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The prevalence and recovery of concussed male and female collegiate athletes

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Abstract

The aims of the present study were two-fold: (1) to examine whether gender and explanatory style influence the number of concussions an athlete has sustained and the amount of time to recover from this type of injury; and (2) to determine whether gender and the type of sport influence the number of and recovery from concussion injuries. University varsity athletes ($n = 170$) who had sustained at least one concussion over the previous 12 months from six sports completed both the Sport History Questionnaire (Delaney, Lacroix, Leclerc, & Johnston, 2000), used to measure concussions, and the Attributional Style Questionnaire (Peterson *et al.*, 1982), used to measure explanatory style. Overall, males sustained more concussions than female athletes ($F_{1,153} = 43.92$, $P < 0.05$). Regarding the type of concussion, male athletes sustained more unrecognized concussions than female athletes ($F_{1,168} = 6.18$, $P < 0.05$), but there was no difference between the sexes for recognized concussions ($F_{1,168} = 0.44$, $P > 0.05$). Male basketball players took longer to recover (mean = 6.17 days) than female basketball players (mean = 1.15 days). In contrast, female hockey players took longer to recover (mean = 9.56 days) than male hockey players (mean = 1.00 day). Finally, gender did not influence an athlete's explanatory style.

Keywords: Concussion, university athletes, team sports

Introduction

The Centers for Disease Control and Prevention estimates that 300,000 sport-related concussions occur annually in the United States (Dupuis, Johnston, Lavoie, Lepore, & Lassonde, 2000) and account for 75% of all sport-related brain injuries (Cantu, 1986). Not surprisingly, the majority of concussions occur in sports that involve physical contact between its participants. For instance, Delaney and colleagues (Delaney, Lacroix, Leclerc, & Johnston, 2002) found that 62% of varsity soccer players and 70% of varsity football players experienced symptoms of a concussion during the previous year. Similarly, using injury report forms to examine the incidence of injury in female ice hockey players, Schick and Meeuwisse (2003) reported that concussions were the most common injury for Canadian university female ice hockey players. Additionally,

other studies have shown that the concussion rate in athletics is increasing at an alarming rate in nearly all sporting events, for both men and women, including non-contact sports such as baseball and volleyball (Powell & Barber-Foss, 1999). It is not yet clear whether reported rates are due to more injuries or better identification of injuries.

Despite the growing body of research concerning head injuries in athletics, the recognition and diagnosis of concussion in sport is reported to be among the greatest challenges facing medical personnel, and the true incidence of concussion is believed to be much higher than that recorded (McCrea, Hammeke, Olsen, Leo, & Guskiewicz, 2004). The detection and diagnosis of concussion during sporting matches is difficult because there is no biological marker for the detection of a concussion or any diagnostic test with reliable sensitivity

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and specificity (McCrea *et al.*, 2004). Furthermore, recognition is difficult because 90% of sport-related concussions are considered mild, which are characterized by very subtle symptoms (e.g. headaches, poor concentration) that often go unrecognized (McCrea *et al.*, 2004). For example, Delaney *et al.* (2002) found that only 20% of university football and soccer players who experienced a concussion realized they had suffered this type of injury. Despite experiencing a number of relevant symptoms, including dizziness, headache, and confusion, these athletes continued to play while symptomatic because they were not sufficiently aware of the various symptoms suggestive of a concussion or they purposely decided not to seek medical attention.

A related line of research has examined whether males and females differ on concussion incidence and recovery outcome. More specifically, some experts have suggested that male athletes may be at a greater risk for concussions due to their aggressive nature and that they generally play sports faster than their female counterparts (Barnes *et al.*, 1998). In contrast, others believe that female athletes may be at a greater risk due to their smaller physical size and weaker neck strength (Barnes *et al.*, 1998). To date, the empirical research tends to support the notion that the rate of concussions is higher in female athletes (e.g. Covassin, Swanik, & Sachs, 2003; Farace & Alves, 2000; Gessel, Fields, Collins, Dick, & Comstock, 2007; Powell & Barber-Foss, 1999; Schick & Meeuwisse, 2003). For example, Farace and Alves (2000) undertook a meta-analysis to examine differences between the sexes in traumatic brain injury sequelae following a number of traumatic accidents such as motor vehicle collisions and falls. The results of the meta-analysis demonstrated that the outcome following this type of injury was worse in women than men for approximately 85% of the variables studied (e.g. length of hospitalization, return to work, days of amnesia). Delaney *et al.* (2002) also found that female university soccer players were more than twice as likely as male soccer players to sustain a concussion over a 12-month period.

