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COMPARISON OF DOMINANT VERSUS NON-DOMINANT SHOULDER RANGE OF MOTION AMONG VOLLEYBALL PLAYERS IN PESHAWAR: A CROSS-SECTIONAL STUDY

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Abstract

Background: *Volleyball stands out as a highly popular sport on a global scale, and it often leads to injuries, primarily affecting the ankle, knee, and shoulder. While prevention programs have successfully decreased injury rates at the knee and ankle, there are currently no such programs or identified risk factors addressing shoulder injuries.*

Objective: *To compare dominant versus non-dominant shoulder range of motion among volleyball players in Peshawar.*

Methodology: *A cross-sectional survey was conducted using a validated questionnaire including demographic information, anthropometric measurements and training history. An inclinometer was used to measure Dominant (D) versus Non-Dominant (ND) Shoulder range of motions (ROM). The sample includes 128 male volleyball players who were selected conveniently from volleyball clubs or academies in Peshawar. The data was analyzed and presented in form of means and SD, frequencies and percentages using SPSS version 23.*

Results: *The results of our study shows that there is statistically significant difference between D and ND shoulder ROM in terms of shoulder extension, Internal rotation (IR), External rotation (ER), Abduction and horizontal adduction (HADD) ($P<0.05$), whereas no statistically significant difference was observed in shoulder flexion between D and ND shoulder ($P>0.05$). Our study also revealed that IR on the D side 42.9 $\pm$ 9.0 was significantly decreased as compared to ND side 53.4 $\pm$ 9.4. In contrast, ER on the D side 81.7 $\pm$ 7.8 was increased compared to the ND side 77.5 $\pm$ 7.6. Additionally, HAdd on D side 24.7 $\pm$ 7.9 was also decreased compared to the ND side 30.5 $\pm$ 7.1.*

Conclusion: *This study concluded that volleyball players exhibit variations in the ROM between their D and ND shoulders. Extention, IR, abduction and HADD were limited on D side in relation to the ND. In contrast, ER were increased on D side in relation to ND side. Moreover, Majority of the volleyball players have GIRD on their D shoulder in relation to ND shoulder.*

INTRODUCTION

In the world of sports, volleyball is one of the most popular and around 200 million people worldwide participate in playing it (1). Over the past five years, volleyball has experienced remarkable growth across all levels of competition (2). Volleyball is a team sport typically played by two teams, each consisting of six players on the court at a time. In this game, players use their hands to hit a ball back and forth over a high net, with the objective of making the ball touch the opponent's court before they can return it (3).

Technically challenging sports like volleyball require athletes to make repeated, strong overhead movements, which puts a lot of strain on their shoulders (4). People who engage in volleyball and regularly execute fast and forceful movements with their dominant (D) limb, like spiking and serving, might experience changes in their range of motion (ROM), differences in the power of rotatorcuff muscles, and variations in posture in contrast to their non-dominant (ND) side (5). Rapid motions are required when doing volleyball related actions including leaping, landings, preventing (blocking), & hitting the ball, resulting in a heavy burden on the joints and muscles. Players who play volleyball are hence susceptible to muscular-skeletal problems (6).

The clavicle, scapula, and humerus make up the shoulder complex, one of the largest and most complicated joints in the body. They collectively compose all four of the joints: the glenohumeral (GH), acromioclavicular (AC), coracoclavicular (CC), and scapulothoracic (ST) joints (7). The major joint of the “shoulder complex” is the GH joint, which is a ball and socket joint connecting the humeral head to the glenoid fossa of the scapula (8). The GH joint is innervated by the axillary, suprascapular, and lateral pectoral nerves. The blood supply to the humerus, particularly the upper arm region, is provided by the anterior and posterior circumflex humeral arteries (9). Since only 25% of the head of the humerus is in direct contact with the fossa of the glenoid at this joint, there is a great deal of reliance on static stabilizers such as the labrum & GH ligaments to add depths and stabilization (10).

