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Association between Age Group at Initial Ankle Sprain and Athletic History in Patients with Chronic Ankle Instability

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ABSTRACT

Inadequate management of the initial ankle sprain, particularly insufficient rehabilitation, has been suggested as a potential cause of chronic ankle instability (CAI). Approximately 46% of individuals who have experienced an initial ankle sprain are at risk of developing CAI. The purpose of this study was to investigate the prevalence of CAI among university athletes and to examine trends in CAI prevalence by age group at the time of the initial ankle sprain and the duration of athletic experience in individuals with CAI. A questionnaire survey was conducted among 248 athletes (155 males, 93 females) belonging to university sports teams, covering the prevalence of CAI, the age at initial ankle sprain, and the number of years of athletic experience. This study was designed as a cross-sectional study and used the recommended selection criteria for CAI research proposed by the International Ankle Consortium (IAC criteria). Furthermore, among those with a history of ankle sprain, we compared the number of years of athletic experience between those with and without CAI. We also examined the prevalence of CAI by age group at the time of the initial sprain. The prevalence of CAI was 8.46%. The average duration of athletic experience was 11.76 ± 1.63 years in the CAI group and 11.48 ± 2.73 years in the non-CAI group, with no statistically significant difference. The prevalence of CAI by age group at the time of the initial ankle sprain was highest in the 6–12 years old (elementary school) group at 20.05%, showing a statistically significant difference compared to other age groups. These results emphasize the importance of appropriate management and rehabilitation of ankle sprains in junior sports.

Keywords: Chronic Ankle Instability; Ankle Sprain; Junior Sports

Abbreviations: AS: Ankle Sprain; NCAA: National Collegiate Athletic Association; IAC: International Ankle Consortium; CAIT: Cumberland Ankle Instability Tool; CAI: Chronic Ankle Instability; NATA: National Athletic Trainers' Association

Introduction

Ankle sprain (AS) is one of the most common musculoskeletal injuries, and especially, the incidence of Lateral ankle sprain (LAS) is high 1.3). This is due to the mechanism of injury in which the foot is forced to turn inwards when landing from a jump. In an epidemiological study of 6 seasons in 25 sports affiliated with the National Collegiate Athletic Association (NCAA), the incidence of LAS was 4.95/10,000 Athlete Exposure, the highest of all injuries [1]. In addition, the re-injury rate for LAS is very high, and it has been reported that athletes who have experienced LAS have a risk of injury that is approximately 5 times higher than that of athletes who have not experienced LAS [2]. Many athletes who suffer from repetitive sprains develop structural and functional instability, and if they chronically experience subjective instability (giving way) in the affected ankle joint, they will progress to chronic ankle instability (CAI) [3,4]. CAI is made up of three main components: subjective instability (giving way), functional instability and recurrent sprains, and an athlete may

experience one, two or all of these [5]. Such symptoms can lead to a decline in performance for athletes, making it difficult for them to continue competing. Liu et al. [6] also point out that in cases where there is CAI but no recurrence of LAS, there are those who change their sport or reduce the intensity of their exercise, or who restrict their activities in daily life ('adapters').

Factors that can lead to the transition to CAI include inadequate management of the initial AS, and in particular, inadequate rehabilitation is thought to be a factor that can lead to CAI. It is thought that around 46% of athletes who experience their initial AS will go on to develop CAI [7]. In order to prevent CAI, the importance of management and rehabilitation after the initial AS has been emphasised in past reports [8,9]. It is important for athletes to return to their pre-injury level of competition after their initial AS and to transition becoming a 'Coper' (someone who has not experienced a re-injury of the sprain) [10]. However, an epidemiological study in the United States reported that 55% of patients with AS did not visit a medical institution, and that more than 90% of patients with AS did not receive appropriate rehabilitation within 30 days of injury [11]. In addition, in a study of high school athletes, it was reported that approximately 90% of athletes return to competition within about a week after suffering an AS [12], and the importance of management and rehabilitation after the initial AS, as well as a lack of awareness of CAI, were cited. The average age of athletes in Japan when they start playing sports is 11.3 years old for boys and 11.6 years old for girls [13], and it is thought that athletes with a long history of playing sports will inevitably have a higher rate of LAS, and that younger athletes junior sports, it is thought that they are more susceptible to the effects of a lack of awareness of LAS sequelae.

