The relationship between the female athlete triad and injury rates in collegiate female athletes

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Background This study aimed to clarify the relationship between the Triad risk assessment score and the sports injury rate in 116 female college athletes in 7 sports at the national level of competition. **Methods** Bone mineral density (BMD) was measured on the heel of the right leg using an ultrasonic bone densitometer. Those with menstrual deficiency for >3 months or <6 menses in 12 months were classed as amenorrheic athletes. Low energy availability was defined as BMI ≤17.5 kg/m^2. Low BMD was defined as a BMD Z-score <−1.0. The total score for each athlete was calculated, and the cumulative risk of stress fractures was defined as follows: a total score of 0-1 was low risk, a score of 2-5 was moderate risk, and a score of 6 was high risk. The injury survey recorded injuries referring to the injury survey items used by the International Olympic Committee. **Results** In swimming, significantly more athletes were in the low-risk category than in the moderate and high-risk categories. In athletics long-distance, significantly more athletes were in the moderate-risk category than in the low and high-risk categories. In the moderate and high-risk categories, significantly more athletes were in the injury group, whereas significantly more athletes in the low-risk category were in the non-injury group. Significantly more athletes at moderate and high risk had bone stress fractures and bursitis than athletes at low risk. **Discussion** Though this was not a prospective study, it suggested that athletes with relative energy deficiency in sport may be at increased injury risk.

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Abstract

Background

This study aimed to clarify the relationship between the Triad risk assessment score and the sports injury rate in 116 female college athletes in 7 sports at the national level of competition.

Methods

Bone mineral density (BMD) was measured on the heel of the right leg using an ultrasonic bone densitometer. Those with menstrual deficiency for >3 months or <6 menses in 12 months were classed as amenorrheic athletes. Low energy availability was defined as BMI ≤17.5 kg/m^2. Low BMD was defined as a BMD Z-score <−1.0. The total score for each athlete was calculated, and the cumulative risk of stress fractures was defined as follows: a total score of 0-1 was low risk, a score of 2-5 was moderate risk, and a score of 6 was high risk. The injury survey recorded injuries referring to the injury survey items used by the International Olympic Committee.

Results

In swimming, significantly more athletes were in the low-risk category than in the moderate and high-risk categories. In athletics long-distance, significantly more athletes were in the moderate-risk category than in the low and high-risk categories. In the moderate and high-risk categories, significantly more athletes were in the injury group, whereas significantly more athletes in the low-risk category were in the non-injury group. Significantly more athletes at moderate and high risk had bone stress fractures and bursitis than athletes at low risk.

Discussion

Though this was not a prospective study, it suggested that athletes with relative energy deficiency in sport may be at increased injury risk.

Key words: RED-S; low energy availability; The Female Athlete Triad Cumulative Risk Assessment

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Introduction

The American College of Sports Medicine (ACSM) defined the female athlete triad (hereafter referred to as triad) in 1997 and updated it in 2007 and 2014.(De Souza et al. 2014a; Nattiv et al. 2007) The Triad has three components: (a) low energy availability (LEA) with or without disordered eating (DE)/eating disordered (ED); (b) menstrual dysfunction; and (c) low bone mineral density (BMD).(De Souza et al. 2014a) The International Olympic Committee (IOC) suggested that relative energy deficiency in sport (RED-S) affects growth, mental conditioning, cardiovascular function, immunity, and BMD, resulting in decreased overall performance. Both RED-S and the Triad emphasize the importance of appropriate energy intake to support exercise.(De Souza et al. 2014b; Mountjoy et al. 2014; Mountjoy et al. 2015; Mountjoy et al. 2018)

The advances in our understanding of risk factors and management of the triad are reflected in evidence-based guidelines developed by the Female Athlete Triad Coalition in 2014 to help guide medical decision-making for female athletes.(De Souza et al. 2014a) The resulting Female Athlete Triad Cumulative Risk Assessment includes the following 6 items scored on a scale from 0 to 2: low LEA with or without DE/ED; low body mass index (BMI); delayed menarche; oligomenorrhea (6-9 periods in 12 months) or amenorrhea (<6 periods in 12 months); low BMD; and prior stress reaction/fracture.(De Souza et al. 2014a) The resulting risk assessment score is used to classify an athlete into 1 of 3 categories: low risk (0-1 points), moderate risk (2-5 points), or high risk (6 points).(De Souza et al. 2014a)