The rotator cuff muscles, which is made up of the supraspinatus, infraspinatus, subscapularis, and teres minor, is primarily responsible for the GH and ST joints' dynamic stability. Each of these muscles arise from the scapula and develop into a protective cuff to centralize and compress the humerus and provide stability to the GH joint (11). The subscapularis, pectoralis major, pectoralis minor, serratus anterior, latissimus dorsi, and teres major are the principal internal rotators of the shoulder. Infraspinatus and teresminor are the main external rotators, with help from the supraspinatus and deltoid. These muscles cooperate as force couples to enable the shoulder to move safely over its wide range ROM (8). The(12) normal shoulder range for flexion is 176°± 7.4, extension is 50°± 11.8, abduction 175°± 7 and HAdd is 35°± 12.9 The anatomical shoulder rotational ranges for external rotation (ER) are 86°± 7.6 and 80°± 6.4 for internal rotation (IR) (13).

RATIONALE OF THE STUDY

There are few studies available on prevalence of volleyball related shoulder pain and its associated risk factors in volley ball players along with comparison of ROM between D and ND shoulder among female volleyball players on international level but to the best of researcher`s knowledge, no study has compared the ROM between D versus ND shoulder among volleyball players in Pakistan. ROM is considered a modifiable risk factor for shoulder injuries. Asymmetry in shoulder ROM between the D and ND shoulders may increase the likelihood of injury. Understanding these factors can aid in injury prevention and rehabilitation strategies. Thus, the purpose of this study was to compare D versus ND shoulder ROM among volleyball players in Peshawar, Pakistan.

MATERIALS AND METHODS

STUDY DESIGN

The study design was cross-sectional survey which compared the ranges of D and ND shoulder among volleyball players in Peshawar.

STUDY SETTINGS

This study was conducted in the following sports complexes/clubs/academies;
Volleyball Arena Peshawar Sports Complex, Khalil Comrade Volleyball Club, Darmangi Volleyball Club, Urmar Volleyball Club, Youngsters Volleyball Club, Ayub Khel Volleyball Club, Tehkal Volleyball Club, Shara Volleyball Pir Kalay, Jan Club Haryangarh, Ali's Volleyball Club Sufaid Sung, Khyber Volleyball Club, Amankot Volleyball Club, Saqib Volleyball Club and Young Yousafzai Volleyball.

STUDY POPULATION

The study population was male volleyball players who were registered with volleyball clubs or academies in Peshawar.

Material & Method

The cross-sectional survey study design was used to determine comparison of dominant versus non-dominant shoulder range of motion among volleyball players in peshawar: a cross-sectional study from May 2023 till october 2023.

SAMPLE SIZE

With a 95% confidence interval, the sample size was 128 people, while the total population size was 190. Using the Open Epi sample size calculator, the sample size was determined.

SAMPLE SELECTION

The study's inclusion criteria stated that all the registered volley ball players with sports complexes/clubs/academies in Peshawar, Male volleyball players, Age group between 16 - 30 years, Active members of volleyball.
The following exclusion criteria were include those: Volley ball players having shoulder injury/pain, Volley ball players who do not practice regularly, Any known systemic diseases, History of trauma and fractures and surgery of shoulder.

DATA COLLECTION PROCEDURE

Following approval from the graduation committee meeting and DRB, the MD/HOD of SHS granted additional authorization for the start of data collecting. Prior to data collection, official permission letters were obtained from the relevant volleyball clubs and academies in order to perform the study. After explaining the goals and methods of the study to all willing participants, their informed consent was obtained. Through inclusion and exclusion criteria, the agreed-upon participants were evaluated. The following instruments were used to gather data:

- A validated questionnaire adopted from Challoumas et al. was used to collect data regarding demographic information, anthropometric measurements and training history. The pilot study was conducted at which the questionnaire reliability was Cronbach's Alpha 0.65.
- Inclinometer: An inclinometer was used to measure the range of motions of the dominant and non-dominant GH joints. This tool can measure angles in relation to gravity. With Intraclass Correlation Coefficients (ICC) for bubble inclinometer 0.81, it has strong intrarater and interrater reliability (14).

