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Effects of Physical and Psychological Factors on Sports Injury Occurrence in Collegiate Football Players

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It should be acknowledged that several factors (including physical and psychological ones) are involved in sports injuries and conditioning. However, most reports related to the conditions of the athletes, consider their physical and psychological aspects separately. This prospective cohort study aimed to assess whether physical and psychological factors synergistically increase the risk of injury among Japanese footballers by examining field-based measurements and online surveys. A total of 94 footballers were followed up during the football season. Eight factors comprising four physical (current injury, pain awareness, functional movements, and ankle instability) and four psychological factors (catastrophic thoughts about pain, sleepiness awareness, sleep disorder, as well as anxiety and depression) were examined. An increased risk of injury was observed when the physical injury was associated with emotional reactions, defined as psychological factors. This study confirms the findings of previous reports focusing on psychological factors and shows that encouraging collegiate athletes to seek treatment for such concerns can be extremely effective. It is, therefore, important to adopt programs that communicate the importance of collaborative and interdisciplinary treatment approaches to collegiate athletes, sports physicians, and administrative staff to provide comprehensive treatment for collegiate athletes.

Keywords: mental health, prospective study, sports injury

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1. Introduction

Conditioning is the preparation for an athlete to perform well, which includes physical, environmental, and psychological factors. Improving athletic performance while avoiding injury is the primary goal of training programs. Pursuing optimal training programs for athletes has always been a concern in sports science research. Even if athletes perform well, an injury may force them to change their training plan. Thus, preventing injury occurrence is essential for efficient conditioning and improving athletic performance. In addition, extracting risk factors from injury surveys and minimizing the intrinsic risk to athletes is a widely known approach to injury prevention (van Mechelen et al., 1992).

Risk factors for injury occurrence include the joint range of motion, muscle strength, joint instability, and sports skills among others (Bahr et al., 2003). Delahunt and Remus (2019) reported these items as elements of ankle instability that remain after an ankle sprain, a common sports injury. Patients with ankle instability often exhibit muscle weakness, joint laxity, and altered biomechanics. These disorders alter the load distribution in the ankle joint, leading to the destruction of the articular cartilage (Taga et al., 1993), making ankle instability a risk factor for sports injuries.

Basic observable patterns of behavior and movement present from childhood are known as fundamental movement skills, including running, hopping, skipping (locomotor), balancing, twisting,

dodging (stability), throwing, catching, and kicking (object control) (Gallahue, 1989). Therefore, skills regarded by Bahr et al. (2003) include fundamental movement patterns. Myklebust and Bahr (2005) reported that exercise-based injury prevention programs could effectively prevent injury by improving biomechanical and neuromuscular characteristics during functional tasks, such as movement patterns during jumping, landing, and cutting maneuvers. Besides, movement improvement patterns reduce the injury occurrence rates (Myklebust et al., 2005). The Functional Movement Screen (FMS), which evaluates movement patterns (good or poor movement pattern quality), is easy to administer in sports settings. As cut-off values have been reported for this instrument, there have been many investigations of its relationship to injury occurrence. According to a systematic review by Bunn et al. (2019), many studies have defined an FMS total score of ≤14 points as "high risk," and individuals with those scores were 51% more likely to be affected by sports injuries than those with scores indicating low risk (Bunn et al., 2019). Furthermore, athletes with dysfunctional or asymmetrical movements may also be at increased risk for sports injuries (Yeung et al., 2016).