To date, research examining the prevalence and recovery of concussions, including gender-related factors, has been descriptive in nature. That is, research has examined the frequency of this injury and whether males and females differ in this prevalence. However, research needs to move beyond description and attempt to determine some of the factors that influence the prevalence and recovery from this type of injury. Recently, one of the factors that has gained some attention is the psychological experience of being injured and the numerous thoughts, feelings, and behaviours associated with this type of injury (e.g. Bloom, Horton,

McCrary, & Johnston, 2004; Gould, Udry, Bridges, & Beck, 1997; Johnston *et al.*, 2004; Udry, 1997). In particular, one psychological factor that has received increased attention and a surge of research in the field of health psychology is explanatory style. Although research has only begun to explore explanatory style in relation to concussions, the early findings suggest that athletes with an optimistic explanatory style take longer to recover from concussions than athletes with a pessimistic or average explanatory style (e.g. Shapcott, Bloom, Johnston, Loughead, & Delaney, 2007). This result was attributed to optimists being more in tune with their bodies and a better understanding of the time needed to fully recover before resuming activity.

Generally, literature on the affects of an optimistic explanatory style has suggested this personality characteristic is highly advantageous. Individuals who are optimistic have been associated with enhanced motivation, persistence, and performance, across a number of achievement domains, including academia, athletics, politics, and work (Carver, Blaney, & Scheier, 1979). Moreover, research results have shown that optimistic athletes responded more positively to setbacks regardless of previous experiences or increases in task difficulties (Seligman, 1998), whereas pessimistic athletes perceived and explained their pathways to success to be impeded and ultimately gave up (Schinke & daCosta, 2001).

Due to the favourable benefits of being optimistic, several researchers have examined whether optimism helps recovery and rehabilitation from illness (e.g. Carver *et al.*, 1993; Reed, Kemeny, Taylor, Wang, & Visscher, 1994; Scheier *et al.*, 1989). For instance, Scheier *et al.* (1989) examined the effects of optimism on recovery from coronary artery bypass surgery and found that optimistic individuals recovered faster than pessimists. Specifically, optimists generally achieved faster behavioural milestones of recovery (e.g. sitting up in bed, walking around the room for first time) than pessimistic patients and they had fewer and less severe complications at 6 weeks post-surgery than pessimistic patients.

Thus, the aims of the present study were two-fold. Our first aim was to examine whether gender and explanatory style influenced the number of concussions an athlete had sustained and the amount of time to recover from this type of injury. Using research by Covassin *et al.* (2003), Ellemberg and colleagues (Ellemberg, Leclerc, Couture, & Daigle, 2007), and Farace and Alves (2000) as a basis, it was hypothesized that female athletes would sustain more concussions and take longer to recover than their male counterparts. In addition, we hypothesized athletes with an optimistic explanatory style would experience more concussions and take longer to recover. Our second aim was to determine

whether gender and the type of sport influence the number of and recovery from a concussion injury. Due to the paucity of research examining type of sport and gender concurrently, no *a priori* hypotheses were forwarded. Overall, the need for this type of study has been highlighted by Koh and colleagues (Koh, Cassidy, & Watkinson, 2003), who called for more research involving female athletes who play contact sports.

Methods

Participants

Three hundred and forty-eight varsity athletes (209 males, 139 females) from two Canadian universities initially completed two questionnaires (see "Measures" sub-section below for a description). Based on the results of the Sport History Questionnaire, 170 athletes (99 males, 71 females) were identified as sustaining at least one concussion in the previous year, representing 51% of the participants; consequently, these 170 athletes were used in the analyses. The sample included varsity athletes competing in six different sports: ice hockey ($n=17$ females, 17 males), football ($n=35$ males), lacrosse ($n=5$ females), soccer ($n=14$ females, 9 males), rugby ($n=24$ females, 31 males), and basketball ($n=11$ females, 7 males). There were 22 first-year players, 38 second-year players, 38 third-year players, 46 fourth-year players, and 22 fifth-year players (four players did not report their current class).

