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Research Article

An Observational Study for Comparison of Glenohumeral Joint Mobility Amongst Indian Badminton Players and Volleyball Players

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Abstract

Does one of the sports' athletes have more mobility of shoulder joint as compared to other?

There has been much research on what are the predisposing factors to shoulder injuries in overhead activities during sports but is one sport more prone to injury has yet to be found out. The results of the study can be used as a data to work upon the training regimen for the athletes to prevent injury and minimize the risk. It can also be used to find out the normative data of glenohumeral range of motion for the athletes who visit any healthcare professional for any intervention.

Badminton is one of the most popular sports in the world, and it is included in the group of racquet sports. It can be practiced by anyone regardless of age or experience and is the fastest racquet game. Volleyball is a team sport in which two teams of six players are separated by a net. Each team tries to score points by grounding a ball on the other team's court under organized rules. Players need to have good Glenohumeral mobility to excel in the game, irrespective of the position at which they play. With previous research it has been proved that the overhead sports injuries can involve poor mobility. A total of 50 (25 Male & 25 Female) players of volleyball & badminton each, playing for over 1 year, aged between 15-28 years, having no history of trauma or any other pathologies, were included in a cross-sectional observational study using convenience sampling. Players were screened for their glenohumeral range of motion using a universal goniometer and Apley's Scratch test. Out of the overhead athletes, it has been observed that the badminton players have more mean external rotation in the dominant side as well as the non-dominant side, while volleyball players have more mean extension in non-dominant side than badminton players.

However, clinically, there is no significant difference in mobility and flexibility amongst the two sports.

Keywords: Volleyball; Badminton; Glenohumeral Range of Motion; Overhead Athletes; Sports Related Shoulder Injury

Introduction

Badminton and volleyball are one of those sports that involve Upper extremity Range of motion, especially Glenohumeral Range of motion. Volleyball involves both or one extremity whereas, badminton is predominantly a dominant hand sport. Glenohumeral joint along with other shoulder joint complex helps to facilitate the motion at the shoulder joint. Thus, both badminton and volleyball are included in this study.

Badminton is one of the most popular sports in the world, and it is included in the group of racquet sports. It can be practiced by anyone regardless of age or experience and is the fastest racquet game. Badminton is a racquet sport played using racquets to hit a shuttlecock across a net. Although it may be played with larger teams, the most common forms of the game are singles and doubles. Badminton is often played as a casual outdoor activity in a yard or on a beach; formal games are played on a rectangular indoor court. Points are scored by striking the shuttlecock with the racquet and landing it on the opposing side's half of the court. Each side may only strike the shuttlecock once before it passes over the net. Play ends once the shuttlecock has struck the floor or if a fault has been called by the umpire or service judge. At high levels of

play, the sport demands excellent fitness: players require aerobic stamina, agility, strength, speed, and precision. It is also a technical sport, requiring good motor coordination and hand-eye coordination and the development of sophisticated racquet movements.

Volleyball is a team sport in which two teams of six players are separated by a net. Each team tries to score points by grounding a ball on the other team's court under organized rules. The complete set of rules is extensive, but play essentially proceeds: a player on one team begins a 'rally' by serving the ball (tossing or releasing it and then hitting it with a hand or arm), from behind the back boundary line of the court, over the net, and into the receiving team's court. The receiving team must not let the ball be grounded in their court. The team may touch the ball up to three times to return the ball to the other side of the court, but individual players may not touch the ball twice consecutively. Typically, the first two touches are used to set up for an attack. An attack is an attempt to direct the ball back over the net in such a way that the team receiving the ball cannot pass the ball and continue the rally, thus losing the point. The team that wins the rally is awarded a point and serves the ball to start the next rally.

Players need to have good Glenohumeral mobility to excel in the game, irrespective of the position at which they play. For example, most of the skills performed by volleyball players, including spiking, setting, serving, and blocking, require the athlete to repeatedly contact the ball with the upper limbs in an overhead position. Consequently, volleyball athletes frequently experience shoulder pain and dysfunction [1,2]. Even in badminton the prevalence of shoulder injuries is high. Overuse dominant shoulder injuries in elite overhead athletes are believed not to happen purely at random but contribute to injury risk factors. Several factors like poor mobility, muscle imbalance, etc. gave been suggested to be the intrinsic etiologic factors that contribute to this study [3-5], Thus it can be ascertained that there have been various studies to correlate the poor mobility with the risk of injury in badminton and volleyball. But there has been no study yet to compare the mobility amongst the two sports. Thus, this study aims to compare the glenohumeral joint mobility amongst the Indian Badminton and Volleyball players.

