as distractibility, narrowing of visual field and increased muscle tension). The stress injury model also suggests that there are three categories of psychological factors that will influence an athlete's appraisal of the situation. These categories are personality (e.g. competitive state anxiety), history of stressful events (e.g. negative life event stress) and coping (e.g. social support) (Rogers and Landers, 2005; Williams and Andersen, 1998). A few studies have tested parts of the Williams and Andersen model in elite soccer populations. For example both Johnson and Ivarsson (2011) and Ivarsson et al. (2012) found that both personality (e.g. anxiety) and stress (e.g., negative life event stress and hassle) variables predicted sport injuries. More specific Ivarsson et al. (2012) suggested a path model that could explain 24 % of the variance of injuries. In the model trait anxiety and negative life event stress have an indirect effect on injury frequency through the variable daily hassle.

Based on the findings in studies aimed to investigate psychological injury prediction factors, a number of preventive intervention studies have been conducted. For example, several stress management programmes based on cognitive-behavioural training have been shown to effectively reduce the numbers of injuries among athletes (Johnson et al., 2005; Noh et al., 2007; Perna et al., 2003). Perna et al. (2003) discovered that athletes in the experimental group, taking part in an intervention programme containing: relaxation, visualisation, cognitive restructuring and emotional relief, reported significantly fewer injury and illness days than the control group.

Johnson et al. (2005) conducted a further intervention study which included a population of at-injury risk football players that participated in a psychology-based counselling programme. The results showed that the experimental group experienced significantly less injuries

Received: 26 September 2011 / Accepted: 08 April 2012 / Published (online): 01 June 2012

compared with the control group. Similar findings were found in a population of dancers (Noh et al., 2007) and rugby players (Maddison and Prapavessis, 2005). A common theme among these intervention studies is the focus on strengthening the individual's coping resources. Junge (2000) recommended that preventive intervention programmes should focus on strengthening coping (coping skills, health behaviour and social support) and also situational dependent emotional states (fatigue, general well-being and competitive anxiety).

Even though an increasing number of intervention programmes with solid methodological framework have been developed, with the focus of strengthening an athlete's coping skills and emotional states, only a few have used biofeedback training as part of the injury prevention programme (De Witt, 1980; Maddison and Prapavessis, 2007). Biofeedback is a method that makes the body's physiological signals visible (e.g. finger temperature, heart rate variability), with the aim of teaching individuals how to manage these physiological responses (Tenenbaum et al., 2002). Direct bodily feedback can motivate athletes to implement relaxation programmes while enhancing a sense of control over their behaviour (Johnson, 2007; Tenenbaum, et al., 2002). Biofeedback training can also help athletes getting into a state of homeostasis (Strack and Gevirtz, 2011) which is a state of emotional and physiological coherence similar to the "adaptive stress response" that decreases the risk of sustaining injury (Williams and Andersen, 1998). Intervention studies based on biofeedback in sports have mostly been focused on performance enhancement and anxiety reducing effects (see, for example, Blumenstein et al., 1997; Bar-Eli and Blumenstein, 2004a; Bar-Eli et al., 2002). The cognitive-behavioural-inspired biofeedback model "The Wingate five-step approach", where athletes first learn stress management techniques and then gradually move closer to the stressful events, building up a resistance to stress, has been used in research and has helped athletes to handle their responses to stress (Blumenstein et al., 2002; Blumenstein, et al., 1997). De Witt (1980) has conducted, to the best of the authors' knowledge, the only biofeedback intervention where injury occurrence has been observed. The intervention consisted of cognitive training together with the use of EMG and heart rate biofeedback. In addition to performance-enhancing effects and greater arousal control, a reduction of sports injuries after the intervention, was observed.

The technical development of biofeedback products has made the equipment more affordable and user-friendly, which, in turn, has enabled new methodology approaches (Amon and Campbell, 2008; McCraty, 2005). Injury prevention research has rarely examined or used any biofeedback approaches, resulting in an absence of applied biofeedback interventions in the field (Johnson, 2007; Maddison and Prapavessis, 2007; Williams and Andersen, 2007). Stress responses could contribute to an increased risk of sustaining injury (Williams and Andersen, 1998), and biofeedback training is a way of learning to control stress response (Bar-Eli and Blumenstein, 2004a). Consequently, it is important to investigate whether an intervention consisting of sport psychology counselling and biofeedback methods can reduce the risk of sports injuries in young football players in Swedish elite football high schools.

The purpose of this study is to examine whether a cognitive-behavioural biofeedback intervention reduces the occurrence of sports injuries for football players in Swedish elite football high schools.