The incidence of injury in children aged 12 and under is said to be higher than in other age groups, and in particular, the high proportion of AS is emphasized [14]. In addition, in the First Survey of the Current Situation of Trainers in Japan' conducted by the Japan Sports Association which targeted 1054 athletic trainers, it was reported that the enrollment rate of trainers who work with elementary school students (aged 6 to 12) was 1.2% [15], and there are concerns about the lack of safety management systems and educational activities for injury prevention in junior sports for young children. Currently, there are no reports on the prevalence of CAI and its relationship with athletic history or the age at which the initial AS injury occurred. In this study, we conducted a questionnaire survey on the prevalence of CAI among university athletes and investigated the trends in the duration of athletic history among those with CAI. Additionally, we examined the prevalence of CAI by age group at the time of the initial ankle sprain.

Materials and Methods

This study conducted a survey among 248 athletes (155 males, mean age 19.21 ± 1.01 years; 93 females, mean age 19.07 ± 0.91 years) who were members of the Fukuoka University Athletic Association. The survey aimed to investigate the prevalence of chronic ankle instability (CAI), the timing of the initial ankle sprain (AS), and the duration of athletic experience. This cross-sectional study was designed using the recommended selection criteria proposed by the International Ankle Consortium (IAC criteria) for research targeting CAI [16]. A questionnaire survey was conducted that included items on CAI prevalence, the timing of the initial AS, and the number of years of athletic experience. The main objectives of this study were to investigate the prevalence of CAI, the prevalence by age group at the time of initial AS occurrence, and the duration of athletic experience, in order to characterize trends in CAI prevalence. The questionnaire survey was administered using paper questionnaires during university lectures from October 2023 to March 2024. All participants were asked, using a questionnaire based on the IAC criteria, about the presence or absence of an AS history, the timing of the initial AS, any AS history within the past three months, the presence of ankle "giving way," and the occurrence of recurrent AS. Participants also completed the recommended questionnaire, the Cumberland Ankle Instability Tool (CAIT). In this study, participants were determined to have CAI if they met the following conditions in the same ankle.

Inclusion Criteria

Criterion 1:

- The initial AS occurred more than 12 months ago.
- Experienced inflammatory symptoms (pain, swelling, etc.) at the time of injury.
- Ceased physical activity for at least one day due to the injury.
- No history of AS within the past three months.

Criterion 2:

- Experienced AS two or more times in the same ankle.
- Experienced "giving way" two or more times within the past six months.
- A CAIT score of 24 or less.
- Participants who met all of the above inclusion criteria were classified as having CAI.

Exclusion Criteria

- Having an acute lower limb injury (sprain or fracture).
- Having a history of lower limb surgery or fracture.
- Unable to complete the questionnaire or assessment.

The survey items for the timing of the initial sprain included four age categories

- Elementary school students (6–12 years old)
- Junior high school students (12–15 years old)
- High school students (15–18 years old)
- University students (18 years and older)

This age classification corresponds to the Japanese education system of 6-3-3-4 years (elementary, junior high, high school, and university). Additionally, questions about athletic history (the time when participants started belonging to a team or organization) were included. Athletic history was defined as the time when participants started participating in sports, not limited to their current sport.

Comparison of Average Athletic Experience Between the CAI and Non-CAI Groups

We calculated the proportion of participants with unilateral or bilateral CAI who met all the IAC inclusion criteria. Subsequently, we compared and analyzed the duration of athletic experience between the CAI group and the non-CAI group, which included participants with a history of AS but without CAI. Considering the possibility that the data might not follow a normal distribution, we used the Mann-Whitney U test for statistical analysis to evaluate differences. A p-value of less than 0.05 was considered statistically significant.

Comparison of the Proportion of CAI Cases by Age Group at Initial Ankle Sprain

From the questionnaire responses, we identified CAI cases that met all the IAC inclusion criteria. We calculated the proportion of CAI cases within each of the four age groups at initial AS: (1) 6–12 years, (2) 12–15 years, (3) 15–18 years, and (4) 18 years and older.

Comparison of CAI Prevalence and Recurrent Ankle Sprain Rates by Age Group at Initial Ankle Sprain

We determined the number of participants who experienced their initial AS in each age group and calculated the prevalence of CAI and the rate of recurrent AS within each initial AS age group. Recurrent AS was defined as having a history of two or more AS on the same side. Furthermore, we compared the prevalence of CAI and the rate of recurrent AS between participants who experienced their initial AS at ages 6–12 and those in other age groups. Statistical analysis was performed using the chi-square test, with a significance level set at $p < 0.05$. This study was conducted in accordance with the ethical guidelines for medical research involving human subjects, as stipulated by the Declaration of Helsinki, and was approved by the Fukuoka University Research Ethics Review Committee (approval number: K23-06-002).