All participants provided their informed consent before having their data gathered at a time that worked for them. The participant responses were recorded after the researcher had read the questions to them.

DATA ANALYSIS PROCEDURE

Data was analyzed using SPSS version 23**.** Frequencies and percentages were calculated for categorical variables such as gender, BMI, hand dominance, role of volleyball player, volleyball clubs/academies and training history. For numerical variables such as age, height, weight, GH joint ROMs, means and standard deviation were calculated. Cross tabulation was used to find frequency counts and percentage for each variable. Normality of data was checked through Shapero-Wilk test. Data was normally distributed, so Paired t-test was used to compare range of motion between D Versus ND shoulder of volleyball players.

RESULTS & ANALYSIS

A total of 128 male volleyball players were included in the study, comprising 95 right-hand dominant (74.2%) and 33 left-hand dominant (25.7%) participants.

The mean age was comparable between groups: 23.7 ± 3.4 years in the right-dominant group and 23.8 ± 3.5 years in the left-dominant group. Similarly, height and weight showed minimal variation, with mean heights of 175.2 ± 7.6 cm (right-dominant) and 175.4 ± 7.7 cm (left-dominant), and mean weights of 71.2 ± 5.5 kg and 70.6 ± 7.03 kg, respectively.

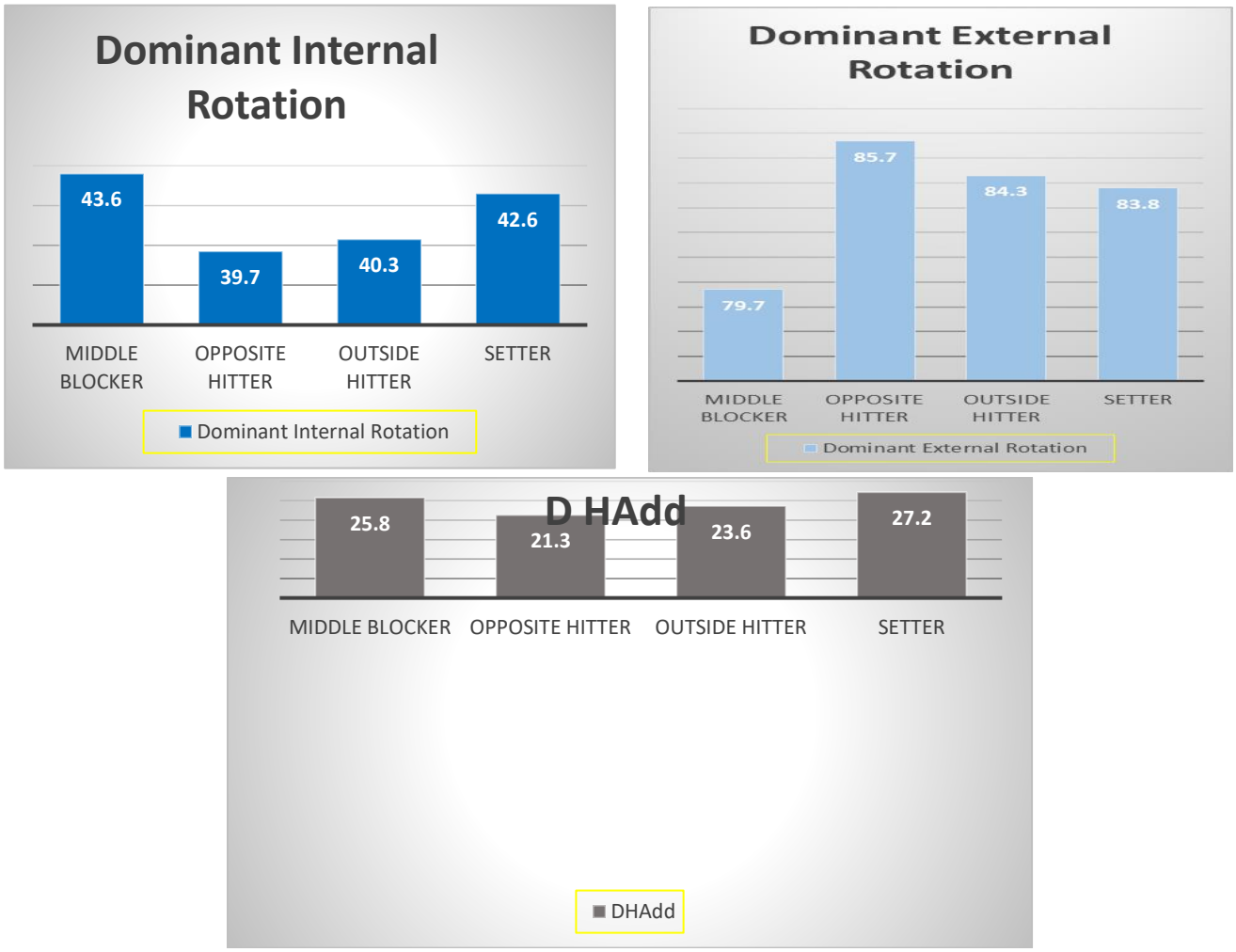
BMI classification revealed that the majority of participants fell within the normal range (18.5–24.9), accounting for 90.6% of the total sample. Specifically, 87 right-dominant (75%) and 29 left-dominant (25%) participants were in this category. Overweight individuals (BMI 25–29.9) comprised 8.5% of the sample, with a slightly higher representation from the right-dominant group (72.7%). Only one participant (0.78%), from the left-dominant group, was underweight, and no cases of obesity were reported.