Methods

Participants

In cooperation with the Swedish Football Association, four high schools, located in western Sweden, were randomly selected to be included in the study. All four high schools were certified by the Swedish Football Association and followed a strict soccer and academic education plan. The certified schools must have at least two training session each week scheduled between 08.00-12.00 am. Moreover, the soccer instructors need to have advanced training diploma from UEFA with not more than 15 players in each training group. The schools also have to cooperate with local clubs to develop an individual education plan for each player. At three of the high schools, participants were recruited to the experimental group and at one high school participants were recruited to the control group. That is, the groups had no opportunity to interact with each other (i.e. control and experimental group members could not come from the same school). In total, there were 29 participants in the study. All of the participants received an informed consent form, which they were asked to complete. The experimental group (n = 15) consisted of six girls and nine boys (M = 17.0, SD = 0.7), however, one boy and one girl dropped out due to time constraints. The control group (n = 14) consisted of 13 boys and one girl (M = 17.2, SD = 1.1). Besides the training in school the players regularly trained with their club teams (3–5 training sessions per week). The experimental group came from 13 different clubs and the control group came from 10 different clubs. Together with the informed consent a question was distributed to the players "What is your previous experience with mental training?" in which the scale was ranging from 1=no experience to 10=lots of experience. Results showed a low experience level in both the experimental (M=2.86, SD=1,7) and the control group (M=2.58, SD=2.1). The difference between the groups was not statistically significant. Participants in the control group were, after the study was completed, offered individual sport psychology sessions. The study was reviewed and approved by a regional ethical review board.

Measurements

Psychological measurement

Three psychometric tests were used in the study (LESCA, SAS and ACSI-28) to ensure that the athletes in the control and experimental groups had similar psychological injury risk profiles at the start of the intervention. The selection of the measurements was based on the categories in Williams and Andersen (1998) "stress – injury model" (Johnson et al., 2005).

Life Event Scale for Collegiate Athletes (LESCA):

LESCA (Petrie, 1992) was used to measure athletes' history of life-event stressors. The scale is comprised of a list of 69 life events. Athletes were asked to indicate which events they had experienced in the previous 12 months, and then for each event, to rate the intensity of the stressor on an 8-point Likert type scale, ranging from -4 (extremely negative) to +4 (extremely positive). An average score for negative life-event stress (69 items), and positive life event stress (69 items) was calculated by adding the sum of each respective subscale. Test-retest reliabilities for the two scales have been found to range from 0.76 to 0.84 (Petrie, 1992).

Sport Anxiety Scale (SAS): SAS (Smith et al., 1990) was used to measure an athlete's anxiety level. The test consists of 21 statements divided into three categories. The categories are somatic anxiety (nine statements), worry (seven statements) and concentration disruptions (five statements). Participants get to imagine how they feel before a competition. An example statement is: "My body feels tight." Statements are answered on a four-point Likert scale, ranging from 1 ("not at all") to 4 ("very much so"). Smith et al. (1990) found a good validity for the instrument (alpha = 0.89). The measurement in present study used the revised version of SAS (Smith et al., 2006) based on a Swedish translation. Alphas ranged between 0.68 and 0.88 for the different categories. The fact that alpha value for one of the scales was lower than the general recommended .70 which clearly suggest measurement issues represent a limitation in the present study.

Athletic Coping Skills Inventory 28 (ACSI-28): ACSI-28 (Smith et al., 1995) was used to measure athletes' coping skills. This instrument consists of 28 questions divided into seven parts: (a) coping with adversity, (b) peaking under pressure, (c) goal setting/mental preparation, (d) concentration, (e) freedom from worry, (f) confidence and achievement motivation and (g) coachability. One example of a question statement is: "I have my own game plan worked out in my head long before the game begins." Participants are able to respond on a four-point Likert scale ranging from 1 = almost never to 4 = almost always. Alpha´s ranged between 0.57 and 0.80 for the different categories. Alpha values were similar to those found on the SAS, also two categories in the ACSI – 28 had alphas lower than 0.70 and this should therefore be considered as a limitation.

Biofeedback instruments

The biofeedback instrument used in this study measures both heart rate variability (HRV) and galvanic skin response (GSR) by finger sensors (see below). The software is called "Healing Rhythms" and is produced by the company Wild Divine. This program displays both graphical curves and allows various training exercises to be performed with biofeedback (Amon and Campbell, 2008).

Galvanic skin response (GSR): GSR measures the skin's ability to conduct electricity (Blumenstein, 2002). GSR has long been regarded as an objective way to measure psychophysiological activation (Peek, 2003). Changes in mood and anxiety can make an immediate impact on GSR equipment (Sime, 2003).

Heart rate variability (HRV): HRV measures the body's natural changes in heart rate fluctuations. Lehrer (2007) have produced an instruction manual describing how to adapt a slow, deep abdominal breathing, creating a regular heart beat rhythm, which triggers relaxation processes in the body and strengthens the autonomic nervous system. Emotions that athletes experience, e.g. anxiety before a big game, often affect breathing patterns, and thereby also the HRV graphical curve. Learning to control HRV can both contributes to a better control of tension levels, enhance levels of well-being and even, in the long run, increase self-confidence (Sime, 2003).

Procedure

At the first meeting, participants in the study received information about the study design and ethical considerations. They were also asked to complete the LESCA, SAS and ACSI-28 questionnaires. The duration of the study was over a nine-week period during the match-intensive part of the spring season (April to June). All players in the experimental group and control group reported that they were injury free at the start of the intervention. The experimental group underwent seven counselling sessions that lasted 30–60 minutes. The meetings took place at participants' schools in different classrooms and restrooms. The control group had a brief personal meeting with the researcher once a week during the school's football practice. The purpose of these meetings was to give participants full attention (in order to prevent impact from the Hawthorne effect, Maddison and Prapaveissis, 2005). Participants in both experiment and control groups continuously reported the types of injury and the days they were unable to practise. A player is defined as injured if he/she misses a practice session or competition due to injury or if he/she can only participate with severe limitations (Johnson et al., 2005; Lysens et al., 1991). The sessions were held by one of the authors who had a professional academic degree in applied sport psychology.

