Original Article
ISSN (Online): 2582-7472

ShodhKosh: Journal of Visual and Performing Arts
April 2024 5(4), 2037–2042

ANALYSIS OF UPPER LIMB KINEMATICS IN VERTICAL JUMP SHOTS IN HANDBALL

Karam Shyamananda Singh [1], Laishram Thambal Singh [1]

[1] Department of Physical Education and Sports Science, Manipur University, Imphal, Manipur, India

Corresponding Author

Karam Shyamananda Singh,
karamshyamanandasingh@gmail.com

DOI
10.29121/shodhkosh.v5.i4.2024.5934

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ABSTRACT

Background: The kinematic analysis of jump shot with reference to the analysis of the release angle of different joints of the arm helps us to understand how to improve the maximal force muscles produced where the motor actions are performed at that instant frame of release.

Objective: The main objective was to investigate, assess and compare the angle of release of different joints of the right arm among handball players (Under-16 and Under-18).

Methodology: Thirty right handed national-level handball players (15 players of under-16 and 15 players of under-18) were selected by employing a stratified random sampling technique so that the possibilities of selection of players from each position were uniform. For measuring the angle of release of different joints of the right arm (wrist joint, elbow joint and shoulder joint) at the instant frame of the handball released, a high-speed action camera (GoPro 12) was used for capturing the frame for this study. Kinovea, a video annotation tool designed for sports analysis was used for record and further investigation and analysis of the angle of the joints of the right arm.

Result and Conclusion: There was significant differences among the two groups of the means comparison of the shoulder joint ($P<0.05$), but there were insignificant differences in the elbow and wrist joints of the two groups which were considered for the study ($P>0.05$). This result could give a few understanding regarding the speed thrown by the groups and studying the range of movements of the players.

Keywords: Kinematic, Angle of Release and Handball

1. INTRODUCTION

Handball was introduced early in the Olympics and is a very vigorous team sport enjoyed by millions of people around the globe [1-2]. Handball is a game that originated in Europe and is now played worldwide. It is played by both male and female athletes. It is a dynamic team sport where two teams of seven players each aim to score more goals than their opponents by throwing the ball into the opposing team's goalpost. A game of handball consists of two periods of 30 minutes each, with a 10-minute halftime break. The team that scores the most goals during the game wins the match. If the score is tied at the end of the game, the match is considered a draw. The game is played on a court that measures 40 meters in length and 20 meters in width. The court is divided into two halves, with a centre line marking the halfway point. Each team has a goalpost at either end of the court, and the aim is to throw the ball into the opposition's goalpost. Handball is a fast-paced and high-scoring game. The game involves a lot of running, jumping, and throwing, making it a physically demanding sport. Body contact is allowed when defending, but fouls are penalized, and players can be sent off the court for repeated fouls.

Handball is a high-intensity contact sport of various actions such as dribbling, running, passing, jumping, blocking, pushing and catching [3-4]. Male players generally tend to produce higher throwing speeds than female players. This

could be attributed to differences in physical strength and muscle mass between the two genders [5]. The speed of the ball is definitely a crucial factor when it comes to successfully throwing the ball towards the goal. The faster the ball travels, the more difficult it becomes to save by the goalkeeper. However, accuracy and ball placement are also important factors to consider when attempting to score a goal. The release angles of the arm play a major role in producing the speed of the handball. The maximum endpoint velocities of the hand and wrist segments produced different speeds in males and females. Both male and female players exhibited the same throwing technique in handball [6]. In handball, there are different types of shots employed by players for scoring goals, such as jump shots, diving shots penalty shots etc. The jump shots can be divided into two types: vertical jump shots and forward jump shots. Jump throws are an essential task in handball and are frequently used from different positions when players shoot towards the goal. In handball competition, 73-75% of all throws during the play constitute jump throws, followed by the run-up standing throw of 14-18%, penalty throw with 6-9%, diving throw with 2-4% and direct free throw of 0-1% [7].

