



Factors Associated with Chronic Ankle Instability Among Saudi Arabian Male Volleyball Players: A Cross-sectional Study

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Abstract Background: Chronic ankle instability (CAI) is a common long-term consequence of lateral ankle sprains and is characterised by persistent symptoms, perceived ankle instability, and functional deficits that impair athletic performance. Volleyball players are extremely vulnerable to ankle injuries due to frequent jumping, landing, and rapid directional changes during play. However, the factors associated with CAI in this athletic population—especially in Saudi Arabia—remain underexplored. **Objective:** This study aimed to investigate the association between Cumberland Ankle Instability Tool (CAIT) scores and selected demographic, training-related, and clinical variables among male professional volleyball players in Saudi Arabia. **Methods:** A cross-sectional study was conducted among 117 male professional volleyball players, recruited through cluster sampling from multiple volleyball clubs across the country. Participants provided demographic, anthropometric, and training-related information. CAI was assessed using the validated Arabic version of the CAIT. Spearman's correlation was used to examine associations between CAIT scores and selected variables, while multiple linear regression identified independent factors of CAIT scores. Statistical significance was set at $p < 0.05$. **Results:** The mean age of participants was 25.76 ± 3.72 years, and the mean BMI was 23.53 ± 3.05 kg/m². Players reported an average of 5.11 ± 2.47 years of training experience and trained approximately 2.09 ± 0.93 hours per day. Limb dominance scores (1.27 ± 0.45) indicated predominant right-sided dominance. CAIT scores are significantly associated with previous ankle instability ($\rho = 0.031$, $p < 0.01$) and reinjury ($\rho = 0.046$, $p < 0.01$). However, the direction of these associations should be interpreted in relation to how the binary injury-history variable is coded and the scoring direction of CAIT. The regression model was significant ($F(10,117) = 167.66$, $p < 0.001$), explaining 83.5% of the variance ($R^2 = 0.835$). Previous ankle instability ($\beta = 0.72$, $p < 0.001$), age ($\beta = 0.07$, $p = 0.002$), and reinjury ($\beta = 0.17$, $p = 0.006$) emerged as significant predictors. Age, prior ankle instability, and reinjury were significantly associated with CAI among Saudi male volleyball players. **Conclusion:** These findings support the crucial need for targeted prevention strategies and structured neuromuscular rehabilitation following initial ankle sprains to reduce chronicity and recurrent injury in this population.

Key Words Athletes, Chronic Ankle Instability, Key Risk Factors, Saudi Arabia, Volleyball, CAIT

INTRODUCTION

Volleyball is an intense sport characterised by high agility, precise upper-limb movements, and frequent jump-landing manoeuvres. These motions apply significant mechanical stress to the ankle joint. Although the sport is predominantly played with the hands and wrists, the ankle remains the most injury-prone area, accounting for over 30% of all recorded volleyball injuries [1]. Ankle injuries frequently occur during the blocking and attacking phase, during landing after a jump when an athlete lands on an opponent's foot near the net, resulting in a quick inward roll of the ankle without the foot being directed [2]. Indoors, ankle injuries occur near the

net when an attacking player lands on a foot and collides with a blocker over the goal line, resulting in a sudden combination of excessive plantarflexion and inversion of the ankle; this mechanism causes excessive stress on the lateral ligament complex and may result in acute ankle sprains [3]. If these acute sprains occur frequently or do not heal properly, they are often followed by chronic ankle injury (CAI).

CAI is characterised by persistent mechanical impairments in the ankle joint complex following an initial injury [4]. Athletes diagnosed with CAI often experience repeated ankle sprains, ongoing pain, restricted joint mobility,

ligamentous laxity, impaired proprioception, poor neuromuscular control, and a subjective feeling of instability [4,5,6]. CAI, in addition to acute impacts, is associated with long-term physical and psychological consequences that negatively affect athletic performance, postural balance, quality of life, and continued participation in sports [6, 7]. Evidence indicates that this condition also alters loading patterns in the rearfoot, shifting weight towards the lateral aspect as a compensatory response to instability during weight-bearing, and has been linked to early-onset ankle osteoarthritis [8,9].