The biofeedback intervention used was inspired by several previous biofeedback studies (i.e. Amon and Campbell, 2008; De Witt, 1980) as well as the model: "The Wingate five-step approach" (Blumenstein et al., 1997; 2002), which, in turn, is an approach influenced by cognitive-behavioural-oriented stress management training (Meichenbaum, 1977). In accordance with "The Wingate five-step approach" the present intervention began with the teaching of self-regulation techniques: thought stopping, somatic relaxation and abdominal breathing. Then, participants were sequentially presented to environments similar to their own training and competition environment to stimulate real emotions and bodily reactions. This was made possible by allowing athletes to see video clips of actual game situations filmed from the player's perspective. The meetings followed the structure of a cognitive-behavioural session (Beck, 2011). First, the agenda was presented which the athletes had the opportunity to influence (e.g. by bringing forward any stressful event that might have occurred in the school for discussion). After that, experiences from the previous meeting and the homework assignment were discussed. The adherence to the programme was 100%.

Session 1 – *Introduction.* In the first session, the participants received an overview of the training programme (see Figure 1) and working material was introduced. A part of the working material consisted of a “daily log" (Noh, 2005) were the athletes were asked to indicate how much they were actively engaged in the programme every week. This first session was conducted in small groups, as opposed to the remaining six sessions which were individual. An 18-minute-long progressive relaxation was presented with the recommendations to implement it three times a week. This session and all following sessions were completed with biofeedback training.

Session 2 – *Respiration.* Participants got to practise abdominal breathing in 10-second cycles using HRV biofeedback (Lehrer, 2007). By using breathing instructions developed by Lehrer, it is possible to help the athletes to balance their inhalation and exhalation. The athletes were also instructed on how they could complete a cognitive-behavioural-oriented critical incidence diary. Johnson et al. (2005) reported that this type of diary can have stress buffering effects because it makes athletes more aware of problematic/emotional situations. It also provides a good basis for discussion during the meetings.

Session 3 – *Thought stopping.* All of the following meetings started with a follow-up on the cognitive-behavioural-oriented critical incident diary as recommended by Johnson et al. (2005). In the discussion that followed, the researcher used a “stress inoculation training” approach, including seeing threatening situations as challenging etc. Stressful events were interpreted as either a problem that could be solved (problem focused coping) or as a situation where it was possible to make attitude changes (emotion focused coping) (Meichenbaum, 2007). Socratic dialogue (Overholser, 1991) and motivational dialogue (Tenenbaum et al., 2002) were also important parts of the sessions. The athletes were instructed using thought stopping which is described more closely under “session 5” (Prapavessis et al., 1992). At the end, the participants were able to formulate their goals for participating in the study (Tenenbaum et al., 2002).

Session 4 – *Relaxation.* Athletes were introduced to an 18-minute-long relaxation programme. The GSR and HRV curve readings enabled a follow-up discussion about the mind-body connection. Feelings and thoughts experienced during and after the session were compared with more stressful events in school life and on the football field.

Session 5 – *Thought stopping 2.* The thought stopping technique that was introduced in session 3 was tested in a real situation created by a two-minute-long video clip filmed from the player’s perspective. First, the players were instructed to write down their technique in three stages (A = identify stressful/distracted moment, B = use the stop, breathe and clear your mind and, finally, C = use the recall cues, e.g. relax, focus and go), so that is was easier to memorise (Appaneal and Granquist, 2009). After that, the players were asked to visualise themselves in the clip and find an appropriate video sequence to perform the thought stopping technique.

Session 6 – *Real game.* Players discussed their best and worst performances, the arousal levels connected to these experiences and how to reach their individual zone optimal performance more often (Weinberg and Gould, 2007). The athletes got to watch a real football game with players of their own age/gender, filmed from a player perspective. During the film clips they were asked to try to quickly gain control of and create a comfortable activation level (De Witt, 1980).

Session 7 – *Summary.* The researcher, together with the athletes, summed up all of the sessions and discussed future directions, as suggested by Johnson et al., (2005).

Nine-week intervention overview is summarized in Figure 1.

