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# Effects of Functional Ankle Instability on Collegiate Female Football Players' Performances

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**Abstract:** The purpose of this study was to investigate the relationship between functional ankle instability and collegiate female football players' performance. Ankle instability was defined as functional instability based on the Karlsson score. All participants underwent performance tests (Yo-Yo Intermittent Recovery test level 1, 20 m and 40 m Sprint, Bounding test, Shuttle run, Figure-of-8 hop test, and Side hopping). A positive relationship was observed between functional ankle instability and performance deficits on the Figure-of-8 hop test. However, functional ankle instability is thought to have an influence on football performance. In the performance tests, the results suggest the necessity of a new evaluation method with more difficult tests incorporating football movements, subjective "pain" and "instability" indices, and mechanical instability.

**Key words:** Ankle instability, female football, performance.

## 1. Introduction

Football is probably the most popular sport worldwide, with a growing interest and an increasing number of female players in particular. The number of female players in Japan also continues to increase every year exceeding approximately 28,000 today [1].

Football is a sport that intermittently requires players walking, jogging, running, and sprinting. Injuries to the lower extremity are common in female football players, and the part with the most traumas that occur during games is the ankle [2].

Despite ankle sprains considered as one of the most common injuries in sports, the rates of chronic ankle instability and recurrent injury are thought to exceed 56% to 74% [3, 4].

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Ankle sprain is a common and serious residual disability that possibly causes muscle weakness, neuromuscular dysfunction and functional ankle instability (FAI). FAI is considered as the result of neural (proprioception, reflexes, and muscular reaction time) and muscular (strength, power, and endurance) dysfunctions [5, 6].

Ankle instability is one of the risk factors for recurrent ankle sprain and has a harmful influence on performances [7]. Although there are reports that found the performance declines with functional ankle instabilities, researches that reported the influence of subjective ankle instability on physical ability and performance are rare, especially for female football players. There are few previous studies. Therefore, we investigated the influence of subjective ankle instability on physical capability and performance in collegiate female football players.

## 2. Methods

### *2.1 Subjects*

Sixteen healthy collegiate female football players participated in this study (mean ± SD age, 19.7 ± 1.4 years; height, 159.8 ± 7.6 cm; weight, 56.7 ± 6.1 kg, career, 11.6 ± 3.3 years). Participants belonged to the grade of playing in All Japan University Women's Football Tournament. All procedures in this study were approved by the ethics committee of Sendai University (approval number: 28-39). All subjects gave their consent to participate.

Ankle instability was defined as functional instability, which was evaluated by the Karlsson and Peterson scoring system for ankle function [8]. The Karlsson score evaluates 8 different functional parameters: pain, swelling, instability, stiffness, stair climbing, running, work activities, and use of an ankle support. On this scale, 100 points were divided among these items, and the participant with higher than 80 points was considered to have a normal ankle. In the participant with 80 points or less, the ankle was determined to have functional instability. Participants were categorized into two groups by Karlsson score: instability ankle group (IA) and stable ankle group (SA).

A questionnaire was used to investigate the history of ankle sprain: (1) Have you ever sprained your ankle? (2) How many times have you sprained your ankle? (3) Have you received medical treatment at a medical institution?

### *2.2 Performance Tests*

Yo-Yo intermittent recovery test level 1, Sprint (20 m and 40 m), 10 m × 5 shuttle run, and bounding test were utilized for the performance tests that were recommended for physical performance measurement of football players in "Japan Football Association Guideline for measuring physical fitness" [9]. Moreover, two unilateral hopping tests were performed: The Figure-of-8 hop test and the Side-hop test [10].

The aim of the Yo-Yo test was to evaluate a player's capability to recover after repeated intense exercise simulating that in a football game.

The 10 m × 5 shuttle run was a test that evaluated dash, stop, and changing direction in a complex manner and it recorded the time for two round trips of 10 m.

The bounding test measured the distance from the starting point to the landing point, with both feet aligned after a total of 5 steps.

The Figure-of-8 hop test was performed on a 5 m course outlined by cones. Participants were instructed to hop two laps through the course as quickly as possible.

For the Side-hop test, participants were instructed to hop laterally 30 cm and back for a total of 10 repetitions.

### *2.3 Statistical Analysis*

Method of analysis is that all values were expressed as mean ± standard deviation (SD). Differences in performance tests between the two groups were analyzed by a paired *t* test (IBM SPSS version 22). The significance level for this study was set at a *p* value of 0.05.

## 3. Results

Results of body composition and Karlsson score are shown in Table 1. Based on the Karlsson score, 11 participants were categorized in the IA group (96.6 ± 4.7 points) whereas 5 were in the SA group (62.4 ± 11.2 points); a significant difference was observed between the two groups ($p < 0.01$).

Four out of the 11 players in the SA group and 5 out of 5 in the IA group had a history of ankle sprains, and these were all lateral ankle sprains.

Means and standard deviations for the performance tests are shown in Table 2.

In the Figure-of-8 hop test, the SA group (9.1 ± 0.7 sec) was significantly faster than the IA group (9.9 ± 0.9 sec) ($p < 0.05$).