Materials and Methods

Study design

Cross-sectional Observational Study.

Study population

Semi-professional/professional asymptomatic badminton and volleyball athletes between age 15-28 years**.**

Sample size

Two groups of asymptomatic overhead athletes volunteered for this study.

N = 50 (Group A comprised 50 Badminton Players)

N = 50 (Group B comprised 50 Volleyball Players)

Type of sampling

Convenient Sampling (Non-probability type)

Criteria for the study

Inclusion criteria	Exclusion criteria
Male and Female Players are included in this study. Volunteers practicing semi-professional/professional volleyball or badminton for more than a year. Volunteers between the age of 15 and 28 were included in this study.	Volunteers suffering from any prior shoulder injury. Athletes refusing to be a part of this study.

Table a

Outcome measure

- **Passive range of motion using Universal Goniometer:** For all Glenohumeral joint movement (Flexion, extension, abduction, internal rotation, external rotation).
- **Apley's scratch test:** It is a simple flexibility test of the shoulder. There are two parts of the test, reaching the opposite scapula (shoulder blade) from either above or below. This test is performed in the standing position. Each subject attempts to reach back with one hand and touch the superior medial angle of the opposite scapula. No rapid movement is allowed. They must be able to hold that position for 1 to 2 seconds. This is an assessment of the shoulder's abduction and external rotation. While in shoulder's internal rotation and adduction assessment, the subject reaches back and attempts to touch the inferior angle of the opposite scapula with the same hand, and holds that position for 1-2 seconds.

Materials used

- Universal Goniometer
- Velcro Straps
- Towel Rolls
- Measuring Tape

The rationale for using all the materials is because all the materials are easily available, dependable, durable, and cost effective.

Procedure

- Volunteers are made to lie supine, and a towel roll is used to support their shoulder.
- With the help of Velcro straps, the universal goniometer is fixed to the long axis of the humerus. Passively, all the range of motion is measured, including flexion, extension, abduction, internal rotation, and external rotation.
- Volunteers are then asked to stand and then asked to touch their hands behind their back with first dominant hand up and later non-dominant hand up. Using a measuring tape, both these measurements are noted down.
- Finally, all the documentation is done for a particular volunteer, including all the demographic data, ranges, end-feel and Apley's scratch test measures.

Results and Discussion

The data was recorded using Microsoft Excel and was subjected to analysis using GraphPad Prism Software version 9. 100 subjects were taken for the sample size using a convenient (non-probability) type sampling method. The mean age of the badminton athletes was 22.24 +/- 2.241 for females and 22.36 +/- 2.196 for males. The mean experience years playing the sport professionally/semi-professionally for badminton athletes was 5.840 +/- 2.375 for females and 4.920 +/- 2.361 for males. The mean age of the volleyball athletes was 21.52 +/- 1.917 for females and 22.28 +/- 2.011 for males. The mean experience years playing the sport professionally/semi-professionally for volleyball athletes was 4.560 +/- 2.103 for females and 4.080 +/- 1.778 for males. A range of motion and flexibility analysis is available as:

Badminton external rotation dominant side

	Male	Female
Mean	88.64	88.44
Standard Deviation	1.604	2.200
Minimum	85	82
Maximum	90	90
p value	0.7226	

Table b

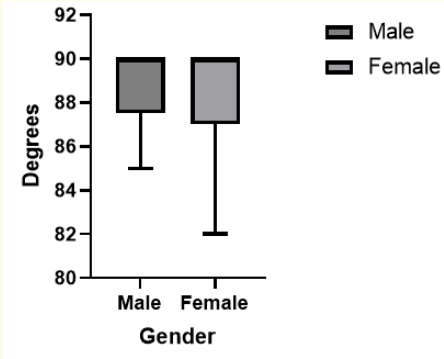

Figure 1: Badminton external rotation dominant male vs female.