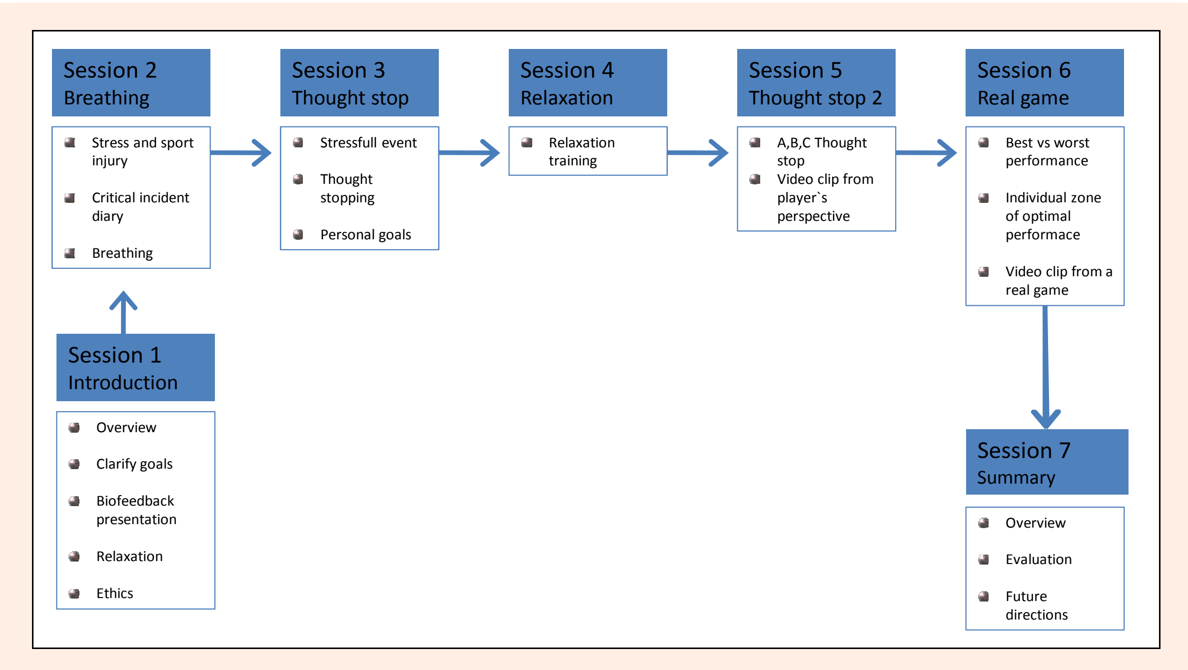

Figure 1. Nine-week intervention overview.

Statistical analysis

According to recommendations in the APA manual (2010) both statistical significance testing and calculations of effect size should be presented. In present study Mann Whitney U tests were conducted to investigate potential differences between the experimental and control group and between men and women on the psychometric questionnaires (SAS, LESC and ACSI-28) used in the baseline measure. A Mann-Whitney U test was also used to examine differences in injuries between the control and experimental group due to non-normally distributed data. To calculate the effect size for the non-parametric test we used the equation $r = z/\sqrt{N}$ (Fritz et al., 2012). In the formula z is the z distribution and N is the sample size in the study. In order to compare the calculated effect size with other effect sizes (for example Cohen´s d) formula $d = 2r/\sqrt{(1-r^2)}$ was used (Fritz et al., 2012). The calculated Cohen´s d value was then used to approximate width 95 % CI in the formula 95 % CI = ES -1.96se to ES + 1.96se (Nakagawa and Cuthill, 2007). The se value was calculated from the formula:

$$\sqrt{\left(\frac{n1+n2-1}{n1+n2-3}\right)\left[\left(\frac{4}{n1+n2}\right)\left(1+\frac{d^2}{8}\right)\right]}$$

Results

The results from Mann Whitney U tests showed no significant differences between the experimental and control group based on the scoring of LESCA, SAS and ACSI-28 in the beginning of the study. Neither did the tests show any gender differences concerning these instruments. In the control group, a total of 14 injuries occurred (1.00 injuries per player), that is, four players suffered two injuries while four players were completely injury free during the period. The remaining six players suffered one injury each. Examples of reported injuries were a sprained ankle and a hamstring strain. In the experimental group, five injuries occurred (0.38 injuries per player), divided between three participants. A Mann-Whitney U test showed no significant differences between the two groups, U ($n1$ = 13, $n2$ = 14) = 51.00, $p < 0.054$. (effect size, r = 0,409 equivalent Cohen's d = 0.89, approximated 95 % CI 0.14 – 1.63). The statistical power to detect potential differences in injury score between the two groups was 0.50.

Discussion

The aim of this study was to examine whether a cognitive-behavioural biofeedback intervention could reduce the occurrence of sports injuries among players in Swedish elite football high schools. In summary, combining cognitive-behavioural training together with biofeedback training showed no statistical significant results in decreasing the occurrence of injuries in the experimental group and therefore we can´t reject the null hypothesis. One possible explanation could be that the study had low statistical power (0.50). Even if intervention studies show no statistical significant results it could still be of practical value such as addressed by Andersen and Stroove (1998). In their analyses of Kerr and Goss study “The effects of a stress management program on injuries and stress levels” (1996), reporting a lower incidence rate for the experimental group compared to the control group, however not statistical significant, several methodological and practical implications was drawn. For instance, in individualized service delivery (as was done in our study), the personality, self-reliance and responsiveness of the experimental leader are all parts of the intervention. Consistent with the large effect size (Cohen´s d = .89) and the difference in injury scores between the intervention and control group the result demonstrates a practical value even if the result was not statistically significant. Using the framework of Probability of Superiority (Fritz and Morris, 2012) index it is possible to exemplify what a Cohen´s d effect size of 0.89 stands for. According to Fritz and Morris (2012) the PS score for the Cohen´s d effect size 0.89 is approximately 74. A PS score of 74 states that if participants were sampled randomly, one from each of the groups, the one from the condition with the higher mean (in this case the control group) should be bigger than that from the experimental group for 74 % of the pairs. Taking into consideration that the participants in the control group have higher injury score in approximately three out of four pairs a substantial difference between the intervention and control group is evident.