Table 1: Demographic characteristics and BMI of the participant

Variable	*Right Dominant (n = 95)*	*Left Dominant (n = 33)*	
Age (years), Mean (SD)	23.7 (3.4)	23.8 (3.5)	
Height (cm), Mean (SD)	175.2 (7.6)	175.4 (7.7)	
Weight (kg), Mean (SD)	71.2 (5.5)	70.6 (7.03)	
Hand Dominance – f (%)	95 (74.2%)	33 (25.7%)	
BMI	**Total N = 128** *f*(%)	**Total n = 95** *f*(%)	**Total n = 33** *f*(%)
Underweight (<18.5)	1(0.78%)	0 (0%)	1 (100%)
Normal (18.5–24.9)	116 (90.6%)	87 (75%)	29 (25%)
Overweight (25–29.9)	11 (8.5%)	8 (72.7%)	3 (27.2%)
Obese (>30)	0 (0%)	0 (0%)	0 (0%)

The descriptive analysis of flexion, extension, ER, IR, HADD and Abduction of GHJ was carried out to find the mean and SD of flexion, extension, ER, IR, HAdd and Abduction between types of volleyball players. Differences were present for IR, ER and HAdd in between the types of volleyball players. Descriptive analysis revealed that in the majority of participants, the D shoulder possessed a decreased HADD and IR, and increased ER ROM when compared to the ND shoulder. IR on D side in comparison to the ND side were more limited in opposite hitters 39.7 ± 9.3 and outside hitters 40.3 ± 7.7 followed by setters 42.6 ± 9.4 and middle blockers 43.6 ± 9.8. ER on D side in comparison to the ND side were more increased in opposite hitters 85.7 ± 6.9 and outside hitters 84.3 ± 8.5 followed by setters 83.8 ± 8.1 and middle blockers 79.7 ± 8.3. Moreover, HADD on D side in comparison to the ND side were more limited in opposite hitters 21.3 ± 7.9 and outside hitters 23.6 ± 8.4 followed by middle blockers 25.8 ± 8.7 and setters 27.2 ± 5.4. (Figure 2)