Measures

Concussions. The Sport History Questionnaire (SHQ; Delaney, Lacroix, Leclerc, & Johnston, 2000) is a self-report, retrospective inventory that identifies the number of concussions experienced during the previous 12 months of sport participation, and the recovery time taken before the athlete returned to his or her sport. In addition, the SHQ provides information about past recognized and unrecognized/undiagnosed concussions. Despite the increased awareness of the incidence, risks, and possible long-term effects of concussions, research to date reveals that the vast majority of concussions in university and professional athletes go unrecognized (Delaney *et al.*, 2000, 2002; Delaney, Lacroix, Gagne, & Antoniou, 2001). When one combines this reality with the fact that many athletes who recognize they may have suffered a concussion decide not to volunteer their symptoms or seek medical attention, the under-reporting of and limitations of prospective concussion evaluation becomes plainly evident. As such, the SHQ asks about symptoms that the athlete may not have reported

prospectively because they were either unaware that the symptoms experienced were the result of a concussion or they were aware that their symptoms were possibly due to a concussion, but they did not wish to volunteer this information to the medical staff at the time of the injury. Furthermore, the SHQ gathers information on the amount of time (days) athletes were unable to compete and the time that their symptoms persisted. A modified version of this questionnaire, made generic for athletes of all sports, was used for the current study, since the original inventory was created for soccer and football. The present study used the same criteria as Delaney and colleagues to determine if a concussion had occurred in the previous 12 months. It should be noted that a common method for determining injury rates is to take the duration of games and multiply it by the number of players, multiplied by the number of games played. Unfortunately, the SHQ was not designed to record the rate of injuries per 1000 player-hours. Instead, it was designed to list the amount of time (in days) or the number of times a player was concussed or how long they were unable to participate in their sport.

Explanatory style. Explanatory style was measured using the Attributional Style Questionnaire (ASQ; Peterson *et al.*, 1982), a self-report measure consisting of six hypothetical negative events and six hypothetical positive events. Participants are asked to imagine these hypothetical events and assign causes to them. The scoring of the items is organized so that higher scores represent more internal, stable, and global attributions, whereas lower scores represent more external, unstable, and specific attributions (Peterson *et al.*, 1982). The ASQ generates 36 scores, three items (internal, stable, global) for each of the 12 hypothetical events. While many scores can be derived from the ASQ, the present study used a composite total score, which has shown the most consistent psychometric properties (e.g. Peterson & Seligman, 1984). A total composite score is obtained by subtracting the mean of the ratings of internality, stability, and globality for the positive events from the mean of the ratings of internality, stability, and globality for the negative events. Therefore, a total composite score can range from -18 to $+18$. Based on the total composite score, individuals are then classified as optimistic (a score greater than or equal to 6), pessimistic (a score less than or equal to 2), or average – neither optimistic nor pessimistic (a score of 3–5). Cronbach's alpha measures the internal consistency of a group of items. Nunally (1978) has suggested that Cronbach's alpha be greater than 0.70. Cronbach's alphas in the current study were 0.80 for the positive events and 0.76 for the negative events.

Procedures

Institutional review board approval was obtained before data collection. Varsity coaches were first contacted and informed about the nature of the study and were asked if the surveys could be administered to their teams before the start of their competitive seasons. Once permission was obtained from the coaches, athletes were approached with a description of the study and were asked to participate. All participants were informed that participation was voluntary and were assured anonymity and confidentiality of their responses. Informed consent was obtained from all athletes before they completed the questionnaires. The administration of the surveys occurred pre-season following either a team meeting or practice. One of the researchers was present at all times to answer any questions. It took approximately 20 min to complete the questionnaires.