According to the International Ankle Consortium, CAI is a sequela to several ankle sprains, persistent sensation of instability, or a history of two ankle instability incidents within the preceding six months [6]. This condition affects approximately 25% of physically active individuals, with a higher prevalence among females and younger athletes, such as high school players, than among university-level athletes [10-13]. Previous studies have found that approximately 30–40% of players who sustain an ankle injury subsequently develop CAI. Among player populations, the prevalence of CAI has been observed to range from 20% to 40%, with higher rates reported in sports that require repetitive jumping and landing. Volleyball players are considered more prone to CAI because of frequent jump-land cycles and rapid directional changes, which increase the likelihood of recurrent ankle sprains and persistent instability symptoms [3,7,10].

CAI is broadly distinguished into two types: mechanical instability, which often involves ligamentous laxity of structures like the anterior talofibular and calcaneofibular ligaments that limit dorsiflexion; and functional instability, marked by neuromuscular deficits, altered gait mechanics, weakness of the evtor and plantar flexor muscles, and reduced postural control [13-16]. CAI is associated with multiple factors, including a prior history of ankle sprain, female gender, high Body Mass Index, pain intensity, CAI history in the contralateral limb, and an increased number of painful ankles [17]. Other important associated factors include delayed peroneal reaction time, decreased dynamic balance, the severity of the initial injury, and inadequate rehabilitation procedures [15,18-20].

There are several self-reported outcome measures available to assess perceived ankle instability, including the Identification of Functional Ankle Instability (IdFAI), the Ankle Instability Instrument, and the Cumberland Ankle Instability Tool (CAIT) [21]. In this study, CAIT was used due to its established validity and reliability in assessing chronic ankle instability, as well as its strong psychometric properties and widespread use in both clinical and research settings [14]. These tools are reliable Patient-Reported Outcome Measures (PROMs) for capturing subjective evaluations of ankle instability, functional impairments, and activity-related complaints [22]. The CAIT tool has been validated as a reliable tool for assessing ankle stability in volleyball players, and it is especially advantageous in identifying individuals who may benefit from targeted

preventative interventions [14]. Increase in research on CAI risk factors, there is still a noteworthy shortage of sport-specific information, particularly in volleyball, where movement patterns and ankle injury processes differ dramatically from those in other sports. Several studies have used heterogeneous samples, generalized player populations, or non-athletic groups, limiting the significance of their findings. This study aimed to examine the associations between CAIT scores and selected demographic, anthropometric, training-related, and ankle injury history variables among male professional volleyball players in Saudi Arabia.

METHODS

Study Design and Setting

This was an observational cross-sectional study focused on male volleyball players representing different professional clubs in Saudi Arabia. The research received ethical clearance from the Majmaah University Ethics Committee (Approval No. MUREC-April.14/COM-2025/181).

Sampling Technique

We identified 10 eligible professional volleyball clubs. Of these, 10 clubs 6 were approached, and 4 clubs were selected using a computer-generated random number procedure. The number of eligible players within each selected club was approximately 145. A total of 117 players were recruited from the 4 selected clubs, including 28 players from club 1, 29 players from club 2, 30 players from club 3 & 30 players from club 4.

Participants

The study comprised male professional volleyball players who were actively competing in the Saudi Arabian professional volleyball league, aged 18 to 35 years, competing in club-level competitions, and engaged in regular training programs. During the data collection, participants were enrolled from multiple volleyball clubs across Saudi Arabia and had a history of ankle sprains, as documented through self-report or medical records. Players who had undergone surgery for ankle instability, had a major lower limb injury that could affect performance, or were inactive in volleyball training or competitions were excluded. The study also excluded participants who did not provide informed consent, were unable to complete the questionnaire, or had any neuromuscular or other medical condition that affected ankle stability.

Sample size

An estimated population of 5,606 male volleyball players affiliated with professional clubs across Saudi Arabia was used to determine the sample size. To ensure sufficient statistical power, the Raosoft online sample size calculator was used with a 95% confidence level, a 5% margin of error, and a 50% expected response rate. According to these assumptions, the minimum sample size was 360 participants. However, to improve representativeness and account for