Biomechanics of motor movements is the science that studies human movement and discovers the laws that mechanically regulate the results of movement. The study and knowledge of biomechanics are crucial in playing handball due to its impact on performance and injury prevention. The biomechanical analysis provides insights into movements, coordination, technique, and forces exerted on the body during sports-specific actions like throwing, jumping, and sudden changes in direction [8]. In handball, where high forces are generated around the knee joint and arm joints, understanding biomechanics is essential to prevent injuries like ACL ruptures, which are common in the sport [9-10]. Additionally, biomechanical assessments help in identifying neuromuscular deficits, optimizing rehabilitation programs post-injury, and enhancing specific agility, throwing performance, and overall game-based training methods for improved performance [11]. Studying biomechanics in handball aids in optimizing technical skills, enhancing performance, and correcting errors through the analysis of motor actions and movement characteristics using technical tools [12]. It helps in optimizing techniques for maximal performance, such as increasing handball speed by improving shoulder angular velocity, separation angle, and trunk rotation timing [13]. Therefore, a comprehensive understanding of biomechanics is vital for handball players to enhance performance, prevent injuries, and support effective rehabilitation strategies.

One of the most researched parameters in biomechanics is the jump shot since it is frequently used during play. Every movement of the human body, especially in sports, has an optimal execution technique, which is characterized above all by maximum efficiency and minimum energy consumption. Therefore, design changes in one or more biomechanical parameters can affect the final results [14]. Studying the relationships between the biomechanical analysis and the playing capacity of handball players can improve their performance in future [15].

2. OBJECTIVE

The main objective was to investigate and assess the angle of release of different joints of the right arm among handball players.

Further, the angle of release of the joints of different age groups (Under-16 and Under-18) was compared in order to find out if there were significant differences between the angles of different joints of the right arm between the two groups.

3. METHODOLOGY

Thirty right handed national-level handball players where 15 players from under-16 (U16) and 15 players from under-18 (U18) were selected by employing simple random sampling technique so that the possibilities of selection of players from each position were uniform [16]. The angle of release of different joints of the right arm (wrist joint, elbow joint and shoulder joint) at the frame of the handball released was considered for measurement, the subjects were asked to throw the ball towards the goal beyond the 9m marking with 3 step running while executing vertical jump shot and a high-speed action camera (GoPro Hero 12) was used for capturing the frame for this study [17]. Kinovea was used for processing and analysis of the angle of the right arm joint. These variables had been recorded and shown in table 1.

Table 1 Variables

Sl.no.	Variables
1	Angle of Shoulder Joint

2	Angle of Elbow Joint
3	Angle of Wrist Joint

4. RESULT AND INTERPRETATION

The data were analyzed by using descriptive analysis to observe the main characteristics of the data and t-test to find out differences between the groups, respectively. The descriptive investigation of the obtained data for the different angles of the right arm for both U16 and U18 are presented in table 2.

Table 2 The Descriptive Analysis for different angles of the right arm for both U16 and U18

Variable	Group	N	Mean	SD
Angle of Shoulder Joint	U16	15	168.73	2.37
	U18	15	156.95	5.38
Angle of Elbow joint	U16	15	170.92	8.10
	U18	15	170.53	1.41
Angle of Wrist Joint	U16	15	29.08	4.10
	U18	15	28.08	2.81

Table 2 shows the means and standard deviations of the angle of the joints of the right arm of different age group. Means and standard deviations of U16 for shoulder, elbow and wrist joint were 168.73±2.37, 170.92±8.10 and 29.08±4.10. For U18, means and standard deviations of shoulder, elbow and wrist joint were 156.95±5.38, 170.53±1.41 and 28.08±2.81 respectively. The graphical representation of means for U16 and U18 for different angles of joints of arm has been shown in the figure 1.

