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Original Article

Physiotherapy Section

Comparison of Balance Between Badminton and Volleyball Recreational Players with Chronic Ankle Instability: A Cross-sectional Study

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ABSTRACT

Introduction: Chronic Ankle Instability (CAI) is an injury that presents persistent instability and "giving way" symptoms. The higher rate of reinjury following an initial Lateral Ankle Sprain (LAS) is associated with the development of CAI, which affects athletic and functional performance. Impairment of musculotendinous receptors following an initial ankle sprain may result in recurrent ankle instability. Some studies have suggested an association between CAI and issues with static and dynamic balance. Comparisons of static balance between recreational badminton and volleyball players and dynamic balance between recreational badminton and volleyball players with CAI are required to provide athletes with the proper balance training exercises.

Aim: To analyse the static balance of badminton and volleyball recreational players with CAI using the Balance Error Scoring System (BESS) and a Plantar Pressure Analysis System (PPAS), as well as the dynamic balance of those players using the Y Balance Test (YBT).

Materials and Methods: A cross-sectional study was conducted where recreational players with CAI who play badminton and volleyball were screened using the Cumberland Ankle Instability Tool (CAIT), and 46 participants were selected based on inclusion and exclusion criteria. The study was conducted in the indoor and outdoor stadiums of NITTE (Deemed to be University), Mangaluru, Karnataka, India. The study duration was from March 2023 to March 2024. Ethical clearance was obtained from the same university for the study. Following this, static and dynamic balance of each group was assessed using BESS (number of errors), PPAS (sway velocity), and YBT (distance reached by the limb). The static balance between the groups and dynamic balance between the groups were analysed in Jamovi software using independent sample t-test.

Results: Following the analysis, static balance between badminton and volleyball recreational players using BESS showed a non significant difference with a p-value of 0.282, while PPAS showed non significant differences with p-values of 0.174 for double leg stance and 0.063 for single leg stance. Similarly, dynamic balance between badminton and volleyball recreational players using YBT showed non significant differences with p-values of 0.467, 0.768, and 0.299 for anterior, posteromedial, and posterolateral directions, respectively.

Conclusion: The study concluded that there was no significant difference in static as well as dynamic balance between badminton and volleyball recreational players with CAI. However, it is important to evaluate the static and dynamic balance of recreational players to enhance performance and prevent injuries.

Keywords: Balance error scoring system, Cumberland ankle instability tool, Dynamic balance, Static balance, Y balance test

INTRODUCTION

Recreational sports can be considered both leisure activities and sports. According to the World Health Organisation (WHO) (2010), adults between 18 and 64 years of age should engage in atleast 150 minutes of moderate activity or 75 minutes of vigorous activity each week for atleast 10 minutes at a time [1]. The most frequent sports injury among the recreational sports population is ankle sprains [2].

Individuals who experience an ankle sprain are more likely to experience another injury to the same ankle [3]. The most frequent sports where ankle injuries occur are court and indoor sports. Ankle injuries occur 30% of the time during practices and 70% of the time during tournaments [2]. About 20% of sports-playing youth will experience Chronic Ankle Instability (CAI), with female athletes experiencing a prevalence of 23.6% and male athletes 16.3% [4].

Badminton, the quickest racket sport, is known for its high-intensity strokes and precise motions, leading to a high prevalence of ankle sprains among its players, ranging from 33% to 49% [5].

Rapid motions in badminton, including quick turns, jumps, and directional changes, often cause injuries to lower extremity joints, with jumping and landing movements being common [6]. Volleyball is the fourth leading cause of sports injuries, with 63% of injuries involving jumping and landing, with blocking and smashing are the most common causes. An inversion ankle sprain is the most common injury sustained [7].

The CAI is a persistent condition characterised by a higher rate of reinjury following an initial Lateral Ankle Sprain (LAS) and marked by symptoms of "giving way" [8]. Recurrent ankle sprains, influenced by mechanical and neuromuscular factors, can significantly impact functional and athletic performance [9,10]. LASs, often experienced in recreational physical activities, can result from chronic instability, multiple injuries, or other causes, potentially leading to repeated ankle instability as it affects the mechanoreceptors and ligaments' structural integrity [8].