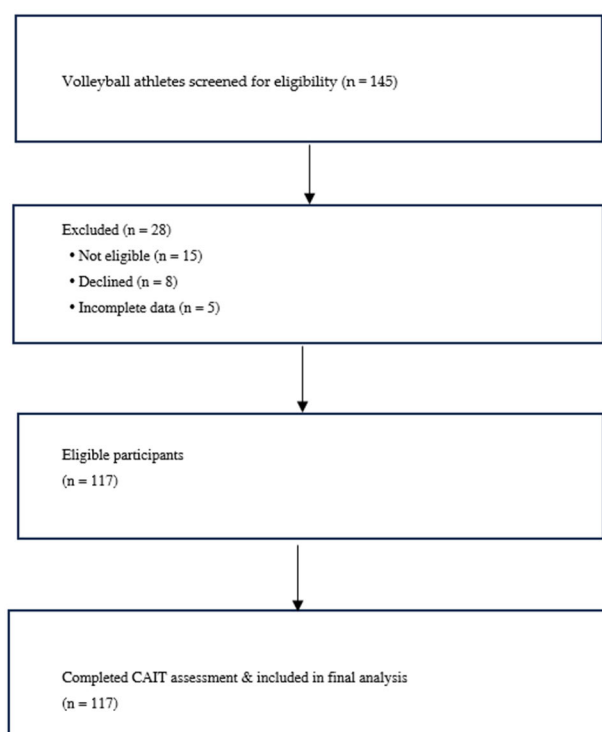


Figure 1: Flowchart of Participant Recruitment and Selection Process

non-responders and incomplete data, the study ultimately recruited 117 volleyball players, exceeding the minimum required level as depicted in Figure 1.

Outcome Variable

A validated self-report measure, the CAIT, was administered to assess perceived ankle instability among the participants [23, 24]. The CAIT tool consists of nine items that evaluate the perceived instability during every day athletic activities. The total score of this tool ranges from 0 to 30; scores below 24 indicate perceived ankle instability [24]. However, the cutoff of <24 can be used for categorical classification. The continuous CAIT score was collected as the primary outcome in the present analysis to preserve information regarding the degree of perceived ankle instability and to allow assessment of associations across the full range of CAIT scores. In addition, the proportion of participants with CAIT scores <24 was calculated to describe the prevalence of perceived ankle instability in the study population.

In this study, the Arabic version of the CAIT was utilized to ensure linguistic and cultural suitability for the population that was targeted in this study. The Arabic version of this tool demonstrated good psychometric properties, with an intraclass correlation coefficient (ICC) of 0.97 and a Cronbach's alpha of 0.92, confirming its reliability and internal consistency. The CAIT tool's worldwide applicability and usefulness further support and justify the fact that it has been translated and verified in several languages, including Persian, Brazilian, Korean, Japanese, and Greek. A recent study by Korakakis et al found

that the Arabic CAIT tool was an 'easy-to-apply', quick, and reliable tool for assessing the different degrees of ankle instability among professional volleyball players. It was also found to be appropriate and relevant for both clinical evaluation and research in the Arabic-speaking populations [24].

Data Collection and Procedure

Data were collected by a trained physiotherapist. A cluster-based sampling technique was then used to select participants who met the inclusion criteria for assessing chronic ankle instability. Two rounds of direct interviews were carried out with the players. Written informed consent was obtained from all players. Demographic and anthropometric data of the players were collected in the first stage using a paper checklist. Subsequently, sports-specific parameters were gathered, including years of volleyball training and average daily training hours per week, limb dominance, history of ankle sprains or initial injury, and recurrent injury were systematically recorded. During the second stage, the validated Arabic version of the Cumberland Ankle Instability Tool (CAIT) was administered to assess perceived ankle instability. The collected data was subsequently compiled and prepared for statistical analysis. This two-stage technique reduced sampling bias, improved population representativeness, and ensured that athletes from diverse training backgrounds, competition levels, and locations were proportionally represented in the study.

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) version 25.0 (IBM Corp., Armonk, NY, USA) was used for all statistical analyses. The distribution of continuous variables was examined by using the Kolmogorov-Smirnov test and inspection of relevant graphical methods. Because several variables did not meet normality assumptions, Spearman's rank-order correlation was used to assess bivariate associations. For every demographic, anthropometric, and training-related variable, descriptive statistics such as mean, standard deviation (SD), standard error (SE), and 95% confidence intervals (CIs) were computed. To investigate the associations between chronic ankle instability and potential contributing factors, Spearman's rank-order correlation (ρ) was applied because several variables were not normally distributed. Spearman's correlation coefficients were used to assess the strength and direction of the association between CAIT scores and key variables, including previous ankle instability and reinjury. Because the CAIT assesses perceived ankle instability, previous ankle instability and reinjury were considered clinically related explanatory variables rather than independent diagnostic indicators of chronic ankle instability. However, correlations involving these variables were interpreted with caution due to their potential conceptual overlap with the construct assessed by the CAIT. After correlation analysis, a multiple linear regression model