Results

From October 2023 to March 2024, we conducted a survey targeting athletes with a history of ankle sprain (AS) to assess the prevalence of chronic ankle instability (CAI), the rate of recurrent AS, athletic history, and the timing of the initial onset of AS (mean age: 19.2 ± 0.9 years). A total of 248 athletes affiliated with the Fukuoka University Athletic Club participated in this study. Data analysis involved calculating the proportions of individuals with CAI (participants who met the IAC criteria) and recurrent AS, as well as determining the mean and standard deviation of their athletic history. Furthermore, based on the CAI prevalence data obtained from the survey, we conducted a comparative analysis of the duration of athletic history between the CAI group and the non-CAI group. Additionally, we calculated the prevalence of CAI, the percentage of individuals with CAI, and the percentage of individuals with recurrent AS (defined as two or more sprains on the same side) according to the age group at which the initial AS occurred and performed comparative analyses.

Comparison of Average Athletic History Between the CAI and Non-CAI Groups

Athletes with a history of AS accounted for 68.95% (171 individuals) of all participants. Among them, 17.74% (44 individuals) had experienced AS only once, while 51.2% (127 individuals) had experienced AS two or more times on the same side. Among all participants who completed the questionnaire, the proportion of individuals with CAI who met all the IAC criteria was 8.46% (21 individuals), and the prevalence of CAI among those with a history of AS was 12.86%. Figure 1 presents the flowchart of this study based on the IAC criteria. The average duration of athletic history among participants with a history of AS was 11.51 ± 2.62 years. When comparing the athletic history between the CAI group and the non-CAI group, the CAI group had an average of 11.76 ± 1.63 years, while the non-CAI group had an average of 11.48 ± 2.73 years (Figure 2). No significant differences were observed between the two groups($p=0.6308$).

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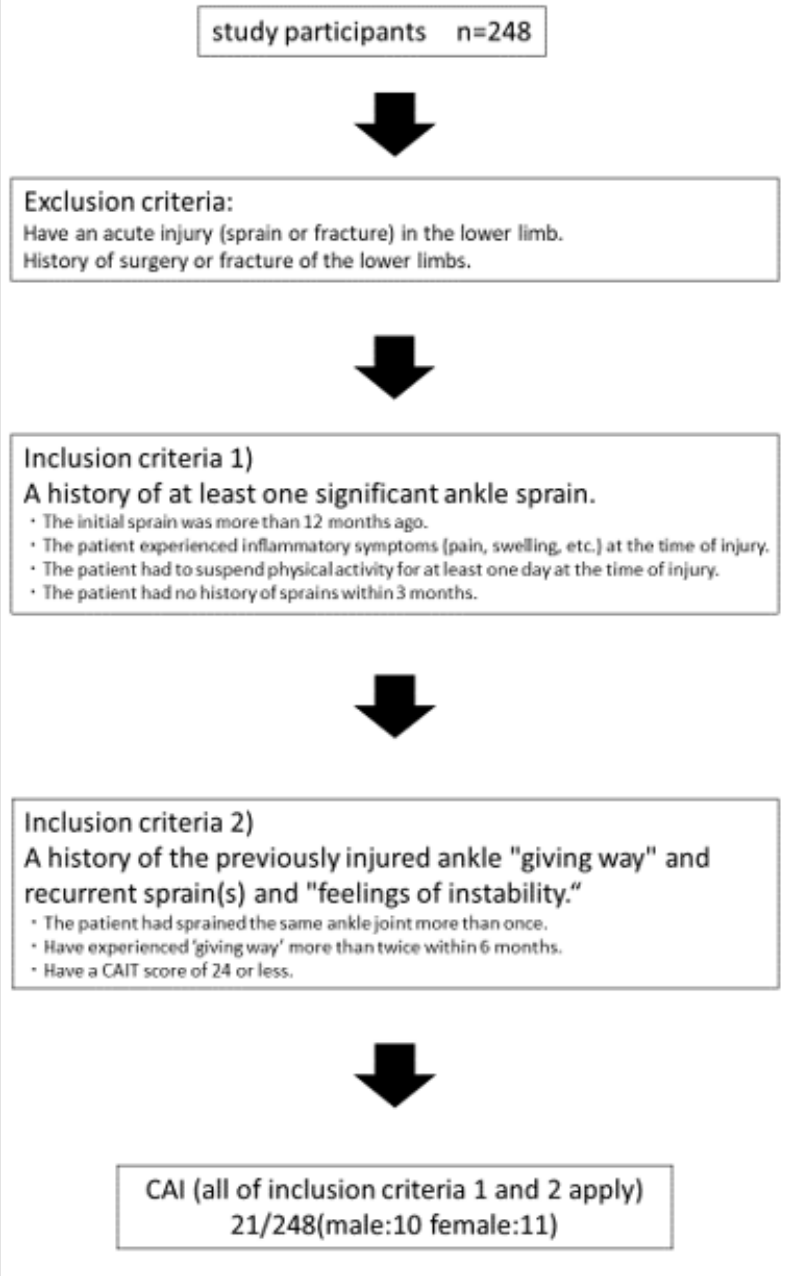