Inference

Above graph is a box and whiskers graph and it shows minimum and maximum values with the topmost line denoting maximum values and the bottom line denotes the minimum value in each box. The boxes represent a single gender, and the darker line is showing the mean. From the table, we can infer that the mean of Male and Female for External Rotation movement of badminton athletes is 88.64 +/- 1.604 and 88.44 +/- 2.200 respectively and the p value using the paired T-test is 0.7226 so it is not significantly different. In similar fashion, each athlete's range of motion was recorded for flexion, extension, abduction, and internal rotation for dominant and non-dominant side. Even the Apley's scratch test was measured and was analyzed in the same manner. Both the genders were compared within the sport using the: Paired T-test. All these analyzes revealed no significant difference within the gender of the same sport.

Flexion dominant side

	Badminton	Volleyball
Mean	180	180
Standard Deviation	0.2828	0.2828
Minimum	180.0	180.0
Maximum	182.0	182.0
p value	0.999	

Table c

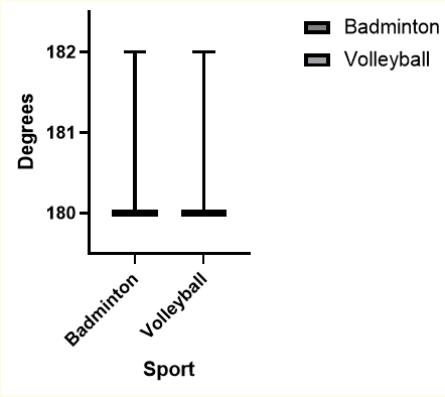

Figure 2: Flexion dominant badminton vs volleyball.

Inference

Above graph is a box and whiskers graph and it shows minimum and maximum values with the topmost line denoting maximum values and the bottom line denotes the minimum value in each box. The boxes represent a single sport, and the darker line is showing the mean. From the table, we can infer that the mean of Badminton and Volleyball for Flexion movement of dominant side is 180 +/- 0.2828 for both and the p value using the unpaired T-test is 0.999, so it is not significantly different.

Flexion non-dominant side

	Badminton	Volleyball
Mean	180	180
Standard Deviation	0.2828	0.000
Minimum	180	180
Maximum	182	180
p value	0.3198	

Table d

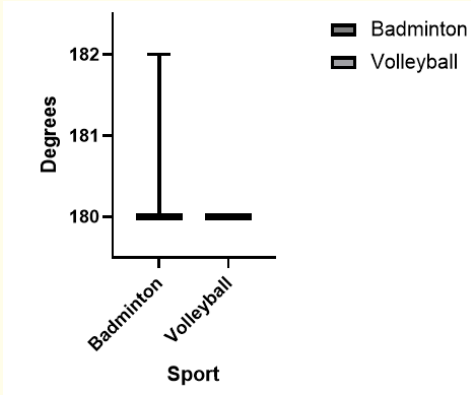

Figure 3: Flexion non-dominant badminton vs volleyball.

Inference

Above graph is a box and whiskers graph and it shows minimum and maximum values with the topmost line denoting maximum values and the bottom line denotes the minimum value in each box. The boxes represent a single sport, and the darker line is showing the mean. From the table, we can infer that the mean of Badminton and Volleyball for Flexion movement of the non-dominant side is 180 +/- 0.2828 for badminton and 180+/- 0.00 for volleyball. The p value using the unpaired T-test is 0.3198, so it is not significantly different.

Extension dominant side

	Badminton	Volleyball
Mean	59.96	60.12
Standard Deviation	1.414	0.6273
Minimum	54	60
Maximum	60	64
p value	0.4662	

Table e

Inference

Above graph is a violin graph, and it shows minimum and maximum values with the topmost peak denoting maximum values and the bottom peak denotes the minimum value in each box. The violins represent a single sport, and the dotted line is showing the mean. From the table, we can infer that the mean of Badminton and Volleyball for Extension movement of dominant side is 59.96 +/-

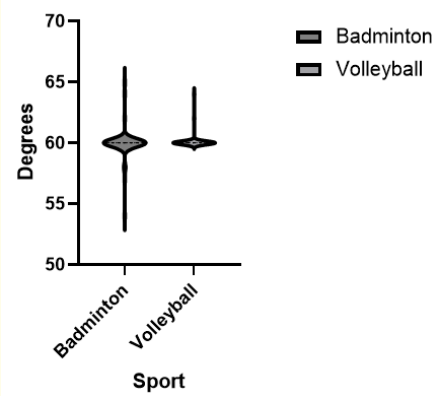

Figure 4: Extension dominant badminton vs volleyball.