Despite the lack of statistical significant results some reflections on the practical value of the study is warranted. Even though discussions about stressful events covered all aspects of athletes’ lives, the cognitive-behavioural programme was specifically developed for a football population. The education material was developed for a Swedish junior football population and contained several examples of how other football players have faced and dealt with stressful events. Noh et al. (2007) highlight the value of adjusting the intervention to the athletes’ sociocultural context. In an intervention, Noh et al. used relaxation, visualisation and self-talk techniques targeted to help Korean dancers cope with stressors strongly associated with the Korean dance culture in a better way: coach criticism, performance pressure and competition with other dancers in the same dance group. Similar methodological reflections was raised by Andersen and Stroove (1998) pointing out the value of a genuine, non-influential behavior in order to avoid experimenter expectancy bias in the experimental group. This line of reasoning was also mentioned by Johnson (2007) saying that “the first step towards understanding the power of influence is to critically examine the behavior of the experimenter and other persons involved in the intervention design and the effect their behavior has on athletes” (p. 363) .

The importance of adapting cognitive-behavioural training approaches, like the “the Wingate five-step approach” on both individual- and group level was also addressed by Meichenbaum (2007) and Blumenstein et al. (1997). In the stress inoculation training approach (SIT), Meichenbaum suggests that athletes who get to inoculate a small portion of a potential stressor (e.g. listening to sounds of an important game) are better able to resist and cope with tougher stressors ahead (e.g. actually playing an important game). This SIT approach is an important part of the Wingate five-step model and has therefore been adopted frequently in biofeedback research (Blumenstein et al., 1997; Bar-Eli et al., 2002). Through the progressive simulation of real game situations, athletes in the present study first learned mental techniques, then physiological reactions and then gradually got to test the techniques when the pressure was on. This kind of approach has previously been used, with success, by athletes to deal with anxiety and to improve skills (Bar-Eli and Blumenstein, 2004a; 2004b).

Biofeedback training (often in combination with external distractions) has previously been reported to contribute to a deeper understanding and discussions about the underlying thoughts and emotions that are clearly manifested with athletes (Cupal, 1998; Sime, 2003). Creating a motivating intervention and developing a strong working alliance with the athletes have previously been recognised as important factors when creating a successful biofeedback intervention with few drop-outs (Tenenbaum et al., 2002). The authors of the present study also stress the importance of using systematic progress notes (see, for example, DART notes in Baird, 2002), which makes it easier to understand the client's situation, strengthen the preparation of the sessions and help the individual to feel that they have been noticed and their opinions are being listened to.

Method discussion

First, problems about diversity between the two groups, in terms of gender and affiliation could be discussed. That is the experimental group consisted of participants from three different high schools while participants from a fourth school were placed in a control group. Since no football high school had both control and experimental groups located in the same school, they could not influence each other (Noh et al., 2007). However, there are several problems that may occur with this type of arrangement. By randomising each participant instead of randomising at a group level, one can claim, with greater certainty, that the experimental and control groups were similar in all aspects. Confounding variables, such as players having different training schedules and different psychological injury risk profiles could have been better controlled via total randomisation. In order to ensure that experimental and control groups had similar psychological injury risk profiles when the study began, Mann Whitney U tests were conducted. Shadish et al. (2002) have supported this type of baseline measurement in quasi experiments when groups are not totally randomised.

Second, Andersen and Stoove (1998) discuss an expectancy effect that might occur in intervention studies. They reason that in "one-on-one sessions" the experimenter's characteristics (e.g. empathy, confidence and personality) always will have an impact on intervention but that this is an important part of the intervention that is hard to affect. The significance of motivation, cognitive support and social facilitation is also addressed by Tenenbaum et al. (2002) as important methodological concerns to create effective and functional interventions. In the present study the experiment group and control group were given, in many ways, similar information entering the study e.g. that they had the opportunity to participate in an intervention study, that meetings with the experiment leader would be held regularly and that they could drop out at any time without given a reason for doing so.

Third, the statistical power for the study was poor (0.50). This might have influenced the possibility to gain a statistical significant result. In order to better inform readers about the result and the possible practical value of the intervention, such as presented here, Wilkinson and the Task Force on Statistical Inference (1999) recommend to included effect size and confidence interval.

Fourth, the alpha scores for a few of the categories, belonging to SAS and ACSI - 28, were under the general recommendations of 0.70 (Cortina, 1993) and should therefore be discussed as one limitation of the study. Although the Cronbach´s alpha is a common used method to assess internal consistency, there have been discussions about how to use it, and importantly, interpret it, correctly (Cortina, 1993; Schmitt, 1996). For example Cortina (1993) problematize about the acceptance of an alpha value over .70 is adequate without comparing it with the number of items in the scale. Cortina showed in his study that the alpha value is influenced by the number of items. More specific the result showed that an increased number of items were related to a higher Cronbach´s alpha value. The explanation for this is that the alpha value gives information about the extent to which each item in a set of items correlates with at least one other item in the set (Cortina, 1993). Given that, it is important to state that the absolute level of Cronbach´s alpha is not meaningless (Cortina, 1993). It is just important to keep in mind that questionnaires with low alphas could still be useful (even if the low alpha should be discussed as a limitation) (Schmitt, 1996). The facts that ACSI-28 only has 4 items in each category, that might influenced the alpha value, and that the instruments have been commonly used in previous studies (for example Johnson et al., 2005; Noh et al., 2007) is the reason why we decided to use them even if they showed low alphas. Moreover, it is suggested for future research to perform comprehensive studies to demonstrate validity of both ACSI-28 and SAS.