Figure 2: Bar-chart showing Range Of Motion Between T



Cross Tabulation between sports specific characteristics and hand dominancy of the volleyball players was carried out to find the frequency and percentage of role of player, level of participation, playing experience, warm up session, cool down session and shoulder exercises. Out of 128 players, majority of the players 55 (42.9%) were opposite hitters, 37 (28%) players were outside hitters followed by middle blockers 18 (14%) and setters 18(14%). Majority of right D players 62 (75.6%) and left D players 20 (24.3%) have district level of participation followed by regional level. Similarly, majority of the right D players 44 (78.5%) and left D players 12 (21.4) have 4 to 7 years of playing experience. In a total of 128 participants, majority of right D players 85 (78%) and left D players 24 (22%) did their warm up session before whereas 60 (71.4%) right D players and 24 (28.5%) left D players did not perform their cool down session for shoulders after playing volleyball. Moreover, majority of right D players 59 (59.6%) and left D players 23 (40.4%) haven't do shoulder exercises. (Table 3

Table 3: Sports specific characteristics and hand dominancy of the participants.

Variables	N = 128	Right Dominancy (n = 95) *f*(%)	Left Dominancy (n = 33) *f*(%)
Role of Player			
Middle Blocker Opposite	18	16 (88.8%)	2 (11.15)
Hitter Outside Hitter	55	55 (100%)	0 (0%)
Setter	37	11 (29.7%)	26 (70.2%)
	18	13 (72.2%)	5 (27.7%)
Level of participation			
Provincial	14	8 (57.1%)	6 (42.8%)
Region	32	25 (78.1%)	7 (21.8%)
District	82	62(75.6%)	20 (24.3%)
Playing experience (years)			
1 -3			
4 -7	23	15 (65.2%)	8 (34.7%)
8 -10	56	44 (78.5%)	12 (21.4%)
	49	36 (73.4%)	13(26.5%)
Warm up session for shoulder			
Yes	109	85 (78%)	24 (22%)
No	19	10 (52.6%)	9 (47.3%)
Cool down session for shoulder			
Yes	44	35 (79.5%)	9 (20.4%)
No	84	60 (71.4%)	24 (28.5%)
Shoulder Exercises			
Yes	46	36 (78.2%)	10 (36.1%)
No	82	59 (59.6%)	23 (40.4%)

The cross-tabulation between practice history of the volleyball players and hand dominancy and was carried out to find the frequency and percentage of No. of hours per day, days per week, weeks per month and months per year. Majority of the right D players 71 (74.7%) and left D players24 (25.2%) were doing maximum practice of 2 to 4 hrs per day, 49 (79%) right side D and 13 (21%) left side D were doing maximum practice of 7 days per week, 95 (74.2%) right side D and 33 (25.8%) left side D were doing maximum practice of 4 weeks per month and 95 (74.2%) right D and 33 (25.8%) left D players were doing maximum practice of 9 to 12 months per year, respectively. (Table 4

Table 4: Practice history and hand dominancy of the participants.

Variable	Mean	SD	P Value
Flexion			
D	173.2	6.3	.057
ND	173.9	6.3	

Extension			
D	50.5	8.0	.002
ND	51.4	8.1	
External Rotation			
D	81.7	7.8	.00
ND	77.5	7.6	
Internal Rotation			
D	43.7	8.1	.00
ND	56.4	5.9	
Horizontal Add			
D	24.7	7.9	.00
ND	30.5	7.1	
Abduction			
D	173	6.0	.00
ND	174.7	5.3	