Note: N=248 (155 males, average age: 19.21±1.01 years; 93 females, average age: 19.07±0.91 years)

Figure 1: This is a flowchart of the inclusion criteria for the International Ankle Consortium.

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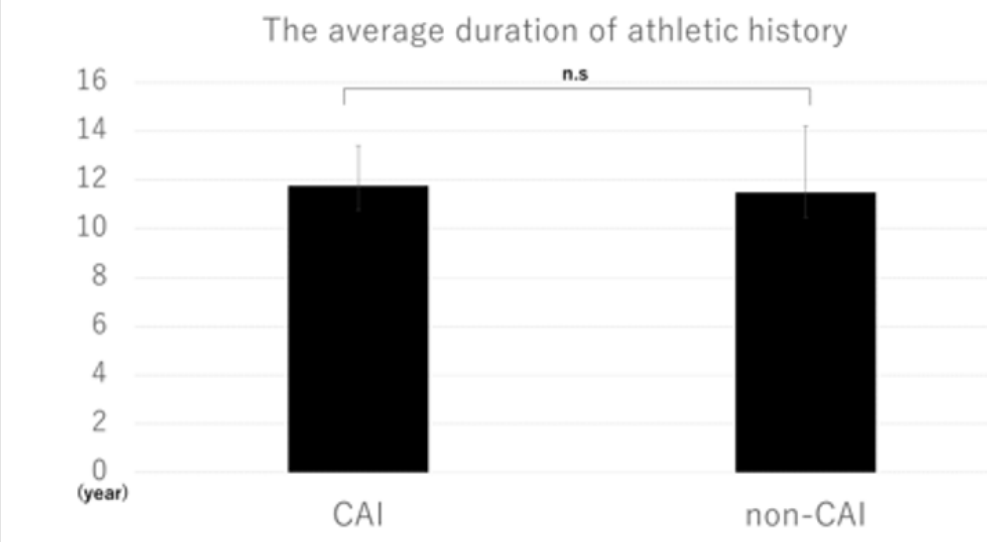

Note: No significant difference was found between the two groups.

Figure 2: This shows the average duration of athletic history in the CAI group and the non-CAI group. the CAI group had an average of 11.76 ± 1.63 years, while the non-CAI group had an average of 11.48 ± 2.73 years.

Comparison of the Proportion of CAI Prevalence and Recurrent Sprains by Age Group at Initial Ankle Sprain

The proportion of CAI prevalence by age group at initial AS was 71.42% for 6-12 years old, 14.28% for 12-15 years old, 14.28% for 15-18 years old, and 0% for 18 years old and over (Figure 3). The proportion of people with recurrent AS by age group was as follows: 6-12 years old: 45.66%, 12-15 years old: 31.49%, 15-18 years old: 19.68%, 18 years old and over: 3.14% (Figure 4).