Using risk assessment scores to help manage treatment for athletes is important, especially considering the evidence for adverse health consequences resulting from the triad. For example, a higher number of triad risk factors is associated with an increased risk for bone stress injuries and low BMD.(Barrack et al. 2014; Gibbs et al. 2014; Tenforde et al. 2013) Furthermore, for female athletes who have one component of the triad, the risk of developing stress fractures is 2.5 times higher than that of athletes with no components of the triad; the risk

is 4.7 times higher for those with two or more components.(Mallinson & De Souza 2014) In addition, collegiate athletes with triad risk factors including oligomenorrhea/amenorrhea or increased risk assessment scores had higher grade bone stress injuries on magnetic resonance imaging and longer return to play.(Nattiv et al. 2013)

RED-S is based on a relative energy deficit and is reported to affect various factors.(Mountjoy et al. 2018) However, there are many studies of bone stress fractures and amenorrhea, and their relationships with the occurrence of sports injury have not been examined. It was previously reported that the frequency of sports injuries was higher in women than in men, suggesting a relationship between the menstrual cycle and sports injury.(Hewett et al. 2007; Park et al. 2009) It has been suggested that there is a strong relationship between the risk of both RED-S and sports injuries.

Therefore, this study aimed to clarify the relationship between the triad risk assessment score and the sports injury rate. The hypothesis of this study was that the moderate and high-risk groups have higher injury rates than the low-risk group on the triad risk assessment score.

Materials and methods

Recruitment

A total of 116 female college athletes were investigated; they were involved in 7 sports (swimming, athletics sprint, athletics long-distance, athletics throwing/jumping, soccer, basketball and volleyball). All sports were at the national level of competition. The Niigata University of Health and Welfare of ethical approval to carry out the study within its facilities (18032). The study content was fully explained to the subjects. Written, informed consent was obtained from all subjects.

Medical examinations

Medical examinations and anthropometry were conducted from August 2018 to January 2019. The participants were asked about age at menarche, date of last menstrual period,

number of menstrual cycles per 12 months, history of bone stress fracture (site and times), dietary restriction, and present or past history of ED/DE using the questionnaire form. Those with menstrual deficiency for >3 months (definition of the Japan Society of Obstetrics and Gynecology) or <6 menses in 12 months were classed as amenorrheic athletes.(De Souza et al. 2014a)

Anthropometry

Height (cm) and body weight (kg) were measured using a body composition monitor (DC150, TANITA, Tokyo, Japan). BMD was measured on the heel of the right leg using an ultrasonic bone densitometer (AOS-100SA, Hitachi Aloka Medical, Tokyo, Japan). The triad is defined as energy intake minus energy expenditure of exercise relative to fat-free mass (FFM) <30 kcal/kg of FFM/d(De Souza et al. 2014a), but it is too complicated to calculate energy balance this way during examinations. Alternatively, the ACSM defines LEA in adult athletes as a BMI ≤17.5 kg/m^2.(De Souza et al. 2014a) Therefore, this criterion was used in the present study.(De Souza et al. 2014a) BMI was calculated as body weight (kg)/height (m^2).

The Female Athlete Triad Cumulative Risk Assessment

The Female Athlete Triad Cumulative Risk Assessment, which was updated by the Triad coalition in 2014, was used.(De Souza et al. 2014a) The following six factors were scored: (a) LEA with or without DE/ED; (b) low BMI; (c) delayed menarche; (d) oligomenorrhea and/or amenorrhea; (e) low BMD; and (f) stress reaction/fractures. With respect to LEA, athletes who received treatment by a psychiatrist received a score of 2, those with some dietary restriction as evidenced by self-report or low/inadequate energy intake on diet logs received a score of 1, and those with no history received a score of 0. Athletes with a BMI ≤17.5 kg/m^2 received a score of 2, and athletes with a BMI between 17.6 and 18.4 kg/m^2 received a score of 1. A score of 0 was given to athletes with a BMI ≥18.5 kg/m^2. For delayed menarche, athletes who had their

menarche at age >16 years received a score of 2, athletes who had their menarche at age 15-16 years received a score of 1, and those with menarche at under 15 years received a score of 0. For athletes with amenorrhea (>3 months or <6 menses in 12 months) were scored 2, 6-9 menses in 12 months were scored 1, and eumenorrheic athletes (>9 menses in 12 months) were scored 0. For low BMD, athletes with a Z-score ≤−2 were scored 2, and those between −1 and −2 were scored 1; a score of 0 was given to those over −1. For a history of stress fractures, those with a history of 2 or more stress fractures or trabecular bone stress fractures were scored 2, those with only one past stress fracture were scored 1, and those with no stress fractures were scored 0. Next, the total score for each athlete was calculated, and the cumulative risk of stress fractures was defined as follows: a total score of 0-1 was low risk, a score of 2-5 was moderate risk and a score of 6 was high risk.(De Souza et al. 2014a)