was constructed to examine the independent factors associated with CAIT scores. A total of 10 variables were included in the study: previous ankle instability, age, height, weight, mean body mass index (BMI), training years, daily training hours, limb dominance, previous history of ankle injury, and reinjury. The model's overall performance, statistical significance, and explained variance (R^2 and adjusted R^2) were examined. Standardized beta coefficients (β), unstandardized coefficients, standard errors, and 95% confidence intervals (CIs) were reported for each variable. A significance level of $p < 0.05$ was implemented for all statistical tests.

RESULTS

Table No. 1 presents a descriptive analysis of 117 Saudi Arabian male professional volleyball players, providing a

detailed overview of their demographic, anthropometric, and training characteristics. Descriptive analysis shows that the mean CAIT score was 23.44 ± 7.61 (95% CI: 22.68–24.20), indicating that the mean CAIT score was slightly below the threshold for CAI (CAIT ≤ 24) for a proportion of participants. The mean age was 25.76 ± 3.72 years (95% CI: 25.39–26.13), and the mean height and weight were 169.34 ± 7.29 cm and 67.46 ± 10.39 kg, with a BMI of 23.53 ± 3.05 kg/m². In the context of sport training experiences, the players had been training for an average of 5.11 ± 2.47 years; the average total daily training duration was 2.09 ± 0.93 hours, and the mean value for limb dominance was 1.27 ± 0.45 (CI: 1.22 - 1.31), showing right-sided dominance across the sample. The mean score for prior ankle injury was 1.14 ± 0.34 (95% CI: 1.10 - 1.17), and reinjury was 1.56 ± 0.50 (95% CI: 1.51 – 1.61).

Table 1: Demographic Data of the Participants

Variable	Mean	SD ($\pm$)	SE	95% CI
CAIT score	23.44	7.61	0.704	22.05–24.83
Previous instability	1.58	0.49	0.045	1.49–1.67
Age (Y)	25.76	3.72	0.344	25.08–26.44
Height (cm)	169.34	7.29	0.674	168.01–170.67
Weight (kgs)	67.46	10.39	0.961	65.56–69.36
BMI (kg/m ²)	23.53	3.05	0.282	22.97–24.09
Training years	5.11	2.47	0.228	4.66–5.56
Training hours	2.09	0.93	0.086	1.92–2.26
Limb dominance	1.27	0.45	0.042	1.19–1.35
Prior history of ankle injury	1.14	0.34	0.031	1.08–1.20
Reinjury	1.56	0.02	0.046	1.47–1.65

BMI: Body mass Index, CAIT: Cumberland Ankle Instability Tool, CI: Confidence Interval, SD: Standard deviation, SE: Standard Error, kg: Kilograms, cm: Centimetres, Y: Years

Table 2: Spearman's Correlation Coefficient (ρ) between CAIT Score and Independent Variables

Variable	CAIT score	Previous ankle instability	Age (Y)	Height (cm)	Weight (kg)	BMI (kg/m ²)	Training years	Hours of training	Limb dominance	Previous history of ankle injury	Reinjury
Previous ankle instability	0.869**	-									
Age (Y)	0.025	-0.063	-								
Height (cm)	0.087	0.094	0.177**	-							
Weight (kg)	0.021	-0.014	0.232**	0.486**	-						
BMI (kg/m ²)	-0.018	-0.045	0.139**	-0.037	0.817	-					
Training years	0.13*	0.165**	0.085	0.01	-0.018	-0.046	-				
Hours of training	-0.099	-0.067	-0.15**	0.058	-0.106*	-0.17**	0.02	-			
Limb dominance	-0.014	-0.043	-0.002	-0.048	-0.098	-0.101	0.096	-0.023	-		
Previous history of ankle injury	0.314**	0.343**	0.053	0.136**	-0.016	-0.112*	0.026	0.086	-0.144**	-	
Reinjury	0.828**	0.923**	-0.086	0.042	-0.054	-0.064	0.137*	-0.038	-0.039		-