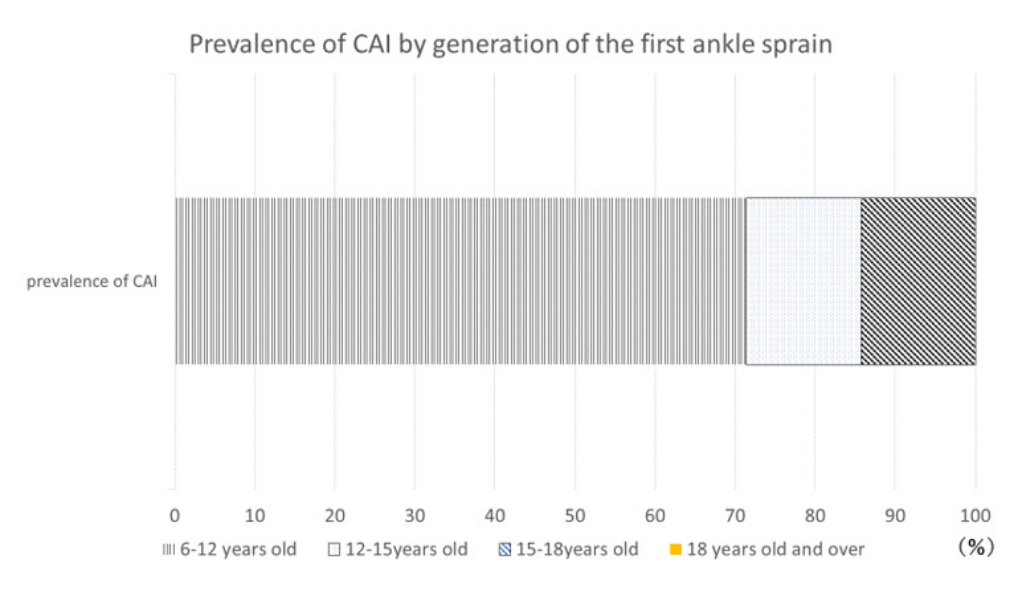

Figure 3: 21 people had CAI. The graph shows the percentage of people in each age group who had a initial ankle sprain.

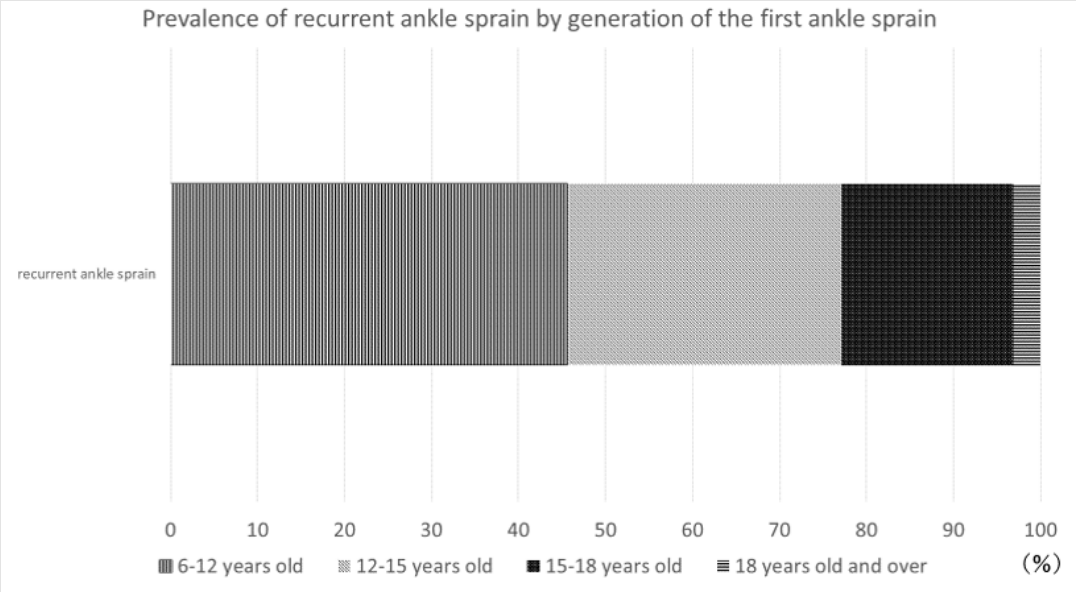

Figure 4: 127 people had recurrent ankle sprains. The graph shows the percentage of people in each age group who had a initial ankle sprain.

Comparison of the Proportions of Individuals with CAI and Recurrent Sprains by Age Group at Initial Ankle Sprain

The proportion of individuals with chronic ankle instability (CAI) by age group at the time of their initial ankle sprain (AS) was as follows: 71.42% in the 6–12 years group, 14.28% in the 12–15 years group, 14.28% in the 15–18 years group, and 0% in the 18 years and older group (Figure 3). The proportion of individuals who experienced recurrent AS at the time of their initial AS by age group was: 45.66% in the 6–12 years group, 31.49% in the 12–15 years group, 19.68% in the 15–18 years group, and 3.14% in the 18 years and older group (Figure 4).