The injury rate

An injury survey during sports activities was conducted for one season from April 2018 to March 2019. The injury survey collected injuries that resulted in failure to participate in practice and competition for more than 24 hours after injury, referring to the injury survey items used by the IOC.(Junge et al. 2008) Data were collected by physical therapists.

Statistical analysis

The chi-squared test was used to compare differences in the risk categories for each sport, to compare differences in the number of injuries by risk categories, and to compare differences in injured body part-location and the type of injury diagnosis by risk category. The level of significance was set at 5%.

RESULTS

Patients' characteristics

158 The sports undertaken by the participants were swimming (n=11), athletics sprint
159 (n=19), athletics long-distance (n=8), athletics throwing/jumping (n=8), soccer (n=27), basketball
160 (n=26), and volleyball (n=17).
161
162 **The three triad components**
163 There were 2/116 (1.7%) athletes with LEA with or without DE/ED (BMI ≤17.5 kg/m^2),
164 6/116 (5.2%) athletes with amenorrhea (>3 months or <6 menses in 12 months), and 0/116
165 (0.0%) athletes had low BMD (Z-score <-1.0). No players had all three triad components.
166
167 **Prevalence of the 7 events for 116 athletes assigned to triad risk categories**
168 In swimming, there were significantly more in the low-risk category than in the moderate
169 and high-risk categories ($p<0.05$). In athletics long-distance, there were significantly more in the
170 moderate-risk category than in the low and high-risk categories ($p<0.05$) (Table 1). In each
171 scoring category, there was a high proportion (41/116, 35.3%) with a history of bone stress
172 fracture, particularly in athletics long-distance (7/8, 87.5%) (Table 2).
173
174 **Number of injuries and injury rates by triad risk categories (Table 3)**
175 Since there was only participant in the high-risk category, the high and moderate-risk
176 categories were combined for the analysis. The number of injuries was 65 (n=41) in one year. In
177 the moderate and high-risk categories, there were significantly more in the injury group than in
178 the non-injury group ($p<0.05$). In the low-risk category, there were significantly more in the non-
179 injury group than in the injury group ($p<0.05$).
180
181 **Injured body part location and type of injury diagnosis by risk category**
182 There was no significant difference in the injured body part location (Table 4). For stress
183 fracture and bursitis, there were significantly more in the moderate and high-risk categories than

in the low-risk category ($p<0.05$) (Table 5).

Discussion

This study clarified the relationship between the triad risk assessment score and the one-year sports injury rate for female college students of multiple sports. To the best of our knowledge, there have been no studies of the relationship between the triad risk assessment score and sports injury rate.

In this study, there were 2/116 (1.7%) athletes with LEA with or without DE/ED, 6/116 (5.2%) with amenorrhea, and 0/116 (0.0%) with low BMD. No athletes had all three triad components. In previous studies of elite Japanese athletes, the number of athletes with LEA was 42/300 (14.0%), with amenorrhea was 117/300 (39.0%), and with low BMD was 68/300 (22.7%). Seventeen athletes (5.7%) had both amenorrhea and LEA, whereas 39 (13%) had both amenorrhea and low BMD, and two (0.7%) had low BMD and LEA. Sixteen (5.3%) had all three components of the triad. In previous studies of American collegiate athletes, the number of athletes with LEA was 2/323 (0.6%), the number with oligomenorrhea or amenorrhea was 64/239 (26.8%), and the number with low BMD was 19/323 (5.9%).(Tenforde et al. 2017) Although the level of competition was different, the present female athletes were considered to be well managed.