Even though the results of the intervention showed no statistical significant, it is important to interpret and consider the practical value of the study by taking the effect size under consideration. The core of the present study is heavily based on psychological injury prevention research, but the research design also integrates a physiological perspective which is requested in the sport psychology literature (Williams and Andersen, 2007; Johnson, 2007). Perhaps future research could develop a biopsychological injury model aimed at predicting injury occurrence which describes the physiological stress responses and how they can be measured in more detail. A enhanced understanding of what specifically happens in the body of athletes under stress can contribute to even more tailored injury prevention interventions based on the individual's specific needs. In practice, this type of model would be applicable to athletes, coaches and medical staff.

It was over 30 years ago that De Witt (1980) noted that biofeedback training together with cognitive training can be effective in reducing sports injuries. This study is, as far as the authors know, the only subsequent study that has re-examined the pioneering work of De Witt. The fact that biofeedback methodology is available for everyone today (Bar-Eli and Blumenstein, 2004a): the instruments have become cheaper and the software more user-friendly (Amon and Campbell, 2008), will perhaps stimulate a wider and more frequent use of prevention biofeedback interventions – for instance, in the area of sport injury. This article showed no statistical significant differences between groups but it is argued that the result is of practical value. The authors suggest that more similar studies (including use of bigger groups) are performed in order to gain increased knowledge in to the injury prevention field but also for the benefit of injury-prone athletes.

Conclusion

The purpose of this study was to examine the extent to which a nine-week cognitive behavioural biofeedback intervention could reduce the number of sports injuries in a sample of players in Swedish elite football high schools. Even if the result showed no statistical significant difference in injury frequency between the intervention- and control group the result suggest that the intervention effect was of practical value since the experimental group experienced less injuries than the control group. Given the difference in injury frequency between the groups it is concluded that cognitive behavioural biofeedback intervention seems to be effective in order to prevent sport injuries.

Acknowledgments

We want to thank the coaches, players and medical staff for their cooperation. Moreover, we want to thank the Swedish Football Association for valuable help.

References

American Psychological Association. (2010) *Publication Manual of the American Psychological Association*. 6th edition. American Psychological Association, New York.

Andersen, M.B. and Stoove, M.A. (1998) The sanctity of p < .05 obfuscates good stuff: a comment of Kerr and Goss. *Journal of Applied Sport Psychology* **10**, 168-173.

Amon, K.L. and Campbell, A. (2008) Can children with AD/HD learn relaxation and breathing techniques through biofeedback video games? *Australian Journal of Educational & Developmental Psychology* **8,** 72-84.

Appaneal, R.R.N. and Granquist, M.D. (2009) Shades of grey: A sport psychology consultation with an athlete with injury. In: *Psychological Bases of Sport Injury.* Ed: Pargman, D. 3rd edition. Morgantown, VW: Fitness information Technology. 335-350.

Baird, B.N. (2002). *The internship, practicum, and field placement handbook: A guide for the helping professions.* 3rd edition. Prentice Hall, New Jersey.

Bar-Eli, M. and Blumenstein, B. (2004a) The effect of extra-curricular mental training with biofeedback on short running performance of adolescent physical education pupils. *European Education Review* **10,** 123-134.

Bar-Eli, M. and Blumenstein, B. (2004b) Performance enhancement in swimming: The effect of mental training with biofeedback. *Journal of Science and Medicine in Sport* **7**, 454-464.

Bar-Eli, M., Dreshman, R., Blumenstein, B. and Weinstein, Y. (2002) The effect of mental training with biofeedback on the performance of young swimmers. *Applied Psychology: An International Review* **51,** 567-581.

Bauer, R. and Steiner, M. (2009) *Injuries in the European Union statistics summary 2005–2007.* Vienna: Eurosafe and KfV. Available from URL: https://webgate.ec.europa.eu/idb/documents/2009-IDB-Report_screen.pdf

Beck, J.S. (2011) *Cognitive Behaviour Therapy: Basics and Beyond.* 2nd edition. Guilford Press, New York.

Brewer, B.W. (2007) Psychology of injury rehabilitation. In: *Handbook of sport psychology.* Eds: Tenenbaum, G. and Eklund, R.C. 3rd edition. Hoboken, NJ: John Wiley & Sons. 404-424.

Blumenstein, B. (2002) Biofeedback applications in sport and exercise. In: *Brain and body in sport and exercise: Biofeedback Applications in Performance Enhancement.* Eds: Blumenstein, B., Bar-Eli, M. and Tenenbaum, G. Chichester: John Wiley & Sons. 37-54.

Blumenstein, B., Bar-Eli, M. and Collins, G. (2002) Biofeedback Training in Sport. In: *Brain and body in sport and exercise: Biofeedback Applications in Performance Enhancement.* Eds: Blumenstein, B., Bar-Eli, M. and Tenenbaum, G. Chichester: John Wiley & Sons. 55-76.