Comparison of CAI Prevalence and Recurrent Ankle Sprain Incidence Rates by Age Group at Initial Ankle Sprain

The distribution of participants based on the age at which they experienced their initial AS was as follows: 39.76% in the 6–12 years group, 30.40% in the 12–15 years group, 24.56% in the 15–18 years group, and 5.26% in the 18 years and older group (Figure 5). The prevalence of CAI in each age group was 22.05% for the 6–12 years group, 5.76% for the 12–15 years group, 7.14% for the 15–18 years group, and 0% for the 18 years and older group. The combined prevalence of CAI in the 12–15, 15–18, and 18 years and older groups was 5.82%. A significant difference in CAI prevalence was observed between the 6–12 years group and the other age groups ($p = 0.0057$) (Figure 6). The prevalence of CAI tended to be higher among those who experienced their initial AS at a younger age. The incidence rates of recurrent ankle sprain in each age group at the time of initial AS were 85.29% for the 6–12 years group, 76.92% for the 12–15 years group, 59.52% for the 15–18 years group, and 0% for the 18 years and older group. The combined incidence rate of recurrent ankle sprain in the 12–15, 15–18, and 18 years and older groups was 66.99%. No significant difference in incidence rate was observed between the 6–12 years group and the other age groups ($p = 0.81702$) (Figure 7). Similar to the prevalence of CAI, the incidence rate of recurrent ankle sprain tended to be higher among those who experienced their initial AS at a younger age.

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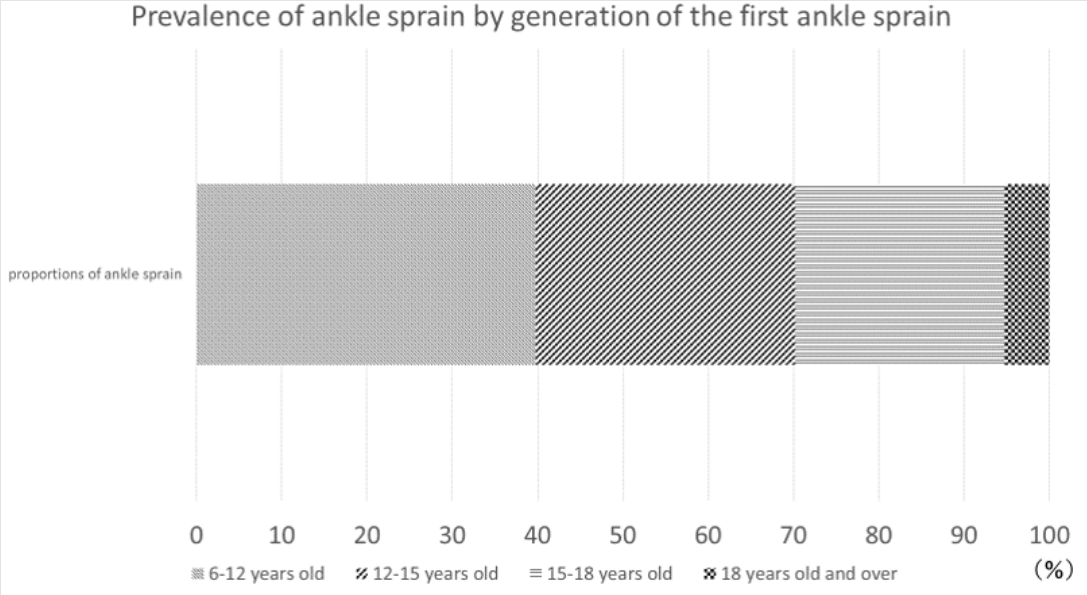

Figure 5: 171 people had experienced an ankle sprain. The graph shows the percentage of people in each age group who had a initial ankle sprain. sprain.