The sensorimotor system maintains posture and balance in sports. Lower extremity injuries can cause sensorimotor deficits, increase the risk of reinjury, and lead to balance issues, with Chronic Ankle Instability (CAI) being associated with both. Evidence suggests

that CAI is associated with both static and dynamic balance issues [9]. Static balance refers to maintaining the centre of mass over a fixed point of support [11]. The Balance Error Scoring System (BESS) and the Plantar Pressure Analysis System (PPAS), which are valid and reliable tools, can be used to assess static balance [12,13]. Dynamic balance refers to maintaining the center of mass above the base of support when the base is moving or when the body is subjected to an external perturbation [11]. The Y Balance Test (YBT), a valid and reliable tool to assess dynamic balance, can be used [14].

In 2007, a study was conducted to compare static and dynamic balance among collegiate athletes competing in soccer, basketball, and gymnastics, and no differences in balance were found among the groups [15]. In 2016, a study was conducted to compare static and dynamic balance in ankle instability among university-level football and basketball players, and found significant differences in static and dynamic balance among the players [9]. In 2020, a study was conducted to compare static and dynamic balance among professional athletes in football and basketball by dividing them into three groups based on ankle sprain, showing differences in BESS scores but no difference in dynamic balance between the groups [3].

Since previous studies have not compared balance among recreational badminton and volleyball players with CAI, the need was to compare the balance of these two groups, considering their similar landing mechanisms during smashing. Thus, the purpose of this study was to compare static balance between badminton and volleyball recreational players, as well as dynamic balance between badminton and volleyball recreational players with CAI, to find out which type of balance is affected among this population and hence, train the athletes' balance exercises accordingly.

MATERIALS AND METHODS

This cross-sectional study was conducted at the indoor and outdoor stadium of NITTE (Deemed to be University), Mangaluru, Karnataka, India from March 2023 to March 2024. Ethical clearance was obtained from the Institutional Ethics Committee of NITTE (Deemed to be University), Mangaluru, Karnataka (Ref: NIPT/IEC/Min//30/2022-2023 dated 09-02-2023).

After receiving ethical clearance, screening was conducted for recreational players with a history of CAI/giving way who play badminton and volleyball from constituent colleges under the university using CAIT [16]. Written informed consent was obtained from all participants, and they were explained about the testing procedures.

Inclusion criteria: The study included males and females aged between 18-35 years who are recreational badminton or volleyball players with unilateral CAI (history of atleast one ankle sprain and recurrent episodes of giving away) [4]. Also, individuals with a CAIT score ≤24 were included. The individuals were adviced not to be included in any balance training program during the study duration [4,17].

Exclusion criteria: The study excluded individuals with bilateral ankle instability, acute or subacute ankle sprain (within 96 hours before participation or within 8 weeks), any management of ankle injuries (like ankle fractures) with plates and screws, limb length discrepancy >2 cm, vestibular problems, visual problems. Also, individuals with any injury or surgery of the spine, hip, and knee were excluded.

Sample size calculation: The sample size was estimated using the following formula:

$$n=2\ \{(z\alpha/2+z\beta)^2/\sigma^2\}/d^2$$

where, $z\alpha/2=1.96$; $z\beta=0.84$; $\sigma=2.235$; d=mean difference

The sample size of 46, with 23 in each group, was estimated based on a study conducted by Melam GR et al., The standard deviation for Group A is 1.64, and for Group B is 2.83, with a combined standard deviation of 2.235. The study was conducted at a 5% level of significance with 80% power and a mean difference of 1.84 [9].

Study Procedure

The purpose and procedure of the study were explained, and written informed consent was obtained from the participants who met the inclusion criteria. A total of 46 participants (23 in each group) were tested for static and dynamic balance after being screened for CAI using the CAIT score.

Primary Outcome Measures:

- **Static balance with BESS and PPAS:** BESS was performed barefoot. It consists of 3 stances: Double-leg stance (hands on the hips and feet together), single-leg stance (standing on the non dominant leg with hands on hips), and tandem stance (non dominant foot behind the dominant foot). These stances were performed on 2 surfaces: firm and foam surfaces with the eyes closed. Errors were counted during each 20-second trial, which included: opening eyes, taking hands off hips, stepping, stumbling, or losing balance, elevating the heel or forefoot, abducting the hips more than 30 degrees, or not returning to the test posture in less than five seconds [13].