In terms of psychological factors, the prevalence of common mental disorders (CMD) in European professional football players was reported for distress, anxiety and depression, sleep disorders, and adverse alcohol with some players having one or more of these conditions (Gouttebarge et al., 2017). CMD symptoms are more likely to develop in professional football players after sustaining a severe injury (Kilic et al., 2018). As football players with depression are 10% more likely to be injured (Yang et al., 2014), it is highly likely that physical and psychological conditions are closely related and affect performance. It is considered necessary to evaluate psychological issues that may affect the occurrence of other injuries or performance and take adequate measures to improve them. The International Olympic Committee established the Sports Mental Health Assessment Tool (SMHAT) in a consensus statement and stated the importance of psychological screening and assessment (Gouttebarge et al., 2021). Among others, the SMHAT includes questions regarding sleep. Sleep dysfunction has been previously reported in 24.7% of Japanese athletes (Hoshikawa et al., 2018). Milewski et al. (2014) reported that athletes with sleep dysfunction were prone to injuries. Daytime sleepiness is reportedly associated with poor academic performance, suicidal tendencies and depression (Liu et al., 2019; Plante et al., 2017; Zhang et al., 2022). This further demonstrates that sleep dysfunction is also significantly associated with sports injuries and performance deterioration in athletes. Besides, pain is a common symptom recognized among athletes and is considered significant, as evidenced by its inclusion as a recommended investigation item by the International Olympic Committee (Bahr, 2009). Additionally, pain is known to be influenced by various factors, and one of these is catastrophic thinking regarding pain, which has been shown to impact athletes' experience of pain (Sullivan et al., 2000). Catastrophic thinking leads to diminished functional performance in the early postoperative stage, as well as reduced physical responses and increased pain intensity. Therefore, this would also be an important indicator in assessing the condition of athletes.

Physical and psychological conditions should be considered important factors affecting performance and, therefore, should be evaluated together. In addition, it is necessary to consider that there might be multiple factors involved in sports injuries and conditioning (Meeuwisse, 1994; Bahr et al., 2005). Besides, young athletes are averse to seeking mental care support, as they perceive it as a sign of weakness. This indicates their lack of knowledge regarding mental health and other related factors (Gulliver et al., 2012). Therefore, it is necessary to conduct studies targeting this younger generation as well.

Many of the aforementioned reports examined either the physical or the psychological aspect and its impact on the risk of injury. It is possible that even if a factor increases the risk of injury, it may be overlooked, as no injury occurs because of the interaction of the outcome of interest with other factors. Another report (Yoshida et al., 2021a) took an integrated view of these factors to determine the extent to which these problems exist. However, the extent to which the simultaneous presence of these factors affects the occurrence of injury is not clear. Therefore, this study aimed to observe the influence of several risk factors on the occurrence of sports injuries via a prospective investigation of Japanese football players.

2. Methods

2.1. Research Design

We designed a longitudinal observation study to address this question. This study was conducted in accordance with the ethical standards formulated in the Helsinki Declaration of 1964 and its revisions and with the approval (R01-112-1) of the Teikyo Heisei University Ethics Committee. The participants in the study provided written informed consent.

2.2. Participants

The participants were recruited among 131 university football players belonging to a single team in the Kanto University Football League in February 2020. Those whose responses could not be measured at baseline and those who stopped participating in practices and games during the study period (37 weeks from March 30, 2020, to December 13, 2020) were excluded owing to the possibility of injury or illness from sports activities that were not accounted for.

We identified 94 eligible participants from the 131 recruited football players (**Figure 1**). Further descriptive data are presented in **Table 1**. In addition, the distribution frequencies of each participant's physical and psychological problems are presented in **Table 2**. None of the participants experienced concussions during the study period.