1.414 and 60.12 +/- 0.6273 for badminton and volleyball respectively and the p value using the unpaired T-test is 0.4662 so it is not significantly different.

Extension non-dominant side

	Badminton	Volleyball
Mean	59.28	59.92
Standard Deviation	1.715	0.7783
Minimum	55	58
Maximum	63	63
p value	0.0181	

Table f

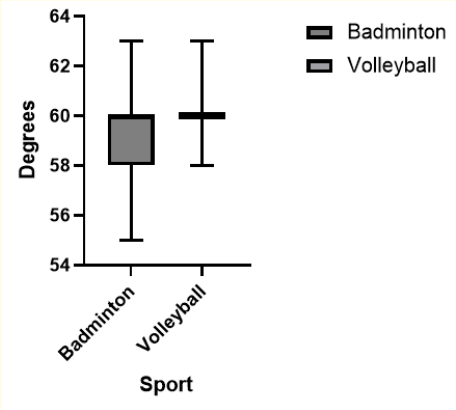

Figure 5: Extension non-dominant badminton vs volleyball.

Inference

Above graph is a box and whiskers graph and it shows minimum and maximum values with the topmost line denoting maximum values and the bottom line denotes the minimum value in each box. The boxes represent a single sport, and the darker line is showing the mean. From the table, we can infer that the mean of Badminton and Volleyball for Extension movement of the non-dominant side is 59.28 +/- 1.715 and 59.92 +/- 0.7783 for badminton and volleyball, respectively. The p value using the unpaired T-test is 0.0181, so it is significantly different statistically, but clinically, it is insignificant.

Abduction dominant side

	Badminton	Volleyball
Mean	180	180
Standard Deviation	0.000	0.000
Minimum	180	180
Maximum	180	180
p value	Since all the values are similar, it was not possible to compute a t-test. Thus, p value couldn't be found.	

Table g

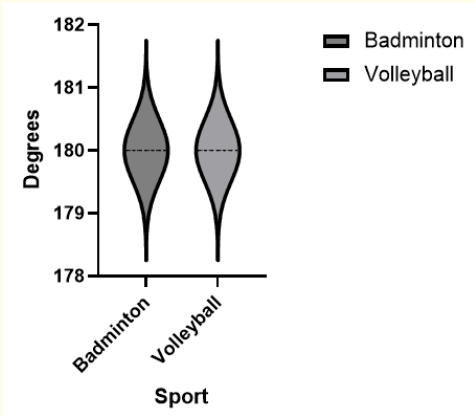

Figure 6: Abduction dominant badminton vs volleyball.

Inference

Above graph is a violin graph, and it shows minimum and maximum values with the topmost peak denoting maximum values and the bottom peak denotes the minimum value in each violin. The violins represent a single sport, and the dotted line is showing the

mean. From the table, we can infer that the mean of Badminton and Volleyball for Abduction movement of dominant side is 180 +/- 0.000 for badminton and volleyball both. The p value couldn't be calculated as the data doesn't have any standard deviation.

The same inference was also found for abduction for the non-dominant side, too.

External rotation dominant side

	Badminton	Volleyball
Mean	88.54	87.78
Standard Deviation	1.908	1.920
Minimum	82.00	82.00
Maximum	90.00	90.00
p value	0.0499	

Table h

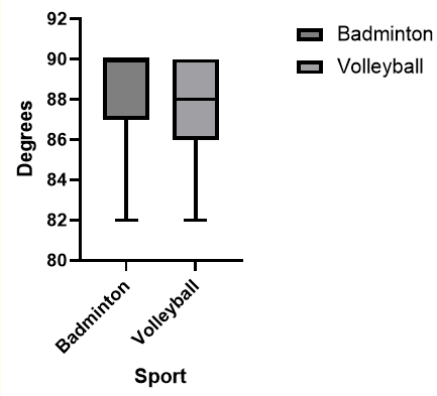

Figure 7: Extension rotation dominant badminton vs volleyball.