The PPAS was used to assess the sway velocity (mm/s) of the participant, in place of a force plate, during two stance positions on the PPAS platform (firm surface): double-leg and single-leg stances. The participant had to maintain both stances for 20 seconds, and the sway velocity was noted [15]. The PPAS device used was by a brand named Auptimo®. The patient information was recorded in a software application named Ezra.

- **Dynamic balance with YBT:** This test was performed in three different directions: anterior, posteromedial, and posterolateral with bare feet. The test procedure was instructed to the individual prior to performing the test, and they were instructed to maintain a single-leg stance in the center while trying to reach as far as possible with the contralateral leg and then come back to the starting position. The maximum reach distance was measured using an inch tape. Three test trials in each direction were performed, and the mean value of the three test trials was determined for data analysis. The test was not considered if the individual failed to maintain balance while reaching, did not maintain smooth contact while reaching, or did not come back to the starting position after reaching [14,18].

Secondary outcome measure: The strength of lower extremity muscles using a push-pull dynamometer: The strength of the following lower extremity muscles was tested in antigravity positions: hip extensors, knee flexors, and ankle plantar flexors in a prone position; hip flexors in a supine position; hip abductors in a side-lying position; knee extensors and ankle dorsiflexors in a high sitting position. The individual was asked to maintain the extremity in a stipulated position while pushing against the dynamometer. The contraction was held for six seconds for three trials. The highest value obtained out of the three trials was considered [19,20].

STATISTICAL ANALYSIS

The data was analysed using Jamovi software. The significance level was set at 5%. Categorical data were summarised by frequency and percentages. A comparison of quantitative normal data between the groups was performed by independent sample t-test.

RESULTS

The study involved a total of 46 recreational players with CAI who play badminton (n=23) and volleyball (n=23). Their mean age was 24±2.72 years, mean height 167±9.89 cm, mean weight 64.7±11.2

kg, mean BMI 23.2±2.86 kg/m^2, and mean CAIT score 18.1±4.02 [Table/Fig-1].

Variables	Age (years)	Height (cm)	Weight (kg)	BMI (kg/m^2)	CAIT score (out of 30)
N	46	46	46	46	46
Missing	0	0	0	0	0
Mean	24.0	167	64.7	23.1	18.1
Median	23.5	166	62.0	23.3	19.0
Standard deviation	2.72	9.89	11.2	2.86	4.02
Minimum	20	149	48	18.3	9
Maximum	30	184	89	28.1	23

[Table/Fig-1]: Descriptive statistics of participants.
CAIT: Cumberland ankle instability tool

Static balance: In the badminton group (n=23), the mean BESS score was 21.0, with a standard deviation of 7.77. In the volleyball group (n=23), the mean BESS score was slightly higher at 23.3, with a standard deviation of 7.11 [Table/Fig-2]. There was no significant difference in the average BESS score between badminton and volleyball players (p-value >0.05) [Table/Fig-2]. For PPAS values of participants in the double leg stance condition, badminton players had a mean pressure of 12.6 units, with a standard deviation of 2.37, while volleyball players had a slightly higher mean pressure of 13.6 units, with a standard deviation of 2.76. In the single leg stance condition of PPAS, badminton players had a mean pressure of 91.2 units, with a standard deviation of 12.70, whereas volleyball players exhibited a higher mean pressure of 99.6 units, with a standard deviation of 16.66 [Table/Fig-3]. There was no significant difference in the average value of PPAS in the case of double leg and single leg stance between badminton and volleyball players (p-value >0.05) [Table/Fig-3].