Binary variables were coded as follows: previous ankle instability, previous history of ankle injury, and reinjury were coded as 0 = No and 1 = Yes. Limb dominance was coded as 1 = Right and 2 = Left. CAIT: Cumberland Ankle Instability Tool, BMI: body mass index, kg: kilograms, cm: centimeters, Y: years. * $p < 0.05$, ** $p < 0.01$ (two-tailed)

Table 3: Presents the Results of the Multiple Linear Regression Analysis Examining the Associations between the Selected Independent Variables and CAIT Scores

Key risk factors	Unstandardized (B)	95% CI for B (Lower -Upper Bound)	S. E	Standardized (β)	t	p
Previous ankle instability	11.19	8.775 13.618	1.23	0.72	9.094	0.001
Age (Y)	0.147	0.056 0.238	0.046	0.07	3.17	0.002*
Height (cm)	0.016	-0.150 0.181	0.084	0.015	0.186	0.853
Weight (Kg)	0.001	-0.198 0.200	0.101	0.001	0.007	0.994
BMI (kg/m ²)	-0.002	-0.578 0.574	0.293	-0.001	-0.007	0.995
Training years	-0.127	-0.262 0.009	0.069	-0.041	-1.839	0.067
Hours of Training	0.07	-0.281 0.421	0.178	0.009	0.39	0.697
Limb Dominance	0.159	-0.561 0.879	0.366	0.009	0.43	0.664
Previous history of ankle injury	-0.19	-1.199 0.819	0.513	-0.009	-0.37	0.71
Reinjury	2.68	0.790 4.573	0.962	0.178	2.78	0.006

** Correlation is significant at the 0.01 level (2-tailed), *Correlation is significant at the 0.05 level (2-tailed), Kg: Kilograms, cm: Centimeters, Y-Years

Table 2 demonstrates the correlation analysis. Spearman's rank (ρ) order was used to evaluate the association between the CAIT tool scores and selected variables among players. The results show a significant association between the CAIT tool score and prior ankle instability ($\rho = 0.704$ & 0.045 , $p < 0.01$) and reinjury ($\rho = 0.046$, $p < 0.01$). A positive association was also found between CAIT scores and previous ankle injury ($\rho = 0.031$, $p < 0.01$). Additionally, a minor but significant association was also found between CAIT tool score and training years ($\rho = 0.228$, $p < 0.05$). No significant association was found between CAIT scores and age, height, weight, BMI, hours of daily training, or limb dominance ($p > 0.05$). Intercorrelations of instability-related variables also showed a significant association with CAIT scores, particularly previous ankle instability with reinjury ($\rho = 0.046$, $p < 0.01$). The higher intercorrelations ($\rho > 0.045$) among instability-related variables highlight potential multicollinearity, which affects regression estimates.

Table 3 shows the multiple linear regression (β) results for all variables associated with the CAIT scores., age ($B = 0.147$, $SE = 0.046$, standardized $\beta = 0.07$, $t = 3.17$, $p = 0.002$), and reinjury ($B = 2.68$, $SE = 0.962$, standardized $\beta = 0.178$, $t = 2.78$, $p = 0.006$) show a significant association with CAIT scores. However, other variables such as height ($\beta = 0.016$, $p = 0.853$), weight ($\beta = 0.001$, $p = 0.994$), BMI ($\beta = -0.002$, $p = 0.995$), training years ($\beta = -0.127$, $p = 0.067$), training hours ($\beta = 0.070$, $p = 0.697$), limb dominance ($B = 0.159$, $p = 0.664$), and prior ankle injury ($B = -0.19$, $p = 0.71$) were not significantly associated with CAIT scores. The model found strong explanatory power ($R^2 = 0.835$). The respective multiple correlation coefficient (R) was 0.913 , indicating a very high degree of correlation between the observed and CAIT tool values. Nevertheless, this outcome should be interpreted with caution, as instability-related variables can overlap conceptually with the CAIT score and not represent independent factors.