Blumenstein, B., Bar-Eli, M. and Tenenbaum, G. (1997) A Five-Step Approach to Mental Training Incorporating Biofeedback. *The Sport Psychologist* **11,** 440-453.

Cortina, J.M. (1993) What is Coefficient Alpha? An Examination of Theory and Applications. *Journal of Applied Psychology* **78**, 98-104.

Cupal, D.D. (1998) Psychological interventions in sport injury prevention and rehabilitation. *Journal of Applied Sport Psychology* **10,** 103–123.

De Witt, D.J. (1980) Cognitive and biofeedback training for stress reduction with university athletes. *Journal of Sport Psychology* **2,** 288-294.

Drawer, S. and Fuller, C.W. (2002) An economic framework for assessing the impact of injuries in professional football. *Safety Science* **40,** 537-556.

Ekstrand, J., Hägglund, M. and Waldén, M. (2011) Injury incidence and injury patterns in professional football – the UEFA injury study. *British Journal of Sports Medicine* **45(7),** 553-558.

Fritz, C.O., Morris, P.E. and Richler, J.J. (2012) Effect Size Estimates: Current Use, Calculations, and Interpretation. *Journal of Experimental Psychology* **141**, 2-18.

Ivarsson, A., Johnson, U. and Podlog, L. (2012) Psychological predictors of injury occurrence: A prospective investigation of professional Swedish soccer players. *Journal of Sport Rehabilitation*, (In press).

Ivarsson, A. and Johnson, U. (2010) Psychological factors as predictors of injuries among senior soccer players. A prospective study. *Journal of Sports Science and Medicine* **9,** 347-352.

Johnson, U. (2007) Psychosocial antecedents to sport injury, prevention and intervention: An overview on theoretical approaches and empirical findings. *International Journal of Sport and Exercise Psychology* **5,** 352-369.

Johnson, U. and Ivarsson, A. (2011) Psychological predictors of sport injuries among junior soccer players. *Scandinavian Journal of Medicine & Science in Sports* **21,** 129-136.

Johnson, U., Ekengren, J. and Andersen, M.B. (2005) Injury prevention in Sweden. Helping Soccer Players at Risk. *Journal of Sport and Exercise Psychology* **1,** 32-38.

Junge, A. (2000) The influence of psychological factors on sports injuries: review of the literature. *American Journal of Sports Medicine* **28,** 10-15.

Lehrer, P.M. (2007) Biofeedback training to increase heart rate variability. In: *Principles and Practice of Stress Management.* Eds: Lehrer, P.M., Woolfolk, R.L. and Sime, W. S. 3rd edition. New York: Guilford Press. 227-248.

Lysens, R.J., de Weerdt, W., and Nieuwboer, A. (1991) Factors associated with injury proneness. *Sports Medicine* **12**, 281-289.

Maddison, R. and Prapavessis, H. (2005) A psychological approach to the prediction and prevention of athletic injury. *Journal of Sport & Exercise Psychology* **27,** 289-310.

Maddison, R. and Prapavessis, H. (2007) Preventing sport injuries: A case for psychology intervention. In: *Psychological Bases of Sport Injury.* Ed: Pargman, D. 3rd edition. Morgantown, VW: Fitness information Technology. 25-38.

McCraty, R. (2005) Enhancing emotional, social, and academic learning with heart rhythm coherence feedback. *Biofeedback* **33,** 130-134.

Meichenbaum, D. (1977) *Cognitive behaviour modification: an integrative approach.* Plenum Press, New York.

Meichenbaum, D. (2007) Stress Inoculation Training: A Preventative and Treatment Approach In: *Principles and Practice of Stress Management.* Eds: Lehrer, P. M., Woolfolk, R. L. and Sime, W. S. 3rd edition. New York: Guilford Press. 497-516.

Nakagawa, S. and Cuthill, I.C. (2007) Effect size, confidence interval and statistical significance: a practical guide for biologists. *Biological Reviews* **82,** 591-605.

Newcombe, R.G. (2006) Confidence intervals forn and effect size measure based on the Mann-Whitney statistic. Part 1: General issues and tail-area-based methods. *Statistics in Medicine* **25**, 543-557.

Noh, Y.E. (2005) *Psychosocial interventions for the prevention of injury in dance.* Doctoral thesis. University of Victoria, Melbourne.

Noh, Y.E., Morris, T. and Andersen, M.B. (2007) Psychological intervention programs for reduction of injury in ballet dancers. *Research in Sports Medicine* ***15,*** 13-32.

Overholser, J.C. (1991) The Socratic method as a technique in psychotherapy supervision. *Professional Psychology: Research and Practice* **22,** 68-74.

Peek, C.J. (2003) A primer of biofeedback instrumentation. In: *Biofeedback: A practitioner's guide.* Ed: Schwartz, M.S. and Andrasik, F. 3rd edition. New York: The Guildford Press. 43-87.

Perna, F.M., Antonio, M.H., Baum, A., Gordon, P. and Schneiderman, N. (2003) Cognitive behavioural stress management effects on injury and illness among competitive athletes: A randomized clinical trial. *Annals of Behavioural Medicine* ***25,*** 66–73.