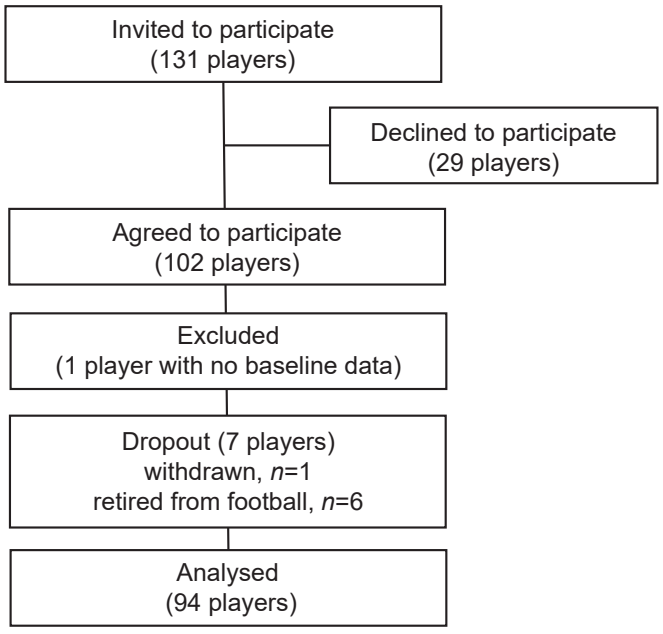

Figure 1 Study flowchart of participants

2.3. Measurement Items

Baseline measurements included physical characteristics (e.g., height and weight), athletic characteristics (e.g., position and level of competition), physical factors (e.g., current injury, pain awareness, functional movement availability, and ankle instability), and psychological factors (e.g., catastrophic thoughts regarding pain, sleepiness, sleep disorders, anxiety and depression). Baseline measurements were performed in February 2020, just after the start of the football season. In addition, sports injuries (e.g., trauma and overuse) that occurred during the study period were investigated.

2.4. Methods of Measurement

Physical and athletic characteristics, as well as physical and psychological factors other than functional movement ability at baseline, were assessed with the Japanese versions of appropriate questionnaires. For "current injury" at baseline, "injury" was defined as the inability or time lost from participating in practice or games resulting from the injury (Fuller et al., 2006). An injury was deemed as one "problem" for any participant. Regarding "pain awareness," pain was defined as an unpleasant sensory and emotional experience associated with or resembling actual or potential tissue damage (Raja et al., 2020); pain awareness was also considered one "problem." In this study, injury and pain were treated as two different entities and included separately in the survey to make this distinction. Body parts with pain and the degree of this pain (at an 11-point numerical rating scale rated from 0 - "no pain" to 10 - "worst imaginable pain") were investigated. The Cumberland Ankle Instability Tool (CAIT) was used to assess ankle instability, with the cut-off score defined as ≥25 points based on the results of a previous study (Tanen et al., 2014; Kunugi et al., 2017). Functional movement was assessed using the FMS by a Level 1-certified person with a cut-off score of <14 points based on a previous study (Kiesel et al., 2011). The criteria for judging psychological factors as "negative" were as follows: Pain Catastrophizing Scale score >30 points for catastrophic thoughts concerning pain (Sullivan et al., 1995; Matsuoka and Sakano, 2007), the Epworth Sleepiness Scale score of ≥11 points for sleepiness (Carter et al., 2020; Takegami et al., 2009), and the Pittsburgh Sleep Quality Index (PSQI)

Table 1 Descriptive statistics of the cohort

Characteristic	Descriptive data[a]
General information	
Male sex, no. (%)	94 (100)
Age, years	20 (19-21)
Height, cm	174.3±5.5
Weight, kg	68.8±5.7
Football experience, months	168.0 (150.5-187.0)
Player position, no. (%)	
FW	14 (14.9)
MF	42 (44.7)
DF	29 (30.9)
GK	9 (9.6)
Physical factors	
1. Presence of sports injury	21 (22.3)
Traumatic injury, no. (%)	14 (14.9)
Contact	9 (9.6)
Non-contact	5 (5.3)
Overuse injury, no. (%)	7 (7.4)
2. Presence of pain, no. (%)	44 (46.8)
Pain in only one body part, no. (%)	27 (28.7)
Head/face	0 (0.0)
Neck/cervical spine	0 (0.0)
Sternum/ribs/upper back	0 (0.0)
Lower back/pelvis/sacrum	4 (4.3)
Shoulder/clavicula	0 (0.0)
Upper arm	0 (0.0)
Elbow	0 (0.0)
Forearm	0 (0.0)
Wrist	0 (0.0)
Hand/finger/thumb	0 (0.0)
Hip/groin	3 (3.2)
Thigh	1 (1.1)
Knee	3 (3.2)
Lower leg/Achilles tendon	0 (0.0)
Ankle	14 (14.9)
Foot/toe	2 (2.1)
Pain in two body parts, no. (%)	17 (18.1)
Sternum/ribs/upper back and thigh	1 (1.1)
Lower back/pelvis/sacrum and hand/finger/thumb	1 (1.1)
Lower back/pelvis/sacrum and knee	1 (1.1)
Shoulder/clavicula and ankle	1 (1.1)
Hand/finger/thumb and knee	1 (1.1)
Hip/groin and knee	1 (1.1)
Hip/groin and Lower leg/Achilles tendon	1 (1.1)
Hip/groin and Ankle	2 (2.1)