Paired t-tests was performed for the comparison of D and ND shoulder range of motion which revealed a statistically significant difference between D and ND shoulder extension ER, IR, HAdd and Abduction, but no significant difference was found between bilateral shoulder flexion ROM. The test shows significance difference for extension, abduction, IR, ER and HAdd. The test reveals that IR on the D side 43.7 ± 8.1 was decreased compared to the ND side 56.4 ± 5.9. In contrast, ER on the D side 81.7 ± 7.8 was increased compared to the ND side 77.5 ± 7.6. Additionally, HAdd on D side 24.7 ± 7.9 was decreased compared to the ND side 30.5 ± 7.1. (Table 5)

No. of practice sessions	Total N=128	Right Dominancy (n = 95) *f*(%)	Left Dominancy (n = 33) *f*(%)
Per day (hours)			
1 - 2	95	71 (74.7%)	24 (25.2%)
2 - 4	32	23 (71.8%)	9 (28.1%)
4 – 6	1	1 (100%)	0 (0%)
Per week (days)			
4	1	0 (0%)	1 (100%)
5	39	26 (66.6%)	13 (33.3%)
6	26	20 (77%)	6 (23%)
7	62	49 (79%)	13 (21%)
Per month (weeks)			
4	128	95(74.2%)	33(25.7%)
Per year (months)			
9 – 12	128	95 (74.2%)	33 (25.7%)

Table 2: Paired T-Test: Dominant vs. Non-dominant

DISCUSSION

In this study, we sought to better understand how volleyball player's D and ND shoulders differed in terms of shoulder ROM. The demographic characteristics of our participants were found to be similar between right-handed (95 players, 74.2%) and left-handed (33 players, 25.7%) individuals in terms of age 23.7 ± 3.4, height 175.2 ± 7.6 and weight 71.2 ± 5.5. Regarding body mass index (BMI), the majority of the participants (90%) fell into the "normal weight" category, which indicates that most of the volleyball players maintains a healthy body composition. In terms of sports-specific characteristics, it was observed that a significant proportion of the participants held the role of "opposite hitter" (42.9%), followed by "outside hitters" (28%), "middle blockers" (14%), and "setters" (14%). Our study also shows that a substantial portion of participants did not perform cool-down sessions and shoulder exercises, which could have implications for shoulder health in these players. The most important findings of our study was regarding comparison of ROM. We found significant differences for extention, abduction, IR, ER and HAdd between the two shoulders. Specifically, the shoulder exhibited reduced IR, HADD and increased ER compared to the ND shoulder. We also compared ROM between types of volleyball players. IR on D side in comparison to the ND side were more limited in opposite hitters 39.7 ± 9.3 and outside hitters 40.3 ± 7.7 followed by setters 42.6 ± 9.4 and middle blockers 43.6 ± 9.8. ER on Dom side in comparison to the ND side were more increased in opposite hitters 85.7 ± 6.9 and outside hitters 84.3 ± 8.5 followed by setters 83.8 ± 8.1 and middle blockers 79.7 ± 8.3. Moreover, HAdd on D side in comparison to the ND side were more limited in opposite hitters 21.3 ± 7.9 and outside hitters 23.6 ± 8.4 followed by middle blockers 25.8 ± 8.7 and setters 27.2 ± 5.4.

A study conducted by Kittrell Chelsea on 15 adolescent female volleyball players and found significant differences between D and ND shoulder for IR, ER and HADD. A significant difference in bilateral passive shoulder ROM was found for ER (p=0.039), IR (p=0.029), and HADD (p=0.039) but no significant difference was found in total rotational motion (p=0.397) (16). Similar findings were found by our study but our study included large sample size (n=128). We have also measured other ranges like flexion, Extension and abduction. We collected data only from male participants because there were no female participants who would meet our inclusion criteria for being active member of volleyball in the aforementioned volleyball clubs.