Inference

Above graph is a box and whiskers graph and it shows minimum and maximum values with the topmost line denoting maximum values and the bottom line denotes the minimum value in each box. The boxes represent a single sport, and the darker line is showing the mean. From the table, we can infer that the mean of Badminton and Volleyball for External Rotation movement of dominant side is 88.54 +/- 1.908 and 87.78 +/- 1.920 for badminton and volleyball, respectively. The p value using the unpaired T-test is 0.0499, so it is significantly different statistically, but clinically, it is insignificant.

External rotation non-dominant side

	Badminton	Volleyball
Mean	87.70	86.98
Standard Deviation	1.898	1.708
Minimum	85.00	85.00
Maximum	90.00	90.00
p value	0.0489	

Table i

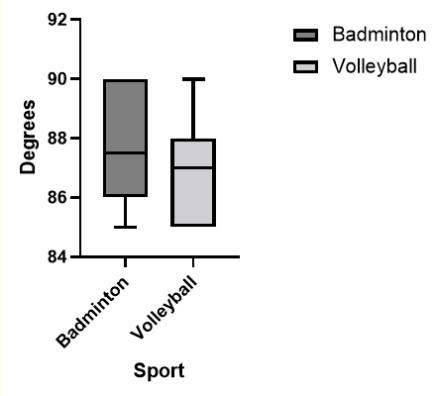

Figure 8: Extension rotation non-dominant badminton vs volleyball.

Inference

Above graph is a box and whiskers graph and it shows minimum and maximum values with the topmost line denoting maximum values and the bottom line denotes the minimum value in each box. The boxes represent a single sport and the line in the middle of each box is showing the mean. From the table, we can infer that the mean of Badminton and Volleyball for External Rotation movement of the non-dominant side is 87.70 +/- 1.898 and 86.98 +/- 1.708 for badminton and volleyball, respectively. The p value using the unpaired T-test is 0.0489, so it is significantly different statistically, but clinically, it is insignificant.

Internal rotation dominant side

	Badminton	Volleyball
Mean	85.72	86.00
Standard Deviation	2.391	1.690
Minimum	80.00	80.00
Maximum	90.00	90.00
p value	0.5005	

Table j

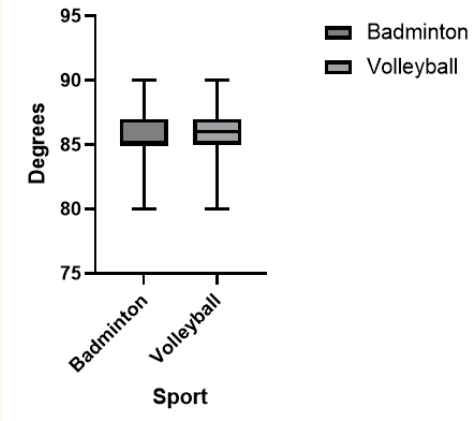

Figure 9: Internal rotation dominant badminton vs volleyball.

Inference

Above graph is a box and whiskers graph and it shows minimum and maximum values with the topmost line denoting maximum values and the bottom line denotes the minimum value in each box. The boxes represent a single sport and the line in the middle of the right box and darker line in the left box is showing the mean. From the table, we can infer that the mean of Badminton and Volleyball for Internal Rotation movement of dominant side is 85.72 +/- 2.391 and 86.00 +/- 1.690 for badminton and volleyball, respectively. The p value using the unpaired T-test is 0.5005, so it is not significantly different.