Petrie, T.A. (1992) Psychosocial antecedents of athletic injury: The effects of life stress and social support on female collegiate gymnasts. *Behavioural Medicine* **18,** 127-138.

Prapavessis, H., Grove J.R., McNair, P.J. and Cable N.T. (1992) Self-Regulation Training, State Anxiety, and Sport Performance: A psychophysiological case study. *The Sport Psychologist* **6,** 213-229.

Rogers, T.M. and Landers, D.M. (2005) Mediating Effects of Peripheral Vision in the Life Event Stress/Athletic Injury Relationship. *Journal of Sport and Exercise Psychology* **27,** 271-288.

Schmitt, N. (1996). Uses and Abuses of Coefficient Alpha. *Psychological Assessment***8**, 350-353.

Shadish, W.R., Cook, T.D. and Campbell, D.T. (2002) *Experimental and Quasi-Experimental Designs for Generalized Causal Inference.* Houghton Mifflin Company, Boston.

Sime, W. (2003) Sports psychology applications of biofeedback and neurofeedback. In: *Biofeedback: A practitioner's guide.* Eds: Schwartz, M.S. and Andrasik, F. 3rd edition. New York: The Guildford Press. 560–588.

Smith, R.E., Cumming, S.P. and Smoll, F.L. (2006) Factorial integrity of the Sport Anxiety Scale: A methodological note and revised scoring recommendations. *Journal of Sport & Exercise Psychology* **28**, 109-112.

Smith, R.E., Schutz, R.W., Smoll, F.L. and Ptacek, J.T. (1995) Development and validation of a multidimensional measure of sport-specific psychological skills: The Athletic Coping Skills Inventory-28. *Journal of Sport & Exercise Psychology* **17,** 379–398.

Smith, R.E., Smoll, F.L. and Schutz, R.W. (1990) Measurement and correlates of sport-specific cognitive and somatic trait anxiety: The Sport Anxiety Scale. *Anxiety Research* **2,** 263–280.

Steffen, K., Pensgaard, A.M. and Bahr, R. (2009) Self-reported psychological characteristics as risk factors for injuries in female youth football. *Scandinavian Journal of Medicine and Science in Sport* **19,** 442-451.

Strack, B. and Gevirtz, R. (2011) Getting to the heart of the matter: Heart variability (HRV) biofeedback (BFB) for enhanced performance. In: *Biofeedback & neurofeedback applications in sport psychology.* Eds: Strack, B.W., Linden, M.K. and Wilson V.S. Wheat ridge: Association for applied psychophysiology and biofeedback. 145-173.

Stroove, M.A. and Andersen, M.B. (2003) What are we looking at, and how big is it? *Physical Therapy in Sport* **4,** 93-97.

Tenenbaum, G., Corbett, M. and Kitsantas, A. (2002) Biofeedback: Applications and methodological concerns. In: *Brain and body in sport and exercise: Biofeedback Applications in Performance Enhancement.* Eds: Blumenstein, B., Bar-Eli, M. and Tenenbaum, G. Chichester: John Wiley & Sons. 101-123

Weinberg, R.S. and Gould, D. (2007) *Foundations of sport and exercise psychology.* 4th edition. Human Kinetics, Champaign, IL.

Wilkinson, L., and the Task Force on Statistical Inference. (1999) Statistical methods in psychology journals: Guidelines and explanations. *American Psychologist* **54**, 594-604.

Williams, J.M. and Andersen, M.B. (1998) Psychosocial antecedents of sport injury: Review and critique of the stress and injury model. *Journal of Applied Sport Psychology* **10,** 5-25.

Williams, J.M. and Andersen, M.B. (2007) Psychosocial antecedents of sport injury and interventions for risk reduction. In: *Handbook of sport psychology.* Eds: Tenenbaum, G. and Eklund, R. C. 3rd edition. Hoboken, NJ: John Wiley & Sons. 3-30.

Key points

- Cognitive-behavioral training together with biofeedback training seems to be an effective strategy to decrease the occurrence of injuries.
- More intervention studies should be conducted applying existing biofeedback methodology, especially in the injury preventive area.
- Future research should develop a bio-psychological injury model aimed at predicting injury occurrence which describes the physiological stress responses and how they can be measured in more detail.

AUTHORS BIOGRAPHY

Arne EDVARDSSON

Employment

Centre for Research on Welfare, Health and Sport at Halmstad University, Sweden

Degree

Master in Sport and Exercise Psychology

Research interests

Injury prevention and biofeedback interventions.

E-mail: arne.edvardsson@gmail.com

Andreas IVARSSON

Employment

Phd Student, Centre for Research on Welfare, Health and Sport at Halmstad University, Sweden

Degree

European Master in Sport and Exercise Psychology

Research interest

Psychological predictors of sport injuries and preventive interventions.

E-mail: Andreas.Ivarsson@hh.se

Urban JOHNSON

Employment

Professor, Centre for Research on Welfare, Health and Sport at Halmstad University, Sweden

Degree

PhD

Research interest

Effects of preventive intervention and sport injury and rehabilitation management of acute and long-term injured competitive athletes.

E-mail: Urban.Johnson@hh.se

✉ **Arne Edvardsson**

Centre for research on Welfare, Health and Sport, Halmstad University, Box 823, 30118 Halmstad, Sweden