DISCUSSION

The present study assessed the association between CAIT scores and selected variables such as demographic, training-related, and clinical variables among 117 male professional volleyball players in Saudi Arabia. The present study identified several important associations, especially between CAIT scores and instability-related variables. The relatively high standard deviation indicates variability in CAIT scores among players, while the mean CAIT score of 23.44 ± 7.61 is slightly below the clinical cutoff, consistent with the presence of chronic ankle instability in a proportion of players. Spearman's correlation analysis revealed significant associations between CAIT scores and instability-related variables, including previous ankle instability ($\rho = 0.045$) and reinjury ($\rho = 0.046$), all of which were statistically significant ($p < 0.01$). Nonetheless, these associations should be interpreted with caution, as the positive direction reflects conceptual overlap between these variables and the CAIT construct rather than an association with improved ankle

stability. Compared with other studies, the present study found moderate to significant associations with measures of instability ($r = 0.52$ – 0.63); it correlated that repeated episodes significantly influence perceived ankle function and substantially lower the functional instability scale and found a significant association between prior instability and functional deficits [25, 26, 23, 27, 28]. These significant interrelationships support that these factors form the core components of chronic ankle instability. This reinforces the established understanding that CAI is multifactorial, caused by both mechanical and functional deficits in proprioception and neuromuscular control [13, 29, 21, 30]. The results of the present study support the importance of early detection, continuous monitoring, and comprehensive and structured rehabilitation programs focused on instability-related symptoms.

Furthermore, a moderate positive correlation was observed between the CAIT tool score and previous history of ankle injury ($p < 0.01$), which may reflect an association between the occurrence and severity of previous ankle injuries slightly impacting the current stability status of players. Another study found that athletes with a prior ankle injury continued to exhibit functional impairment and reduced stability, highlighting a moderate association between prior injury severity and current functional performance [23, 31]. However, unlike these studies, which mainly documented group differences or general associations, the present study quantitatively demonstrates a moderate correlation using CAIT scores, providing clearer evidence of how previous injury contributes to current perceived stability.

A minor but significant positive correlation was also found between the CAIT tool score and training years ($p < 0.05$). This interpretation suggests a weak positive association between training years and CAIT scores. Whereas, given the cross-sectional design, this association should not be interpreted as evidence that longer training duration improves ankle stability. Differences in training exposure, athletic experience, injury history, or selection and survivor effects may also contribute to this finding. Compared with other studies which found that years of training had a weak positive correlation with CAIT scores, the regression model did not find a significant association. This supports the view that training alone does not inevitably improve ankle stability without targeted, planned proprioceptive and neuromuscular interventions [23]. In contrast, anthropometric variables such as height, weight, and BMI showed no significant correlations. These findings indicated that anthropometric parameters and daily training exert minimal associations with perceptions of ankle stability among trained players. It can be assumed that the effects of these physical features are mitigated by training-specific conditioning and skill adaptation in the players. The multiple regression model further confirmed that previous ankle instability ($B = 11.19$, $p = 0.000$), age ($B = 0.147$, $p = 0.002$), and reinjury ($B = 2.68$, $p = 0.006$) were significantly associated with CAIT scores.

Among the ten key associated factors included in the regression model, three variables—prior ankle instability, age, and reinjury—were found to be statistically significant association variables of CAIT score. Prior ankle instability was the strongest statistical association with CAI variable, with an unstandardized coefficient $B = 11.19$ ($SE = 1.23$), standardized $B = 0.72$, $t = 9.094$, and $p < 0.001$. The direct numerical comparison of standardised regression coefficients across studies should be interpreted cautiously because the studies differ in populations, outcome measures, predictor definitions, and statistical models. The analysis found that, after controlling for other variables, an increase in the coded value of prior ankle instability was associated with an increase of approximately 11.19 points in CAIT scores. Nevertheless, this result should be interpreted with caution, as it may reflect the direction of the association with coding structure or conceptual overlap with the CAIT construct rather than a true improvement in ankle stability. The higher standardised beta ($B = 0.72$) further confirms that previous instability is the stronger statistical association compared with other variables. All other variables showed non-significant effects. These findings support the view that functional ankle stability in volleyball players is primarily associated with prior instability and reinjury patterns rather than with physical characteristics or training load.