Data analysis

Before the main analysis, descriptive statistics were computed for the number of concussions, recovery time, and explanatory style. As for the main analysis, a series of multivariate analyses of variance (MANOVAs) was computed to (a) determine whether gender and explanatory style had an impact on the total number of concussions and recovery time, (b) establish whether gender influenced the number of recognized and unrecognized concussions sustained by the player, and (c) determine whether gender and type of sport influenced the number of concussions and recovery time. There are numerous multivariate statistics available in MANOVA programs to test the significance of main effects and interactions (e.g. Wilks' lambda, Pillai's trace, Hotelling's trace, Roy's gcr criterion). Pillai's trace was selected as the most appropriate

multivariate test statistic because it is more robust than the other three (Tabachnick & Fidell, 2001).

Results

Descriptive statistics

Number of concussions. Based on the results from the SHQ, the average number of concussions that males sustained in the previous 12 months was 3.39 ($s=2.66$). Interestingly, the results showed that the majority of concussions that males received were of the unrecognized type (3.03, 89.4%), whereby the athlete was unaware that he had been concussed. In contrast, the number of recognized concussions that male athletes received was relatively low with a mean of just 0.36 (10.6%). These results indicate that, in general, male athletes suffered more concussions that went undiagnosed or unrecognized. For female athletes, the average number of concussions received in a 12-month period was 2.58 ($s=1.58$). In comparing the number of unrecognized and recognized concussions, a similar pattern emerged for female athletes. The majority of female athletes had sustained more unrecognized concussions (mean = 2.14, $s=1.59$, or 82.9%) than recognized ones (mean = 0.44, $s=0.60$, or 17.1%).

Recovery time. Based on the results obtained from the SHQ, recovery time was operationalized as the number of days the athletes could not compete in their sport because of being concussed (both recognized and unrecognized). The results indicated that on average males returned to competition 2.23 days ($s=4.35$) after being concussed. In contrast, females took 3.65 days ($s=5.91$) to return to competition after being concussed (see Table I for a breakdown by gender and sport type).

Table I. Mean number of concussions and recovery time by gender (standard deviations in parentheses)

Sport	No. of concussions		Recovery time	
	Males ($n=99$)	Females ($n=71$)	Males ($n=99$)	Females ($n=71$)
Football	4.03 (2.99)	N.A.	1.77 (2.38)	N.A.
Rugby	3.52 (2.64)	2.62 (1.47)	2.87 (5.91)	2.17 (3.33)
Soccer	3.00 (3.46)	2.79 (1.76)	1.14 (1.51)	2.08 (3.90)
Basketball	2.43 (1.51)	2.00 (1.26)	6.17 (8.37)	1.15 (2.13)
Ice hockey	2.47 (1.42)	3.00 (1.87)	1.00 (1.00)	9.56 (8.46)
Lacrosse	N.A.	1.60 (0.55)	N.A.	0.61 (0.88)
Total	3.39 (2.66)	2.58 (1.58)	2.23 (4.35)	3.65 (5.91)

Note: Number of concussions was operationalized as the average number of concussions that athletes received in the previous 12 months. Recovery time was operationalized as the number of days the athletes could not compete in their sport because of being concussed.

Explanatory style. The results showed that male athletes had a mean explanatory score of 3.41 ($s=2.78$, range = -3 to 12). More specifically, the results indicated that 22.6% of male athletes had an optimistic explanatory style, 39.8% had a pessimistic explanatory style, and 37.6% had an average explanatory style (neither optimistic nor pessimistic). For females, the results revealed a mean explanatory style score of 3.08 ($s=2.83$, range = -2 to 13). The results showed that 19.7% of female athletes were classified as having an optimistic explanatory style, 48.5% had a pessimistic explanatory style, and 31.8% had an average explanatory style.