Thigh and Knee	1 (1.1)
Thigh and Lower leg/Achilles tendon	1 (1.1)
Thigh and Ankle	1 (1.1)
Knee and Ankle	1 (1.1)
Lower leg/Achilles tendon and Ankle	1 (1.1)
Lower leg/Achilles tendon and Foot/toe	1 (1.1)
Ankle and Ankle	2 (2.1)
Degree of pain during exercise (11-point Numerical Rating Scale: NRS) (27+17×2 = total 61 parts)	4.0 (3.0-5.0)
3. Fundamental pattern of movement: FMS	15.0 (14.0-16.0)
FMS risk (score<14), no. (%)	20 (21.3)
4. Ankle instability: CAIT	25.0 (22.0-27.0)
CAIT risk (score≤25), no. (%)	51 (54.3)
Psychological factors	
1. Catastrophic thoughts of pain: PCS	23.5±8.0
PCS risk (score>30), no. (%)	17 (18.1)
2. Daytime sleepiness: ESS	10.3±3.7
ESS risk (score≥11), no. (%)	46 (48.9)
3. Sleep disorder: PSQI	3.0 (2.0-4.0)
PSQI risk (score≥6), no. (%)	15 (16.0)
4. Symptoms of anxiety and depression: HADS	9.0 (6.8-12.3)
HADS risk (score≥15)	12 (12.8)

[a] The Shapiro–Wilk test denotes that the variables do not follow a normal distribution when $p < 0.05$, and the median (25th percentile–75th percentile) is used in such cases. When $p \geq 0.05$ in the Shapiro–Wilk test, the variables follow a normal distribution, and the means ± standard deviations are used in such cases.

Table 2 Distribution of physical and psychological conditions

	The number of physical problems			
	0	1	2	3
Psychological problems				
0	8 (8.5)	8 (8.5)	8 (8.5)	8 (8.5)
1	12 (12.8)	8 (8.5)	12 (12.8)	13 (13.8)
2	2 (2.1)	4 (4.3)	2 (2.1)	0 (0.0)
3	3 (3.2)	1 (1.1)	3 (3.2)	0 (0.0)
4	0 (0.0)	2 (2.1)	0 (0.0)	0 (0.0)

no. (%), Percentages may not total 100 because of rounding.
The number of physical problems + psychological problems ≤ 2 (n=46)
The number of physical problems + psychological problems ≥ 3 (n=48)

of ≥6 points for sleep disorders (adapted from Carter et al., 2020). Sleep dysfunction was assessed using the Pittsburgh Sleep Quality Index (Doi et al., 1998; Doi et al., 2000). Furthermore, a Hospital Anxiety and Depression Scale score of ≥15 points for anxiety and depression (Fischerauer et al., 2018; Kugaya et al., 1998) was used to establish whether either of these criteria had any impact. The occurrence of sports injuries (e.g., trauma and overuse) was measured every week during the study period (i.e., 37 weeks from March 30, 2020, to December 13, 2020) with the Oslo Sports Trauma Research Center questionnaire (Clarsen et al., 2014; Mashimo et al., 2020). For participants with an injury at the start of the study, new sports injuries were defined as those occurring after recovery from the current injury. No cases were observed where a current injury was worsened by further injury. The definition of an injury was, therefore, considered the most significant factor affecting the survey results (Bahr, 2009). Based on recent research, this prospective study defined sports injury as all physical complaints of a player that resulted from a football match or training, irrespective of the need for medical attention or time lost from football activities (Fuller et al., 2006).

2.5. Statistical analyses

The following analysis flow was conducted to examine physical and psychological problems as risks for sports injuries. The data were assessed with Cox proportional hazards analysis for comparing a small number (one or less) and a large number (more than two) of factors. The group with one or less physical risk and the other with two or more physical risks at the beginning of follow-up were compared first. Then, the number of mental risks at the beginning of the follow-up was compared between the groups with less than one and two or more risks. In addition, to assess the combined effects of physical and psychological problems, the total number of physical and psychological risks at the start of follow-up was assigned to groups with two or fewer risks and groups with three or more risks. Furthermore, Kaplan–Meier analysis and the log-rank test were conducted to assess the risk factors for the occurrence of sports injury with the Cox proportional hazards analysis. IBM SPSS Statistics 19 (IBM Corp., Armonk, NY, USA) was used for all statistical analyses.