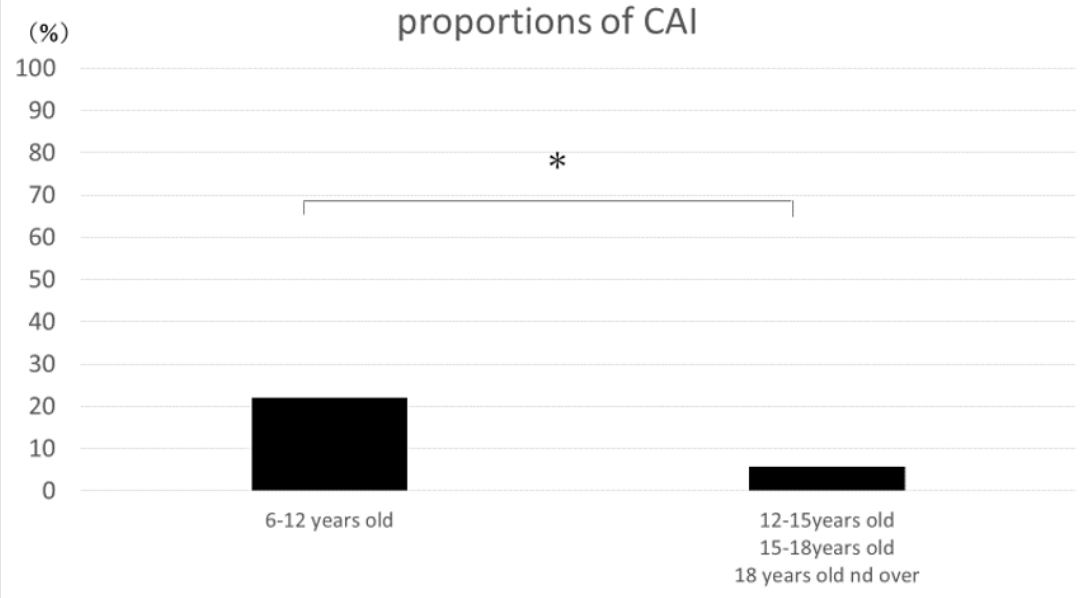

Figure 6: The prevalence of chronic ankle instability (CAI), based on the age group at which individuals sustained their initial ankle sprain, was 22.05% in the 6-12 years old group. The prevalence of CAI in the 12-15, 15-18, and 18+ years old groups was 5.82%. This graph compares the prevalence of CAI between the 6-12 years old group and the combined other age groups.

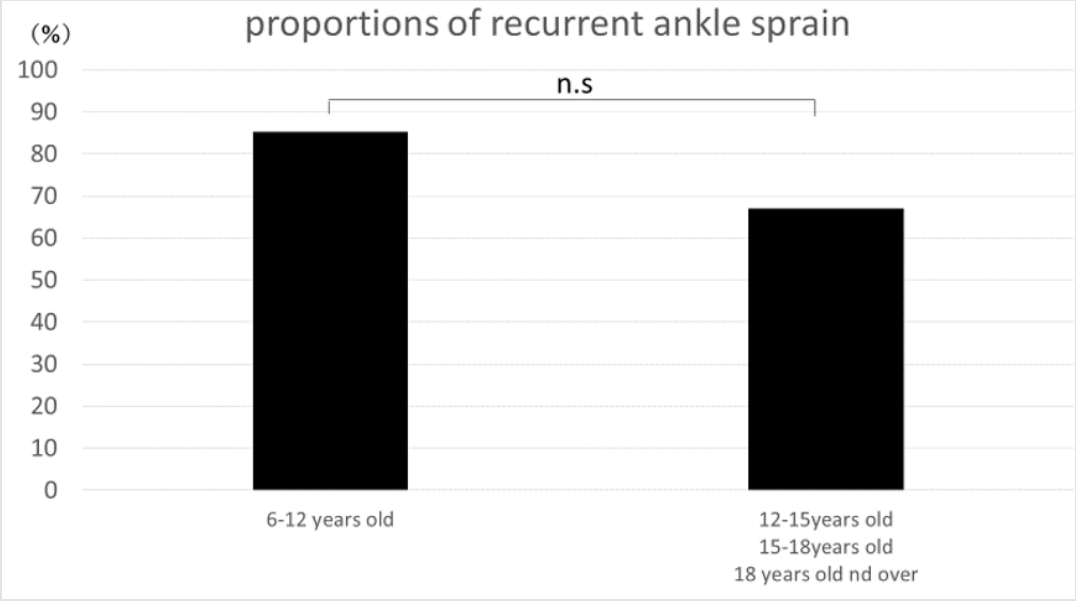

Figure 7: The prevalence of recurrent ankle sprains, based on the age group at which individuals sustained their initial ankle sprain, was 85.29% in the 6-12 years old group. The recurrence rate of ankle sprains in the 12-15, 15-18, and 18+ years old groups was 66.99%. This graph compares the recurrence rate of ankle sprains between the 6-12 years old group and the combined other age groups.