Main analyses

To examine whether gender and explanatory style influenced the total number of concussions and recovery time, a MANOVA was conducted. The independent variables were gender (operationalized as athletes being classified as males or females) and explanatory style (operationalized as athletes being optimistic, pessimistic or average). The total number of concussions athletes received in the previous 12 months and the recovery time (in days) to return to play served as the dependent variables. The MANOVA showed a significant multivariate effect for gender (Pillai's trace, $F_{2,152}=4.74$, $P<0.05$), but not for explanatory style ($F_{4,306}=0.12$, $P>0.05$) or the interaction of gender and explanatory style ($F_{4,306}=1.72$, $P>0.05$). To understand the influence of gender on the two dependent variables, univariate follow-up tests were conducted. *Post-hoc* analyses of variance (ANOVAs) revealed significant mean differences between males and females in terms of the total number of concussions received by the athletes. Specifically, males received a greater number of concussions than female athletes ($F_{1,153}=43.92$, $P<0.05$).

Given that the total number of concussions varied between males and females, a MANOVA was conducted to determine whether males and females differed on the number of concussions that were unrecognized and recognized. Overall, the results indicated a significant multivariate effect for gender (Pillai's trace, $F_{2,167}=3.09$, $P<0.05$). Specifically, the results indicated that males had significantly more unrecognized concussions than females ($F_{1,168}=6.18$, $P<0.05$). However, males and females did not differ on the number of recognized concussions ($F_{1,168}=0.44$, $P>0.05$).

To examine whether gender and type of sport influenced the total number of concussions and recovery time, a MANOVA was conducted. The analysis showed a non-significant multivariate effect for gender (Pillai's trace, $F_{2,159}=0.75$, $P>0.05$), but a significant effect for sport type ($F_{10,320}=2.16$,

$P<0.05$) and the interaction of gender and sport type ($F_{6,320}=5.13$, $P<0.05$). To understand the influence of the gender and sport type interaction, *post-hoc* ANOVAs revealed significant mean differences for recovery time ($F_{3,170}=10.74$, $P<0.05$), but not for the total number of concussions received by the athletes ($F_{3,170}=3.55$, $P>0.05$). Two sets of planned comparisons were conducted. The first set of planned comparisons examined the differences between males and females playing the same sport. The results indicated that female rugby (mean = 2.17, $s=3.33$) and male rugby (mean = 2.87, $s=5.91$) players took the same amount of time (days) to recover from their concussions. Similarly, female soccer (mean = 2.08, $s=3.90$) and male soccer (mean = 1.14, $s=1.51$) players recovered in the same amount of time. However, male basketball players (mean = 6.17, $s=8.37$) took longer to recover than female basketball players (mean = 1.15, $s=2.13$). In addition, female hockey players (mean = 9.56, $s=8.46$) took longer to recover than male hockey players (mean = 1.00, $s=1.00$). The second set of planned comparisons examined the means between same sex and sport type. For females, the results indicated that female hockey players (mean = 9.56, $s=8.46$) took longer to recover than female rugby (mean = 2.17, $s=3.33$), soccer (mean = 2.08, $s=3.90$), basketball (mean = 1.15, $s=2.13$), and lacrosse players (mean = 0.61, $s=0.88$). For males, the results indicated that male basketball players (mean = 6.17, $s=8.37$) took longer to recover than males playing football (mean = 1.77, $s=2.38$), soccer (mean = 1.14, $s=1.51$), and ice hockey (mean = 1.00, $s=1.00$).

Discussion

One of the aims of the present study was to determine whether gender and explanatory style influenced the number of concussions an athlete had sustained and the amount of time to recover from this type of injury. In addition, we also wished to establish whether gender and the type of sport played by the athlete influenced the number of and recovery from concussion injuries. The results from this study demonstrate that gender influenced the number of concussions athletes received, whereby males sustained on average more concussions. In particular, the results showed that males experienced significantly more unrecognized concussions than females, but there were no differences between the sexes with regard to recognized concussions. For type of sport, the results showed that female hockey players and male basketball players took longer to recover from concussions than their respective gender counterparts. Lastly, gender did not influence an athlete's explanatory style. Beyond these findings, a

number of aspects related to the results should be highlighted.