3. Results

No significant effects were observed on the number of risks or trauma injuries in any of the groups. In contrast, overuse injuries occurred in the group with ≤ 1 physical risks (10.4%) and the group with ≥ 2 risks (34.8%) (**Table 3**). A significant effect was noted with a hazard ratio (HR) of 4.40 (95% confidence interval, CI: 1.60–12.07; **Table 3**). Although no significant effect was found for mental risk alone, overuse injuries occurred in the group with a sum of the number of physical and mental risks of ≤ 2 (8.7%) and the group with a sum of the number of physical and mental risks of ≥ 3 (35.4%), with a significant HR of 4.75 (95% CI: 1.59–14.15; **Table 3**). In addition, the Kaplan–Meier survival curves for the "occurrence of overuse injury and physical risk" and the "occurrence of overuse injury and the total number of physical and mental risks," which showed significant effects, are illustrated, and log-rank tests were performed (**Figure 2a, 2b**). The results showed that the relationship between the number of physical risks (≤ 1, ≥ 2) and the time (weeks) of overuse injury (P = 0.002) and that between the total number of physical and mental risks (≤ 2, ≥ 3) and the time (weeks) of overuse injury (P = 0.002) were both significant.

4. Discussion

4.1. Key Results

Similar to conditioning, many factors are likely involved in the occurrence of sports injuries. This study aimed to determine whether eight examined factors in two categories would arise, either individually or in combination, as risk factors of sports injury occurrence.

Hoegh et al. (2021) reported that pain without an identifiable pathology is common in athletes; therefore, sports injuries and pain should be considered with a clear distinction. Considering all pain as a direct sign of tissue damage may result in low priority being given to psychological and social aspects of a return to sports. In addition, inherently unnecessary assessments and interventions may be performed when an athlete has an injury (Nickel et al., 2017). Fear and anxiety concerning pain may be increased when pain is linked to an unconfirmed injury, such as when a clear clinical diagnosis is

Table 3 Association of incidence of sports injury with the low/high-risk groups

	No. of players (%)	Relative risk (95%CI)	Survival time (95%CI)[a]	Hazard ratio (95%CI)	*p*-value
Incidence of traumatic injury					
Physical<2 (n=48)	26 (54.2)		27.8 (24.9-30.7)		
Physical≥2 (n=46)	22 (47.8)	0.88 (0.59-1.32)	24.3 (20.7-27.8)	1.41 (0.80-2.49)	0.241
Psychological<2 (n=77)	40 (51.9)		25.4 (22.8-28.0)		
Psychological≥2 (n=17)	8 (47.1)	0.97 (0.80-1.17)	30.1 (25.8-34.3)	0.72 (0.33-1.53)	0.387
Physical+Psychological<3 (n=46)	27 (58.7)		26.7 (23.7-29.7)		
Physical+Psychological≥3 (n=48)	21 (43.8)	0.73 (0.48-1.12)	25.8 (22.3-29.3)	1.05 (0.59-1.86)	0.871
Incidence of overuse injury					
Physical<2 (n=48)	5 (10.4)		34.1 (31.7-36.5)		
Physical≥2 (n=46)	16 (34.8)	2.47 (1.12-5.44)	26.6 (22.4-30.7)	4.40 (1.60-12.07)	0.004
Psychological<2 (n=77)	16 (20.8)		30.7 (27.9-33.4)		
Psychological≥2 (n=17)	5 (29.4)	1.10 (0.85-1.42)	30.7 (25.6-35.9)	1.22 (0.44-3.33)	0.703
Physical+Psychological<3 (n=46)	4 (8.7)		34.1 (31.4-36.9)		
Physical+Psychological≥3 (n=48)	17 (35.4)	3.02 (1.22-7.46)	27.2 (23.3-31.0)	4.75 (1.59-14.15)	0.005