Internal rotation for non-dominant side

	Badminton	Volleyball
Mean	84.96	85.16
Standard Deviation	2.547	1.788
Minimum	79.00	80.00
Maximum	90.00	90.00
p value	0.6506	

Table k

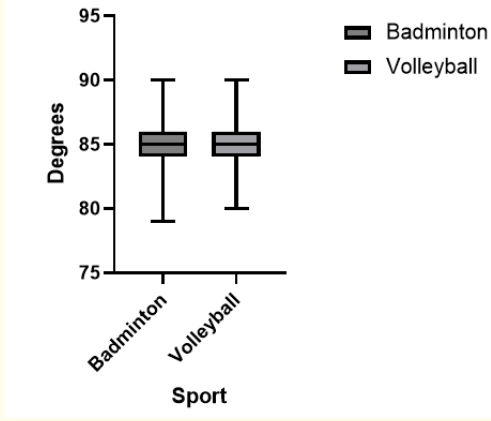

Figure 10: Internal rotation non-dominant badminton vs volleyball.

Inference

Above graph is a box and whiskers graph and it shows minimum and maximum values with the topmost line denoting maximum values and the bottom line denotes the minimum value in each box. The boxes represent a single sport and the line in the middle of the right box and darker line in the left box is showing the mean. From the table, we can infer that the mean of Badminton and Volleyball for Internal Rotation movement of dominant side is 85.72 +/- 2.391 and 86.00 +/- 1.690 for badminton and volleyball, respectively. The p value using the unpaired T-test is 0.5005, so it is not significantly different.

Scratch test dominant side

	Badminton	Volleyball
Mean	3.260	2.000
Standard Deviation	1.782	3.051
Minimum	-7.000	0.000
Maximum	11.000	7.000
P value	0.0133	

Table l

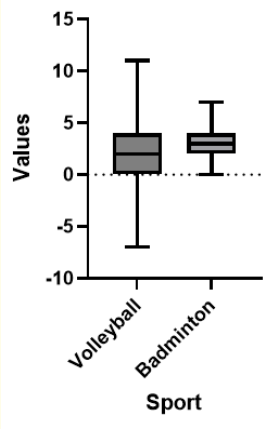

Figure 11: Scratch test dominant badminton vs volleyball.

Inference

Above graph is a box and whiskers graph and it shows minimum and maximum values with the topmost line denoting maximum values and the bottom line denotes the minimum value in each box. The boxes represent a single sport and the line in the middle of each box is showing the mean. From the table, we can infer that the mean of Badminton and Volleyball for the Scratch Test of dominant side is 3.260 +/- 1.782 and 2.000 +/- 3.051, respectively. The p value using the unpaired T-test is 0.0133, so it is significantly different. This would suggest that the flexibility for the dominant side is more in badminton athletes than volleyball athletes.

Scratch test non-dominant side

	Badminton	Volleyball
Mean	2.400	1.220
Standard Deviation	1.773	2.509
Minimum	-4.000	0.000
Maximum	10.000	7.000
P value	0.0078	

Table m

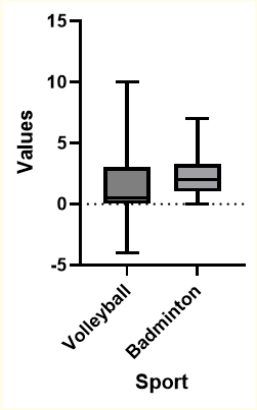

Figure 12: Scratch test non-dominant badminton vs volleyball.

Inference

The boxes represent a single sport and the line in the middle of each box is showing the mean. From the table, we can infer that the mean of Badminton and Volleyball for the Scratch Test of dominant side is 2.400 +/- 1.773 and 1.220 +/- 2.509 for badminton and volleyball, respectively. The p value using the unpaired T-test is 0.0078, so it is significantly different. This would suggest that the flexibility for the dominant side is more in badminton athletes than volleyball athletes.

Discussion

The athletes in this study were highly trained, competitive athletes, practicing at least thrice a week. 50 badminton athletes, which included 25 male and 25 female athletes, and 50 volleyball

athletes, which included 25 male and 25 female athletes, were investigated in this study. They were observed for their mobility and flexibility using a universal goniometer and Apley's scratch test, respectively. The athletes were studied in their familiar environment of their academy. The mean age of the badminton athletes was 22.24 +/- 2.241 for females and 22.36 +/- 2.196 for males. The mean experience years playing the sport professionally/semi-professionally for badminton athletes was 5.840 +/- 2.375 for females and 4.920 +/- 2.361 for males. The mean age of the volleyball athletes was 21.52 +/- 1.917 for females and 22.28 +/- 2.011 for males. The mean experience years playing the sport professionally/semi-professionally for volleyball athletes was 4.560 +/- 2.103 for females and 4.080 +/- 1.778 for males.