	Group	N	Mean	SD	SE	p-value
BESS score	Badminton	23	21.0	7.77	1.62	0.282
	Volleyball	23	23.3	7.11	1.48	

[Table/Fig-2]: Comparison of BESS scores between badminton and volleyball players.
BESS: Balance error scoring system; N: Number of participants; SD: Standard deviation; SE: Standard error, p-value >0.05

Variables	Group	N	Mean	SD	SE	p-value
PPAS Double leg stance	Badminton	23	12.6	2.37	0.495	0.174
	Volleyball	23	13.6	2.76	0.575	
PPAS Single leg stance	Badminton	23	91.2	12.70	2.648	0.063
	Volleyball	23	99.6	16.66	3.473	

[Table/Fig-3]: Comparison of PPAS values between badminton and volleyball players.
PPAS: Plantar pressure analysis system; N: Number of participants; SD: Standard deviation; SE: Standard error, p-value >0.05

Dynamic balance: In YBT values of participants in the anterior direction, badminton players exhibited a mean score of 4.09, slightly lower than the 4.63 mean score of volleyball players. In the posteromedial direction, badminton players' mean score rose to 4.99, whereas volleyball players showed a slightly higher mean score of 5.24. In the posterolateral direction, badminton players demonstrated a mean score of 3.73, while volleyball players exhibited a higher mean score of 4.83 [Table/Fig-4]. There was no significant difference in the average value of YBT in the anterior, posteromedial, and posterolateral directions between badminton and volleyball players (p-value >0.05) [Table/Fig-4].

Strength: In muscle strength measurements using a dynamometer for various muscle groups among badminton and volleyball players in the knee flexors and ankle dorsiflexors, volleyball players exhibited higher mean strength values compared to badminton players. In hip extensors and hip abductors, badminton players showed higher mean strength values [Table/Fig-5]. There was no significant difference in the average value of the dynamometer in the case of hip flexors, hip extensors, hip abductors, knee flexors, knee extensors, and ankle dorsiflexors between badminton and volleyball players (p-value >0.05) [Table/Fig-5].

Variables	Group	N	Mean	Median	SD	SE	p-value
YBT- Anterior	Badminton	23	4.09	3.30	2.27	0.473	0.467
	Volleyball	23	4.63	4.60	2.73	0.570	
YBT-Posteromedial	Badminton	23	4.99	4.70	3.01	0.627	0.768
	Volleyball	23	5.24	4.70	2.65	0.552	
YBT-Posterolateral	Badminton	23	3.73	2.60	3.65	0.762	0.299
	Volleyball	23	4.83	4.30	3.50	0.729	

[Table/Fig-4]: Comparison of YBT values between Badminton and volleyball players.
YBT: Y balance test; N: Number of participants; SD: Standard deviation; SE: Standard error, p-value >0.05

Variables	Group	N	Mean	Median	SD	SE	p-value
Dynamometer hip flexors	Badminton	23	1.88	1.40	1.255	0.262	0.872
	Volleyball	23	1.826	2.60	1.098	0.229	
Dynamometer hip extensors	Badminton	23	1.57	1.30	1.002	0.209	0.159
	Volleyball	23	1.174	1.30	0.864	0.180	
Dynamometer hip abductors	Badminton	23	1.13	1.30	0.978	0.204	0.512
	Volleyball	23	0.935	1.30	0.987	0.206	
Dynamometer knee flexors	Badminton	23	2.20	1.30	1.740	0.363	0.136
	Volleyball	23	3.043	2.70	1.998	0.417	
Dynamometer knee extensors	Badminton	23	2.30	2.00	1.305	0.272	0.747
	Volleyball	23	2.161	1.40	1.669	0.348	
Dynamometer ankle dorsiflexors	Badminton	23	3.34	3.30	1.469	0.306	0.421
	Volleyball	23	3.683	3.30	1.359	0.283	

[Table/Fig-5]: Comparison of dynamometer values between badminton and volleyball players.
N: Number of participants; SD: Standard deviation; SE: Standard error, p-value >0.05

DISCUSSION

The current study compared the static and dynamic balance in recreational badminton and volleyball players with CAI, as there is no existing literature reporting on these two groups of sports. The study included 46 recreational players (23 in badminton and 23 in volleyball) aged between 18 and 35 years, with a mean age of 24±2.72 years, all of whom had CAI. The mean CAIT score for all participants was 18.1±4.02, indicating that all players included had CAI.