Previous studies investigating chronic ankle instability have identified associations between functional instability and factors such as peroneal reaction time, dynamic balance, and muscle strength [21,23]. These findings are broadly consistent with the present study in demonstrating that ankle instability is related to functional measures of ankle status. However, direct comparison of regression coefficients between studies is inappropriate because of differences in study populations, outcome measures, predictor definitions, coding schemes, and statistical models. In the present study, previous ankle instability showed the strongest statistical association with CAIT score within the fitted model ($\beta = 0.72$), while reinjury also showed a statistically significant association ($\beta = 0.178$). These findings should therefore be interpreted within the context of the present study rather than as evidence that the magnitude of association is greater or smaller than that reported in previous investigations.

The results also found that accumulated training experience in volleyball is linked with adaptive benefits through motor learning and organised conditioning, which mitigate age-related physiological declines [34-37,29]. Experienced athletes build superior joint awareness, improve sensorimotor integration, and develop more skilled movement strategies, which contribute to dynamic stability even in the presence of previous injury. Repeated trauma is associated with mechanical laxity, slows down neuromuscular responses, and enhances ligament degeneration, all of which worsen functional impairment [38]. This reinforces the concept of a pathological feedback loop in which repeated injuries gradually weaken joint structures, increasing susceptibility to further instability and impairments [25, 38, 39]. Persistent loading, micro-trauma,

and fatigue-related instability are present in athletes who experience great exposure with insufficient recovery. Therefore, comprehensive, structured prevention and rehabilitation programs targeting balance, plyometric, and neuromuscular training are essential to mitigate CAI and reduce reinjury risk [28,40]. Previous literature strongly supports our findings that prior ankle instability is a significant factor associated with CAI in athletes. Prior studies have consistently shown that athletes with a history of ankle instability have significantly impaired peroneal muscle reaction time and limited dynamic balance, which identifies prior instability as a primary contributor to functional deficits [19,20]. Similarly, another study found that a prior sprain significantly increases the likelihood of developing chronic ankle instability due to persistent ligamentous laxity and mechanical impairments [41,42]. Another study found that athletes with repeated ankle sprains developed structural and neuromuscular impairments, which contribute to long-term symptoms and functional deficits [32,11]. Overall, the present study found significant associations between instability-related variables and CAIT scores, supporting the importance of early identification and appropriate rehabilitation and prevention strategies to enhance functional outcomes in players.

Limitations

The present study has various limitations. First is its cross-sectional design, preventing causal inference. Secondly, information on previous ankle injuries and reinjuries was partly self-reported and may therefore be subject to recall bias. Third, the inclusion of instability-related variables alongside CAIT scores creates potential conceptual overlap between predictors and the outcome. Fourth, no objective biomechanical, neuromuscular, or electrophysiological assessments were performed. Fifth, recruitment through professional volleyball clubs may have introduced selection bias and may limit generalizability. Sixth, the strong intercorrelations among instability-related variables raise concerns regarding multicollinearity, which may affect regression estimates. Finally, because participants were not followed prospectively, the study cannot determine whether the identified associations predict future ankle sprains or the development of CAI.

Additionally, future longitudinal and interventional studies should incorporate objective measures of balance, muscle activation, joint kinematics, and other biomechanical variables to further investigate the factors associated with perceived CAI and clarify their temporal relationships.

CONCLUSION

Age, reinjury, and prior ankle instability were statistically associated with CAI in male professional volleyball players from Saudi Arabia. The direction and clinical interpretation of these associations should be considered in relation to the coding of injury-related variables and the conceptual overlap between these variables and the CAIT outcome. These findings support the importance of early identification and

appropriate rehabilitation following ankle injury, although prospective studies are required to determine temporal and causal relationships.

Supplementary Materials

None

Acknowledgements

The author would like to thank the participants, club administrators, and staff members for their support in facilitating this study.

Author Contributions

M.A. independently formulated the title, abstract, and methodology, performed data collection, carried out data analysis and interpretation of results and wrote the discussion and reviewed the paper and allotted sections for technical robustness.

Conflicts of Interest

The author declares no conflicts of interest.

Funding

The author extends appreciation to the Deanship of Postgraduate Studies and Scientific Research at Majmaah University for funding this research work through the project number: R-2026.

Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Scientific Research Ethics Committee of Majmaah University. Approval was obtained under reference approval No. MUREC-April.14/COM-2025/181).

Informed Consent Statement

Written informed consent was obtained from all participants before participation in the study.

Data Availability Statement

The dataset generated and/or analyzed during the current study is available from the corresponding author on reasonable request.

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