In swimming, the number in the low-risk category was significantly higher than in the moderate and high-risk categories. In athletics long-distance, the number in the moderate-risk category was significantly higher than in the low-risk category. In a previous study, athletics (64/86; 74.4%),(Nose-Ogura et al. 2019) track (0/4; 0.0%),(Tenforde et al. 2017) cycling (3/4; 75.0%),(Nose-Ogura et al. 2019) swimming (7/11; 63.6%),(Nose-Ogura et al. 2019) gymnastics (7/7; 100.0%)(Nose-Ogura et al. 2019) (9/16; 56.2%), (Tenforde et al. 2017) rhythmic gymnastics (31/35; 88.6%),(Nose-Ogura et al. 2019) and cross-country (23/47; 48.9%)(Tenforde et al. 2017) were in the moderate or high-risk categories. Although there is no clear consensus, it was

considered that there were many endurance and aesthetic sports athletes in the middle- and high-risk categories.

In addition, for each scoring category, there was a large proportion (41/116, 35.3%) with a history of bone stress fractures, particularly in athletics long-distance (7/8; 87.8%). In previous studies, female athletes were at a higher risk of bone stress fractures than male athletes.(De Souza et al. 2014a; Nose-Ogura et al. 2019) It has also been reported that the frequency of bone stress fractures among 1616 female Japanese athletes and 537 controls (non-athletes) was 22.6% for athletes competing at the international level, 23.3% for athletes competing at the national level, 20.8% for athletes competing at the local level, 18.8% for athletes competing at other levels, and 4.3% for controls.(Takamatsu & Kitawaki 2016) Therefore, the athletes in the present study had a high rate of bone stress fractures. Furthermore, it was thought that one needs to carefully consider the reason why significantly more athletes were in the moderate-risk category than in the low-risk category in athletics long-distance.

Regarding the number of injured athletes by triad risk category, in the moderate and high-risk categories, there were significantly more athletes in the injury group than in the non-injury group. In previous studies, attention was paid to the relationship between the Female Athlete Triad Cumulative Risk Assessment and bone stress fractures.(Barrack et al. 2014; Gibbs et al. 2014; Mallinson & De Souza 2014; Tenforde et al. 2013) The IOC suggested that RED-S affects growth, mental conditioning, cardiovascular function, immunity, and BMD, resulting in decreased overall performance. In addition, the performance parameters identified in the RED-S conceptual model have been shown to be involved in increased injury risk.(Mountjoy et al. 2018) Though this was not a prospective survey, it suggests that athletes with RED-S may be at increased risk of injury.

Regarding the type of injury diagnosis by risk category, bone stress fracture and bursitis were significantly higher in the moderate and high-risk category than in the low-risk category. In previous studies, a higher number of triad risk factors was associated with an increased risk for

bone stress injuries and low BMD.(Barrack et al. 2014; Gibbs et al. 2014; Tenforde et al. 2013) Furthermore, for female athletes with one component of the triad, the risk of developing stress fractures was 2.5 times higher than that of athletes with no components of the triad; the risk was 4.7 times higher for those with two or more components.(Mallinson & De Souza 2014) Therefore, this study was considered to have supported the results of the previous studies. However, it is necessary to examine bursitis in greater detail in the future.

Several limitations must be considered in this study. First, injury rates could not be calculated by 1000 athlete exposures. Second, the survey of injuries during sports activities was conducted for one season from April 2018 to March 2019, but medical examinations and anthropometry were conducted from August 2018 to January 2019. Therefore, this was not a prospective study.

Conclusions

This study clarified the relationship between the triad risk assessment score and the one-year sports injury rate for female college students of multiple sports. Regarding the number of injured athletes and injury rates by risk category, in the moderate and high-risk categories, there were significantly more athletes in the injury group than in the non-injury group. In addition, there were significantly more athletes in the moderate and high-risk categories than in the low-risk category with bone stress fractures and bursitis. This was not a prospective survey, but its results suggest that athletes with RED-S may be at increased risk of injury. In the future, prospective research was considered necessary.

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Legend

Table 1. Numbers of athletes assigned to triad risk categories by event

Data presented as n (%).

[a]p<0.05 vs. moderate and high risk category

[b]p<0.05 vs. low and high risk category

Table 2. Number of low-, moderate- and high-risk athletes in each event by female athlete triad coalition scoring category

Data presented as n (%).

Table 3. Injury rates by triad risk category

Date presented as n (%).

[a]: p<0.05, Non-injury group in moderate risk (%)

[b]: p<0.05, Injury group in low risk (%)

Table 4. Injured body part location by risk category

Date presented as n (%).

Only items that occurred are listed.