[a] For athletes who had a sports injury at the start of follow up, follow up was started after they recovered and were able to participate in practice.

lacking (Ardern et al., 2013). A disagreement was noted regarding whether ankle instability alone (Attenborough et al., 2014) or FMS scores alone (Moran et al., 2017) would influence the occurrence of other injuries. However, in this study, ankle instability and functional movement ability based on the FMS score were both included as physical factors that may influence sports injuries. The results suggested that ankle instability and functional movement ability can be included in the physical factors as indicators for calculating the risk of overuse injuries. Ankle instability or impairment of physical

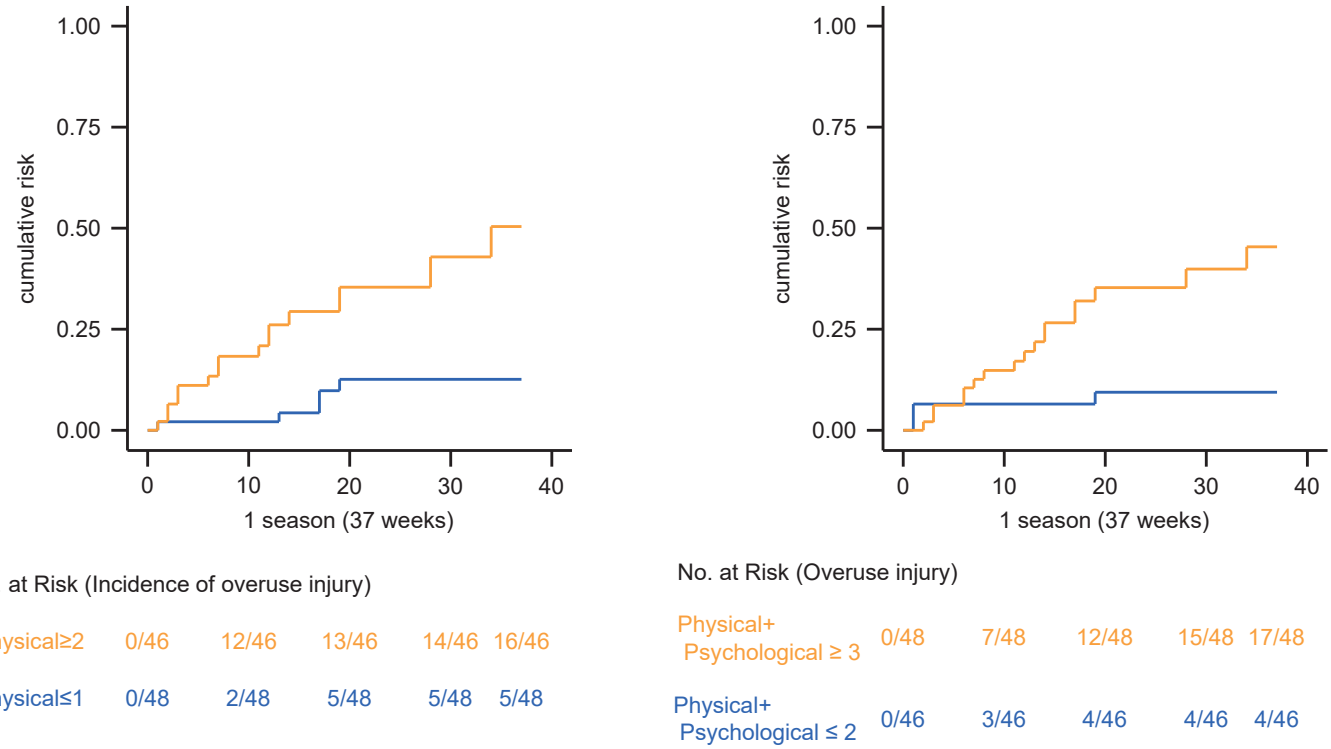

Figure 2 Kaplan–Meier survival curves for the occurrence of overuse injury and physical risk and occurrence of overuse injury and the total number of physical and mental risks.