In the current study evaluating BESS between both groups, it was suggested that there was no significant effect of CAI on BESS, with the mean scores in badminton players being 21.0±7.77 and volleyball players being 23.3±7.11, respectively. In a study conducted by Halabchi F et al., they compared the static balance of basketball and football players and found that those players did not significantly differ in their total BESS scores [3]. On the contrary, in a study conducted by Melam GR et al., for both the football and basketball groups, there were significant differences in static balance between limbs that had been injured and those that hadn't been injured [9]. Similarly, in a study conducted by Tabrizi HB et al., there was a significant difference in static balance between the groups playing handball and volleyball, but not between the groups playing futsal and basketball, volleyball and basketball, or futsal and volleyball [21].

One possible explanation for the lack of significance in static balance could be the variety of sports covered in the current research, which included badminton and volleyball. Previous

research has covered sports such as football and basketball in studies by Halabchi F et al., and Melam G et al., as well as field hockey and football in a study by Bhat R and Moiz JA, [3,9,22]. Additionally, the two groups assessed in the current study may have certain sensorimotor difficulties following CAI, which might be common in the chosen sports. Players in badminton and volleyball rarely balance stationarily on double or single legs during play, as they are always attentive to the shuttle or the ball [9]. However, it is important to evaluate the static balance of recreational players to enhance performance and prevent injuries.

In the current study, another static measure was used to assess the sway velocity of the players using PPAS. After evaluating PPAS with a double leg stance, it was suggested that there was no significant effect of CAI on PPAS. A similar study was conducted by Brown CN and Mynark R, where they concluded that, on a firm surface, there was no significant difference in the sway velocity induced by single and double leg stances. This could be because, under static conditions, the CAI patients seem to give more consistent sway velocity measurements [11].

In the current study, during the evaluation of YBT in the anterior direction, posteromedial direction, and posterolateral direction, it was found that there was no significant effect of CAI on all three directions of YBT. Similarly, in a study conducted by Melam G et al., there were no significant differences in dynamic balance between the basketball and football groups [9]. Also, in a study conducted by Bhat R and Moiz JA, collegiate football and hockey players' dynamic balance scores did not significantly differ from one another [22]. Correspondingly, in a study conducted by Halabchi F et al., dynamic measurement results revealed no statistical difference between male football and basketball players [3].

Differences in stability among athletes may be because of their differences in the sensitivity of the sensory system. It is likely that players of volleyball and badminton have similar sensory systems because of their comparable dynamic balancing performances. The dynamic balance may not significantly differ between the two groups of players since they are both alert to cues regarding the shuttle, volleyball, and their teammates' positions on the court. The insignificance of dynamic balance scores could be attributed to the sensitivity of YBT in detecting variations [3,9]. The same could be the reason for the insignificance of YBT directions among badminton and volleyball recreational players in the current study.

In the current study, during the evaluation of strength testing using a dynamometer for hip flexors, hip extensors, hip abductors, knee flexors, knee extensors, and ankle dorsiflexors, it was found that there was no significant difference in the average value of the dynamometer. The findings from Khalaj N et al., indicate that individuals suffering from CAI showed differences in the strength of the ankle dorsiflexor, ankle invertor, and evertor, as well as the knee extensor muscles. Additionally, they recommended that those with CAI have low hip flexors, abductors, and external rotators strength. Their study focused on normal individuals with CAI [23]. On the contrary, the present study focused on the lower extremity strength of recreational players with CAI, and no significant difference was found in their strength.

Even though the current study could not find any significant differences in static and dynamic balance between badminton and volleyball recreational players with CAI, it is necessary to evaluate their static and dynamic balance regularly for injury prevention as well as for enhancement of their performance.

Limitation(s)

The Balance Error Scoring System (BESS) is a subjective outcome measure used to assess static balance. It would become an objective measure if all the components of the BESS were used on the Plantar Pressure Analysis System (PPAS), whereas only double-leg and single-leg stances on a firm surface could be measured on the PPAS.

CONCLUSION(S)

In the current study, after assessing the static and dynamic balance among recreational badminton and volleyball players with CAI, along with lower extremity strength, the study concludes that there was no significant difference in static balance between badminton and volleyball recreational players, as well as in dynamic balance between badminton and volleyball recreational players with CAI.

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