Table 5. Injury diagnosis by triad risk category

Date presented as n (%).

Only items that occurred are listed.

[a]p<0.05 vs. low risk category in stress fracture

[b]p<0.05 vs. low risk category in bursitis

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Table 1(on next page)

Table 2. Number of low-, moderate- and high-risk athletes in each event by female athlete triad coalition scoring category

Data presented as n (%).

Table 1. Numbers of athletes assigned to triad risk categories by event

Sport	No. of athletes	Low risk	Moderate risk	High risk
Swimming	11	11 (100.0) [a]	0 (0.0)	0 (0.0)
Athletics sprint	19	13 (68.4)	6 (31.6)	0 (0.0)
Athletics long-distance	8	2 (25.0)	5 (62.5) [b]	1 (12.5)
Athletics throwing/jumping	8	7 (87.5)	1 (12.5)	0 (0.0)
Soccer	27	20 (74.1)	7 (25.9)	0 (0.0)
Basketball	26	21 (80.8)	5 (19.2)	0 (0.0)
Volleyball	17	14 (82.4)	3 (17.6)	0 (0.0)
Total	116	88 (75.9)	27 (23.3)	1 (0.8)

Data presented as n (%).

[a]$p<0.05$ vs. moderate and high risk category

[b]$p<0.05$ vs. low and high risk category

Table 2(on next page)

Table 2. Number of low-, moderate- and high-risk athletes in each event by female athlete triad coalition scoring category

Data presented as n (%).

Table 2. Number of low-, moderate- and high-risk athletes in each event by female athlete triad coalition scoring category

Category and risk	Swimming (n=11)	Athletic sprint (n=19)	Athletic long-distance (n=8)	Athletic throwing/ Jumping (n=8)	Soccer (n=27)	Basketball (n=26)	Volleyball (n=17)	Total (n=116)
Low energy availability								
Low	9 (7.8)	16 (13.8	6 (5.2)	8 (6.9)	25 (21.6)	25 (21.6)	16 (13.8)	105 (90.5)
Moderate	2 (1.7)	3 (2.6)	2 (1.7)	0 (0.0)	2 (1.7)	1 (0.9)	1 (0.9)	11 (9.5)
High	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Body mass index								
Low	11 (9.5)	16 (13.8)	7 (6.0)	7 (6.0)	26 (22.4)	26 (22.4)	17 (14.7)	110 (94.8)
Moderate	0 (0.0)	2 (1.7)	0 (0.0)	1 (0.9)	1 (0.9)	0 (0.0)	0 (0.0)	4 (3.4)
High	0 (0.0)	1 (0.9)	1 (0.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (1.7)
Age at menarche								
Low	11 (9.5)	17 (14.7)	3 (2.6)	7 (6.0)	23 (19.8)	21 (18.1)	15 (12.9)	97 (83.6)
Moderate	0 (0.0)	2 (1.7)	4 (3.4)	1 (0.9)	4 (3.4)	4 (3.4)	2 (1.7)	17 (14.7)
High	0 (0.0)	0 (0.0)	1 (0.9)	0 (0.0)	0 (0.0)	1 (0.9)	0 (0.0)	2 (1.7)
Oligomenorrhea/ amenorrhea								
Low	11 (9.5)	13 (11.2)	6 (5.2)	7 (6.0)	24 (20.7)	21 (18.1)	16 (13.8)	98 (84.5)
Moderate	0 (0.0)	5 (4.3)	1 (0.9)	1 (0.9)	1 (0.9)	2 (1.7)	0 (0.0)	10 (8.6)
High	0 (0.0)	1 (0.9)	1 (0.9)	0 (0.0)	2 (1.7)	3 (2.6)	1 (0.9)	8 (6.9)
Low bone mineral density								
Low	11 (9.5)	19 (16.4)	8 (6.9)	8 (6.9)	27 (23.3)	26 (22.4)	17 (14.7)	116 (100.0)
Moderate	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

High	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Stress reaction/fracture								
Low	11 (9.5)	10 (8.6)	1 (0.9)	6 (5.2)	18 (15.5)	20 (17.2)	9 (7.8)	75 (64.7)
Moderate	0 (0.0)	8 (6.9)	4 (3.4)	2 (1.7)	9 (7.8)	6 (5.2)	7 (6.0)	36 (31.0)
High	0 (0.0)	1 (0.9)	3 (2.6)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.9)	5 (4.3)

Data presented as n (%).