(a) Time to the first adjudicated sports injury (n=94) in terms of the relationship between the number of physical risks (≤ 1, ≥ 2) and the time (weeks) of overuse injury

(b) Time to the first adjudicated sports injury (n=94) in terms of the relationship between the total number of physical and mental risks (≤ 2, ≥ 3) and the time (weeks) of overuse injury

function may lead to poor dynamic alignment and compensatory movements (Chang et al., 2019; Kim et al., 2019), which could contribute to the development of overuse injuries. It has been reported that balance training can improve neuromuscular control, proprioception, strength, and postural control of ankle stability (Anguish et al., 2018), and implementation of corrective exercises targeting the FMS can improve FMS scores (Yoshida et al., 2021b). Applying these approaches could be useful in reducing the risk of overuse injuries.

Although a previous report denied the association between sleep deprivation and injury occurrence (Burke et al., 2020), another study (Von Rosen et al., 2017) presented a positive association. In addition, it has been recommended to include catastrophic thoughts concerning pain as an item in a medical check before sports participation (Sciascia et al., 2020). Injury risk was also higher in athletes who reported anxiety or depression (Li et al., 2017). Therefore, this study included catastrophic thoughts concerning pain, sleepiness, sleep disorder, anxiety and depression as psychological factors. Our results showed that psychological factors alone were not directly related to sports injuries. However, even if the number of physical risks was less than two, the sum of the number of physical and psychological risks was a risk factor for the occurrence of new sports injuries during a season if the total number of physical and psychological risks together was three or more. In a previous study (Vetter et al., 2010), a statistically significant difference was found between mental fatigue and the occurrence of injury during competitive (in-season) and non-competitive (off-season) activities; our study results support this finding. A low literacy level has been found to contribute to sleep and mental health issues among young athletes (Gulliver et al., 2012), and it is possible that addressing these issues through awareness improvement approaches could help to alleviate them (Castaldelli-Maia et al., 2019). While more severe cases may require specialized interventions, for young college-going athletes such as those in this study, introducing approaches to improve awareness is the recommended first step.

Many reports have examined the relationship

between injury occurrence based on a single indicator, and the existence of an association has been controversial. Conversely, the results of this study suggest that, by investigating several indices, it may be possible to extract factors associated with the occurrence of overuse injuries. However, the factors analyzed in this study had no significant effect on trauma injuries. In either case, this work suggests that it may be difficult to use the items adopted in this study to predict the risk of trauma injuries based on the presence or absence of physical and psychological problems.

Concussion has also been cited as an injury that affects psychological issues and may follow a different return-to-play protocol in anterior cruciate ligament (ACL) injuries and sprains. These injuries can be very challenging for collegiate athletes to handle emotionally, and the timeline for recovery and return to play is unknown. This is very different from an ACL injury that has a somewhat predictable timeline for rehabilitation and recovery (Weber et al., 2018). Moreover, the athlete appears to be functioning normally, which makes the requirement to stay away from training more challenging. However, concussions did not occur in any of the participants in this study.

4.2. Limitation

In this study, we set four physical problems as evaluation items because of their potential to impact the whole body and cause injury. Various factors may contribute to injury occurrence beyond the problems we examined in this study. Besides, several studies have shown no relationship between ankle instability and other injuries in the body. The most significant limitation of this study was that it did not investigate the relationship of injury occurrence with other factors, including knee-, hip-, and trunk-related issues. Future research should consider these other factors. This study only included male collegiate football players. It is necessary to expand the scope of the research to include female football players and players of other sports, as well as individuals belonging to a wider age range and at varying levels of competition. Additionally, this study did not investigate methods for improving the factors under consideration, thereby failing to indicate an appropriate approach for resolution of the issues. Future studies should aim to devise methods to improve these issues.

4.3. Generalizability

Our results may be applicable to a wider population, including players of other sports that primarily involve the lower limbs or to athletes in similar age groups. To affirm this, it is necessary to conduct research involving a broader and varied sample including female players.

5. Conclusion

This study investigated the influence of physical and psychological factors on the occurrence of sports injuries in Japanese football players. It is possible to screen players at high risk of overuse injury by monitoring their physical and mental conditions. However, it is difficult to screen the players' whole body for high trauma injury risk. In addition, high-risk players should improve their physical and psychological well-being to prevent such injuries in the future.

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