The results revealed that males suffered significantly more concussions than females, a finding that is at odds with previous research (e.g. Covassin *et al.*, 2003; Gessel *et al.*, 2007; Powell & Barber-Foss, 1999). For example, Covassin *et al.* (2003) compared concussion incidence among collegiate athletes over a 3-year period and found that female soccer players sustained significantly more concussions than male soccer players (192 vs. 123), as did female basketball players compared with male basketball players (147 vs. 118). Similarly, Powell and Barber-Foss (1999) found similar differences in high school athletes. The incidence of concussion was higher in girl's soccer (6.2% vs. 5.7%), basketball (5.2% vs. 4.2%), and baseball/softball (2.1% vs. 1.2%) than in the boys' games. Finally, Gessel *et al.* (2007) found that high school girls sustained a higher number of concussions in the school season in soccer (51 vs. 33) and basketball (40 vs. 16) than boys. Furthermore, the authors found concussions represented a greater proportion of total injuries for high school girls (15%) than high school boys (9%). We propose three explanations for our results: measurement, reporting, and physiological.

First, the difference in the results between the present study and previous research may be due to differences in the measurement of a concussion. For example, Covassin *et al.* (2003) considered concussions that were reported to the team athletic trainer that resulted in the athlete missing at least one day due to the injury, whereas the present study utilized an approach that considered concussions that were not only reported to medical personnel but also concussions that went unreported. In fact, several researchers have demonstrated that the true incidence of concussion is higher than that reported (e.g. Delaney *et al.*, 2002; Marshall & Spencer, 2001; McCrea *et al.*, 2004; Thurman, Branche, & Sniezek, 1998). For instance, Delaney *et al.* (2002) showed that approximately 75% of university football and soccer players did not report their concussions either because they did not recognize they had sustained a concussion or they did not want to be withheld from competition. Therefore, determining the incidence of concussions based only on what athletes report may underestimate the true frequency of concussion. As such, the current study used an anonymous questionnaire designed to gather information on both recognized and unrecognized concussions.

Second, the reporting of symptoms may play a role since it has been suggested that males are less likely to report an injury to medical personnel. This would appear to be the case, as males were found to have the most cases of unrecognized concussions.

Additionally, this leads one to speculate whether male athletes perceive the symptoms differently than their female counterparts (i.e. is there a difference in tolerance to pain?). It is possible that in spite of similar symptoms, males may be less likely to "share" their experiences.

Third, as noted by Farace and Alves (2000), the difference between males and females could be physiological, including differences in brain organization or morphological and hormonal differences. Recent findings in the sport concussion field suggest there may be differences in certain aspects of cognitive function, both in baseline testing and in recovery patterns (Covassin, Schatz, & Swanik, 2007; Covassin *et al.*, 2006).

Using the current questionnaire, a significant difference between gender and total number of unrecognized concussions was demonstrated. That is, males experienced significantly more concussions that went unrecognized than females. Since past research has collected concussion data on recognized/reported concussions, it is possible that gender differences resulted from the different ways in which the two genders reported symptoms, whereby males were less likely to report them. This finding is consistent with past research examining gender differences in the reporting of physical and somatic symptoms for illnesses and injuries besides concussion (e.g. Davis, 1981; Kroenke & Spitzer, 1998). Health surveys, studies on physical symptom reporting, and medical registration of physical complaints consistently report that females use health care services and report symptoms more than males (e.g. Barsky, Peekna, & Borus, 2001; Farace & Alves, 2000; Gijssbers van Wijk, van Vliet, Kolk, & Everaerd, 1991; Kroenke & Spitzer, 1998). For instance, Almeida *et al.* (1999) examined whether differences in the likelihood of reporting musculoskeletal injury were apparent among US Marine Corps recruits, and if so, whether these reporting differences contributed to the higher rates of injury found among female trainees. Their results showed that females were more likely to report their injuries than their male counterparts. It is unclear why males were less likely to report injuries; however, research has suggested factors that include biological differences, socialization and social roles, and gender bias (Barsky *et al.*, 2001). Interestingly, there were no differences for recognized concussions. The main reason for that finding is likely that recognition of concussion depends upon concussion education of the athlete and support staff, which would typically be similar for both sexes.