The analysis of the comparison of glenohumeral joint mobility within the sport for the gender did not reveal any significant difference. It was also proven by a previous study by Olga Zuzgina., *et al*. that the internal rotation and external rotation range of motion was similar between dominant and non-dominant side, and between men and women within the sport [6]. It was also supported by a previous study that reported a similar range of motion in dominant and non-dominant shoulders for elite volleyball players. It also proposed that a reason for no range of motion differences in volleyball, when compared with other overhead activities, might be due to there being no extra weight of the ball/racket in the movement that could force the shoulder into more external rotation and potentially increase its range of motion [7]. The analysis of the comparison of glenohumeral joint mobility amongst the sport for flexion in dominant, flexion in non-dominant, extension in dominant, abduction in dominant, abduction in non-dominant, internal rotation in dominant and internal rotation in non-dominant revealed no significant difference.

The analysis of the comparison of glenohumeral joint mobility amongst the sport for extension in non-dominant hand, external rotation in dominant and external rotation for non-dominant was found to be significantly different. Many studies have shown that shoulder ROM is changed as an adaptive response to throwing or in sports like tennis, etc. [8-10]. First observed in baseball pitchers, the main adaptations described that the sport causes changes in the rotation range of motion of the dominant shoulder, leading to greater range of motion of external rotation and a concurrent internal rotation deficit, also known as glenohumeral internal rotation deficit [11]. This pattern of ROM is consistent with the description of upper extremity athletes found in previous literature [12-14]. The overhead athletes may have excessive external rotation due to repetitive stress to the anterior/inferior capsule during the overhead motion [15]. Shortening and scarring of posterior capsule and rotator cuff muscles may lead to limited internal rotation in shoulder of overhead athletes.

As per the analysis, it showed that badminton athletes have a greater mean external rotation on dominant side than volleyball athletes. This could be attributed to the single-handed sport play in badminton over largely double handed sport play in volleyball. The literature supports that overhead and throwing athletes develop adaptations to their dominant shoulders that affect their passive range of motion. Multiple studies demonstrate that the athlete's dominant shoulder, when compared with the nondominant shoulder, develops decreased internal rotation, known as glenohumeral internal rotation deficit (GIRD), also there could be external rotation gain (ERG) [16,17]. Various studies have also demonstrated that excessive humeral retro-torsion put additional stresses on the posterior aspect of the shoulder of throwing athletes that could lead to range of motion deficits in volleyball players [18]. Analysis also showed that external rotation in non-dominant side has greater mean in badminton athletes as compared to volleyball athletes. In this study, it also showed that extension on the non-dominant side had greater mean in volleyball as compared to badminton. This can be attributed to the fact that athletes usually tend to use their non-dominant side more in overhead activities as compared to dominant side. As stated by Allegrucci M., *et al.* Overhead athletes that use both the sides do not exclusively use their dominant arm during athletic performances [15].

It was also found out in this study that along with mobility, even flexibility among the sports was found to be significantly different in dominant as well as non-dominant side. Apley's scratch test revealed the mean of badminton athletes on the dominant side to be 3.260 +/- 1.762 which was lesser than volleyball that was found to be 2.000 +/- 3.051. The mean of Apley's scratch test for badminton on the non-dominant side is to be 2.400 +/- 1.773 and 1.220 +/- 2.509 for volleyball.

Conclusion

Out of the overhead athletes, it has been observed that the badminton players have more mean external rotation in dominant side as well as non-dominant side, while volleyball players have more mean an extension in non-dominant side than badminton players.

However, clinically, there is no significant difference in mobility and flexibility amongst the two sports.

Acknowledgements

I would like to express my sincerest gratitude to my project guide, Dr. Medha Deo, for her formidable and able guidance and encouragement in completing my project. Thanks to Dr. Shiva Jain, I could do the statistics and analysis of the project. I would sincerely like to thank all the study participants who took part in the study for their co-operation. I would like to thank my friends, colleagues and family as I could complete this research with their constant support and motivation.

Conflict of Interest

There is no conflict of interest noted for this study.

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