**Table 1 Body composition and Kalsson's score.**

| | SA group ($n$ = 11) | IA group ($n$ = 5) | $p$ value | Effect size |
|---|---|---|---|---|
| Height (cm) | 161.6 ±8.0 | 156.0 ±5.1 | 0.18 | 0.77 |
| Weight (kg) | 57.9 ±5.9 | 53.8 ±6.0 | 0.22 | 0.69 |
| Body fat (%) | 24.9 ±5.3 | 22.9 ±5.0 | 0.49 | 0.38 |
| Age (years) | 19.7 ±1.4 | 19.6 ±1.3 | 0.87 | 0.07 |
| Kalsson's score | 96.9 ±4.6 | 62.4 ±11.2 | 0.00** | 4.83 |

Average ±standard deviation. **$p$ < 0.01.

**Table 2 Results for Each Performance test.**

| | SA group ($n$ = 11) | IA group ($n$ = 5) | $p$ value |
|---|---|---|---|
| YO-YO IRT L1 (m) | 1,087.3 ±220.4 | 1,344.0 ±286.5 | 0.07 |
| 20 m Splint (sec) | 3.5 ±0.1 | 3.6 ±0.2 | 0.28 |
| 40 m Splint (sec) | 6.6 ±0.3 | 6.5 ±0.3 | 0.4 |
| 10 m ×5 shuttle run (sec) | 12.4 ±0.4 | 12.1 ±0.4 | 0.23 |
| Bounding test (m) | 9.8±0.9 | 9.3 ±0.4 | 0.24 |
| Figure of 8 hop test (sec) | 9.1 ±0.7 | 9.9 ±0.9 | 0.03* |
| Side hop test (sec) | 7.5 ±0.8 | 6.9 ±0.5 | 0.06 |

Average ±standard deviation. *$p$ < 0.05.

Conversely, in the Side-hop test, although not significant, the IA group tended to be faster than the SA group. No significant difference was observed between the two groups in the other performance tests.

## 4. Discussion

This study investigated the effect of FAI on the performance of collegiate female football players.

We assessed the results of performance and physical tests to evaluate physical abilities that are considered as important elements in football players. However, between the IA and the SA groups, there were no significant differences, suggesting the relevance of subjective functional ankle instability.

Among the Figure-of-8 hop and Side-hop tests, in the Figure-of-8 hop test, the SA group was significantly faster whereas in the Side-hop test, the IA group was faster. Some reports suggest that the Figure-of-8 hop test and the Side-hop test are useful performance tests targeting ankle instability [10], but other reports do not conform to this viewpoint [11, 12]. Initially, we expected that functional ankle instability would inhibit the performance of these tests, but the results were different from those seen in previous studies.

Recurrent ankle sprains with FAI may cause muscle weakness in the peroneal muscles, delay in muscle reaction time [13, 14], a decrease in intrinsic proprioceptive ability [5, 6] and result in postural control dysfunction.

Comparing the behavior on the performance tests, the Side-hop test is considered to cause stress in the lateral direction in the ankle joint with movement in only the frontal plane on the left and right sides. In contrast, the Figure-of-8 hop test combines the motions along the frontal, sagittal, and the horizontal planes. Additionally, lateral stress is applied to the ankle joint along with rotational stress being applied on the ankle and lower leg during this test.

Miyakawa et al. [15] reported that the characteristic of the foot pressure distribution is subjective and FAI of one leg landing motion was that a plantar pressure was applied to the fourth and the fifth metatarsal bone at an early phase in landing. It was also reported that there was a tendency for the feet to be in a valgus position.

In our study, participants with subjective instability had repeated lateral ankle sprains.

Kaminski et al. [6] reported that with ankle instability the muscular activity of the peroneal muscle was significantly reduced and the phenomenon of controlling the position of the ankle varus is missing. In addition, Nawata et al. [16] reported that with ankle instability it is suggested that calcaneal varus is caused by increasing the load to the outside of the foot during walking.

Therefore, when performing the Figure-of-8 hop test, it is possible that the feet of the participants tended to be in the valgus position during landing due to the speed controlled by the increased rotational stress to the lower limbs.

It is reported that pain stimulation increases the number and sensitivity of mechanoreceptors [5, 6]. Moreover, it is often seen in the sports setting that an athlete with pain fixes the affected body part as compensation. The side-hop test seems to be easier for a participant to fortify the ankle joint than the Figure-of-8 hop test, which may cause pain. Comparing the scores of "pain" based on the Karlsson score, the SA group's score was significantly higher. Therefore, it is possible that pain affected the results in our performance tests. It may be necessary to add additional detailed pain evaluations during performance tests.

There were no consistent reports on the relevance between functional ankle instability and the performance tests, and this study's findings were consistent on this aspect.

There were several limitations in this study. First, there were limited participants with subjective ankle instability. Secondly, we did not measure the precise mechanical instability of the ankle joint and the degree of ligamentous damage. In this study, ankle instability was assessed subjectively by using "The Karlsson score", but quantitative assessment methods such as "Cumberland ankle destabilization tool (CAIT)"[17], which is recently used might have also been required.

Since the presence of mechanical instability affects the actions involved in performance, it is necessary for future studies to evaluate both subjective and mechanical instability.

## 5. Conclusions

It is necessary to use unilateral tests and conduct more complicated tasks in various directions, not only in the forward and backward directions but also in the lateral direction when conducting performance tests related to ankle instability in football players.

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