D. Challoumas et al. reported that age and years of experience are significant predictors of greater scapular lateralization (P = 0.019) and greater anterior tilting (P = 0.019), which are the main causes of disparities in ROM between the D and ND shoulder in OH athletes (15). Same study also reported that there were no significant difference present for ROM between types of volleyball players (15). In contrast, our study found that IR on D side in comparison to the N side were more limited in opposite hitters 39.7 ± 9.3 and outside hitters 40.3 ± 7.7 followed by setters 42.6 ± 9.4 and middle blockers 43.6 ± 9.8. ER on D side in comparison to the N side were more increased in opposite hitters 85.7 ± 6.9 and outside hitters 84.3 ± 8.5 followed by setters 83.8 ± 8.1 and middle blockers 79.7 ± 8.3. Moreover, HADD on D side in comparison to the ND side were more limited in opposite hitters 21.3 ± 7.9 and outside hitters 23.6 ± 8.4 followed by middle blockers 25.8 ± 8.7 and setters 27.2 ± 5.4.

In a cross-sectional study, Harput et al. compared the shoulder ROM in asymptomatic male and female adolescent volleyball attackers. They found results that were similar to those of the present study, including a significant increase in D ER ROM, a loss in D IR ROM, and a decrease in TRM (17). In a systematic review conducted by Challoumas, a comparison of bilateral shoulder rotational ROM was performed among elite male and female volleyball players. The review revealed significant findings, with 67% of the included studies reporting a decrease in IR of the D shoulder and an increase in ER in the same shoulder (14). Similar study observed a significant IR loss and ER increase in the D arm in a cross-sectional research comparing shoulder ROM in teenage male and female beach volleyball players (18). Another study by Perez et al. on professional tennis players found that the D arm of the athlete's IR decreased when compared to their ND arm and that the arm's ER increased when compared to the ND arm (19). While identical results, namely a loss of InR and a gain of ER on the D side compared to the ND side, were found in our study. Additionally, we

discovered a noteworthy difference in HADD, which was lower on the D side as compared to the ND side. Abduction, extention, and flexion were nearly identical on both sides.

Harput et al. evaluated the bilateral ROM of asymptomatic male and female volleyball attackers and discovered that 38% of test subjects had GIRD, which is nearly identical to our study's finding (17). According to the definition of GIRD (IR ROM loss > 18°), we had also found GIRD in 38.2% (49/128) of the participants. This is crucial because it has been demonstrated that ROM changes in OH sportsmen get worse with age and amount of sport exposure (20). In a study Saccol et al. conducted on highly skilled female volleyball athletes, 21% of the subjects had GIRD (18). There are no studies that examine how long it takes for GIRD to develop, however a longitudinal research by Ness et al. discovered that over the course of a competitive season in female volleyball athletes, an average of 6 degrees of D IR was lost and 10 degrees of ER were gained (21). Gillet et al. also reported that they discovered changes in ROM, specifically IR and TRM reduced gradually with biological age and with more sport exposure in adolescent tennis players (20).

Participants who played volleyball exclusively for more than nine months a year were included in our study since they were highly specialized. According to Bell et al., the risk of overuse injuries rises gradually with increasing levels of specialization, with highly specialized athletes being roughly twice as likely to suffer one as athletes with low specialization (21). Early sport specialization in volleyball players has been associated with burnout, morphological alterations, and an increased risk of chronic overuse injury. According to the study's findings, highly specialized volleyball players are more likely to sustain shoulder injuries (23).

CONCLUSION

This study concluded that volleyball players exhibit variations in the ROM between their D and ND shoulders. Extention, IR, abduction and HADD were limited on D side in relation to the ND. In contrast, ER were increased on D side in relation to ND side. Moreover, Majority of the volleyball players have GIRD on their D shoulder in relation to ND shoulder

LIMITATIONS

The shortcomings of this study are given below are;

Only male volleyball players were included whereas female players were not included.

Lack of a control group further threatened internal validity and prevented comparisons between athletes and non-athletes to ascertain if shoulder ROM is correlated with repetitive OH motion.

Convenient sampling, which may not correctly represent the population of interest, was used, which could compromise internal validity.

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