Table 3(on next page)

Table 3. Injury rates by triad risk category

Date presented as n (%). [a]: p<0.05, Non-injury group in moderate risk (%) [b]: p<0.05, Injury group in low risk (%)

Table 3. Injury rates by triad risk category

Kind of sport	Injury group (n=41)		Non-injury group (n=75)	
	Low risk (%)	Moderate and high risk (%)	Low risk (%)	Moderate and high risk (%)
Swimming	3 (7.3)	0 (0.0)	8 (10.7)	0 (0.0)
Athletics sprint	0 (0.0)	1 (2.4)	13 (17.3)	5 (6.7)
Athletics long-distance	0 (0.0)	3 (7.3)	2 (2.7)	3 (4.0)
Athletics throwing/jumping	2 (4.9)	1 (2.4)	5 (6.7)	0 (0.0)
Soccer	12 (29.3)	6 (14.6)	8 (10.7)	1 (1.3)
Basketball	5 (12.2)	2 (4.9)	16 (21.3)	3 (4.0)
Volleyball	4 (9.8)	2 (4.9)	10 (13.3)	1(1.3)
Total	26 (63.4)	15 (36.6) [a]	62 (82.7) [b]	13 (17.3)

Date presented as n (%).

[a]: $p<0.05$, Non-injury group in moderate risk (%)

[b]: $p<0.05$, Injury group in low risk (%)

Table 4(on next page)

Table 1. Numbers of athletes assigned to triad risk categories by event

Data presented as n (%). [a]p<0.05 vs. moderate and high risk category [b]p<0.05 vs. low and high risk category

Table 4. Injured body part location by risk category

Injured body part	Low risk	Moderate and high risk
Face (incl. eye, ear, nose)	1 (1.5)	0 (0.0)
Head	3 (4.6)	1 (1.5)
Neck / cervical spine	1 (1.5)	0 (0.0)
Lumbar spine / lower back	3 (4.6)	1 (1.5)
Shoulder / clavicle	2 (3.1)	0 (0.0)
Elbow	1 (1.5)	0 (0.0)
Wrist	1 (1.5)	0 (0.0)
Finger	1 (1.5)	0 (0.0)
Thumb	1 (1.5)	0 (0.0)
Hip	0 (0.0)	2 (3.1)
Thigh	4 (6.2)	2 (3.1)
Knee	11 (16.9)	2 (3.1)
Lower leg	4 (6.2)	1 (1.5)
Ankle	8 (12.3)	9 (13.8)
Foot/toe	3 (4.6)	0 (0.0)
Others (heatstroke)	2 (3.1)	1 (1.5)
Total	46 (70.8)	19 (29.2)

Date presented as n (%).

Only items that occurred are listed.

Table 5(on next page)

Table 5. Injury diagnosis by triad risk category

Date presented as n (%). Only items that occurred are listed. [a]p<0.05 vs. low risk category in stress fracture [b]p<0.05 vs. low risk category in bursitis

Table 5. Injury diagnosis by triad risk category

Injury diagnosis	Low risk	Moderate and high risk
Concussion	4 (6.2)	1 (1.5)
Fracture	2 (3.1)	0 (0.0)
Stress fracture	0 (0.0)	4 (6.2) [a]
Other bone injuries	1 (1.5)	0 (0.0)
Dislocation, subluxation	5 (7.7)	1 (1.5)
Ligamentous rupture	2 (3.1)	0 (0.0)
Sprain	8 (12.3)	6 (9.2)
Lesion of meniscus or cartilage	3 (4.6)	0 (0.0)
Strain / muscle rupture / tear	4 (6.2)	0 (0.0)
Contusion / hematoma/ bruise	6 (9.2)	0 (0.0)
Tendinosis / tendinopathy	5 (7.7)	1 (1.5)
Bursitis	1 (1.5)	4 (6.2) [b]
Muscle cramps or spasm	1 (1.5)	1 (1.5)
Nerve injury / spinal cord injury	1 (1.5)	0 (0.0)
Others (nail trouble, heatstroke)	3 (4.6)	1 (1.5)
Total	46 (70.8)	19 (29.2)

Date presented as n (%).

Only items that occurred are listed.

[a]$p<0.05$ vs. low risk category in stress fracture

[b]$p<0.05$ vs. low risk category in bursitis