Discussion

In this study, we conducted a survey on the prevalence of chronic ankle instability (CAI) among 248 athletes from various sports teams at Fukuoka University. Among the participants, 68.95% had a history of ankle sprain (AS), and 51.2% had recurrent AS (defined as a history of two or more ankle sprains on the same side). Additionally, 8.46% of the participants met all the criteria set by the International Ankle Consortium (IAC) for CAI. The prevalence of CAI in our study is similar to previous research that reported a 9.4% prevalence of CAI based on the IAC criteria [17]. When comparing the athletic experience between the CAI-positive group and the non-CAI-positive group, no significant differences were observed. We categorized the proportion of individuals with CAI based on the age at their initial AS into four groups:

1) Elementary school students (6–12 years old),

2) Junior high school students (12–15 years old),

3) High school students (15–18 years old), and

4) University students (18 years and older). The highest proportion of individuals with CAI was observed in the 6–12 years age group.

The prevalence of CAI among participants with a history of AS was significantly higher in the 6–12 years age group compared to other age groups at the time of their initial AS. The primary objective of this study was to provide robust evidence on the prevalence and characteristics of CAI. Specifically, we anticipated that understanding the relationship between the age at initial AS and the current prevalence of CAI would significantly contribute to preventing the progression of CAI after AS. Proper management and rehabilitation following an AS are crucial in preventing the development of CAI. The high prevalence of CAI among those who experienced their initial AS between the ages of 6 and 12 suggests that post-AS management and rehabilitation may be inadequate in junior sports at younger ages. According to the "Sports Injury and Disability Statistics" report [18], which summarizes insurance compensation results in Japan for 2017, the highest number of injuries occurred among upper-grade elementary school students (10–12 years old), with over 40,000 cases. In terms of injury location, sprains of the fingers and hands were the most common, followed by a high proportion of AS injuries. A meta-analysis on AS incidence rates categorized the incidence into three groups: children (0–12 years old), adolescents (13–17 years old), and adults (18 years and older). The children's group exhibited the highest cumulative incidence rate, with 2.85 injuries per 1,000 exposures (95% confidence interval: 2.51–3.19) [18]. Considering the high number and incidence of injuries among children aged 12 and under, there is a need to focus on managing AS in this age group and preventing the progression to chronic conditions through AS prevention measures.

Proper neuromuscular control is essential for success in various sports. However, sensorimotor development is generally considered to be completed around the ages of 12 to 13. By this time, the nervous system has developed sufficiently for movements and coordinated actions to become more stable, allowing for more efficient execution of complex movements [19]. Moreover, the sensorimotor systems in

this age group are still developing, making even simple motor control tasks challenging [20]. Therefore, providing training appropriate to each developmental stage is important for injury prevention in this age group. Several key studies have emphasized the importance of appropriate initial management after an AS in preventing CAI 5, [21]. Early and effective treatment of the initial AS is crucial to avoid long-term complications such as CAI and can prevent recurrent sprains, persistent pain, and functional decline. Post-AS symptoms are diverse and may include pain, inflammatory signs, restricted range of motion, decreased muscle strength and function, and impaired balance [22]. Numerous cross-sectional studies have demonstrated that balance function (neuromuscular control) is reduced on both the injured and uninjured sides following lateral ankle sprains [23,24]. The National Athletic Trainers' Association (NATA) position statement also recommends acquiring high-level balance function to prevent recurrence [25,26]. Therefore, returning to sports early with residual foot functional deficits after AS may predispose younger athletes with immature sensorimotor development to recurrent AS or other acute injuries. Additionally, as sports become more structured and competitive with growth in this generation, appropriate management after the initial AS is essential to restore full function and stability.

Conclusion

In this study, we conducted a questionnaire survey among university athletes to investigate the prevalence of CAI based on the IAC criteria, their athletic history, and the age at initial AS occurrence. Based on these results, the prevalence of CAI was similar to previous studies, and no significant differences were found in athletic history between CAI-positive and CAI-negative participants. The prevalence of CAI by age group at initial AS occurrence was highest in the 6–12 years age group, showing a significant difference compared to other age groups. This finding underscores the importance of appropriate management after AS in age groups with immature sensorimotor development.

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