Perhaps surprisingly, female hockey players sustained more concussions than both male hockey players and all other female athletes in our sample, despite the lack of intentional body checking in

women's ice hockey. It has been suggested that male athletes may be at greater risk for concussions due to their aggressive nature or the faster pace of the sport, while female athletes may be at greater risk due to their smaller size and weaker neck strength (Barnes et al., 1998). Further examination of the contribution of neck strength to concussion injury is mandated, especially with regard to potential gender differences. However, it is also possible that female hockey players are getting bigger, stronger, and more aggressive in competition (Bloom & Vanier, 2004), thus contributing to a higher rate of concussions. Additionally, it is possible that female hockey players received their concussions from contact with the boards or the ice instead of an opponent.

The results also showed there was a significant difference in recovery time for male basketball players compared with male football, soccer, and ice hockey players. More specifically, on average basketball players took slightly more than 6 days to return to play, whereas the male athletes from the other three sports in our sample returned to play in just over 1 or just under 2 days. It is possible that both the hockey and football players returned to sport quicker than the basketball players due to the use of protective headgear. The difference between the soccer and basketball players could be explained by the size of the playing field. The basketball players compete in a much smaller and more confined area, which could lead to both more frequent and severe contact with their heads, thus delaying their return to play. This notion is supported by researchers (e.g. Delaney et al., 2002; Delaney, Puni, & Rouah, 2006; McIntosh, McCrory, & Cromerford, 2000; Pellman, Viano, Tucker, & Casson, 2003) who found that concussions are primarily caused by blows delivered to the side of the head.

With respect to explanatory style and gender, our hypothesis was not supported such that no significant differences emerged. Given the lack of sport-specific empirical research in this area, one needs to examine research outside this domain. Overall, the research findings have been equivocal. One body of research has found no differences between explanatory style and gender related to life goals (e.g. Hjelle, Belongia, & Nesser, 1996). Another line of research found that women's pessimistic explanatory style was linked to well-being (e.g. Bunce & Peterson, 1997), and women with a disability had a more optimistic explanatory style (e.g. Martinez & Sewell, 2000). Given that the results of previous non-sport literature have been mixed, it would be premature to conclude that the explanatory style and gender relationship is not important in sport-related concussions.

The participants in our sample generally returned to play within a week. It is possible that explanatory style, regardless of gender, may not have had time to play a role in the recovery process for most of the participants in our study. This suggestion has support from a variety of sport psychology researchers (e.g. Gouvier, Cubic, Jones, Brantley, & Cutlip, 1992; King, Crawford, Weden, Caldwell, & Wade, 1999; Mittenberg & Strauman, 2000) who found that explanatory style contributed to the recovery process for athletes who experienced concussive symptoms that lasted longer than 7 days. For instance, Gouvier et al. (1992) found that post-concussion symptoms varied in accordance with an individual's level of stress, coping style, and cognitive appraisal. Similarly, King et al. (1999) found that psychological vulnerabilities such as anxiety and depression contributed to the persistence of post-concussion symptoms. Finally, Mittenberg and Strauman (2000) found that the initial cause of post-concussion symptoms was physiological, but persistence in post-concussion symptoms could arise from psychological factors. Future research might examine gender issues and explanatory style with respect to recovery period, and use a variety of intervals such as 1, 2, 3-5, 5-10, and more than 10 days.

Conclusions

The current study is of interest to the entire sport community, since concussion injuries are a problem that plagues most sports. Specifically, these results are of interest to individuals involved in contact sports, in particular coaches, athletes, and medical personnel. The present study highlights the need for improving athlete knowledge on the signs and symptoms of a concussion. The current results concur with Delaney et al. (2002), who found that athletes were not fully aware of the significance of their symptoms and the seriousness of sustaining additional head injury during the recovery process. Educating athletes on the effects of concussion, what to expect during recovery, and the dangers of playing while concussed may contribute to better injury recognition and prevention of more serious injury.

While the results of this study provide considerable information regarding concussion prevalence and recovery, many questions surrounding sport-related concussions remain, especially with respect to prevalence, recovery, and gender differences. As such, future research examining concussion prevention strategies should take into consideration this phenomenon as well as physiological gender differences, and the changing nature of women's sports.

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