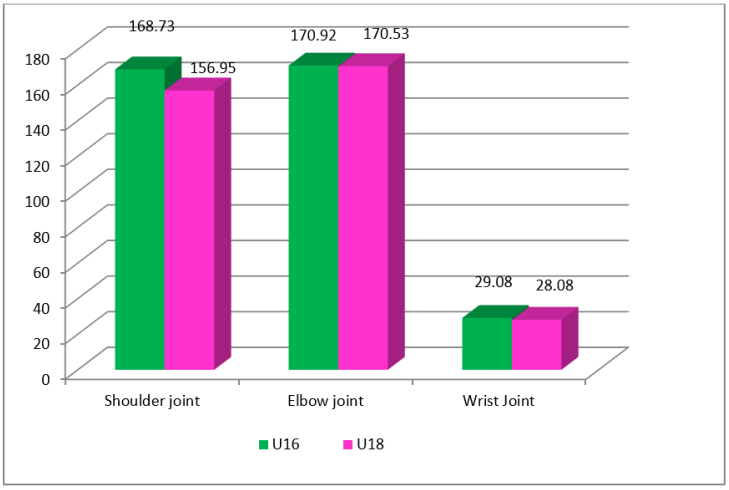

Figure 1 Means for U16 and U18 for different angles of joints of right arm.

The mean comparison of U16 and U18 handball players to consider the contrasts between the groups on different angles of joints of the throwing and thrusting arm in handball players have been interpreted by finding out independent t-test between U16 and U18 handball players.

The mean comparisons of different joints between U16 and U18 have been shown in the table 3.

Table 3 The mean comparison of angles for shoulder, elbow and wrist joints between U16 and U18

Variable	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Shoulder Joint	**7.75***	28	**0**	11.78	1.52
Elbow Joint	0.18	28	0.85	0.39	2.12
Wrist Joint	0.22	28	0.82	0.29	1.28

*Significant Value of t (0.05, df-28) =2.05

For comparing the mean between U16 and U18, an independent t-test was conducted. A significant difference was found between the two groups in the shoulder joint as the obtained value of t(0.05, df-28)= 7.75 was greater than the table value of t(0.05, df-28)= 2.05 and the obtained value of the p= 0.00 was smaller than 0.05 level of significance which indicate that the angle of the shoulder joint in U16 players was significantly greater as compared to U18 players.

While comparing the mean of the elbow and wrist joints, no significant differences were found in both the variables as the obtained t value for both variables was smaller than the table value of t(0.05, df-28) (0.18<2.05 for elbow joint and 0.22<2.05 for wrist joint). Further, the p values were greater than 0.05 level of significance for both variables.

5. DISCUSSION OF THE FINDING

The results revealed a significant difference in the angle of the shoulder joint between the groups being compared. However, no significant differences were observed in the elbow and wrist joints. This finding suggests that while the shoulder joint may play a more critical role in differentiating performance levels or techniques, the elbow and wrist maintain similar angular positions regardless of the group. These findings are further supported by a previous study, which concluded that there were no notable differences in the kinematic parameters of handball jump shots when comparing the average ball release angles across different groups [18]. Moreover, another study analyzing the kinematics of the jump shot technique in handball found that the overall movement pattern exhibited many similarities during skill execution. However, a significant difference was observed in the angle between the shoulder axis and the horizontal axis in the sagittal plane during the terminal phase of the take-off [19]. This particular finding highlights the importance of body orientation and joint coordination in the effective execution of a jump shot. Furthermore, research also indicates that angles associated with shoulder flexion, abduction, internal rotation, and elbow flexion remained consistent between groups using similar throwing techniques. This consistency is likely due to the standardized biomechanical pattern followed by trained players when performing the shot. As a result, no significant differences were recorded between groups in those specific joint movements [20]. Interestingly, it has also been noted that kinematic parameters such as release height, release angle, and ball release velocity tend to vary between national-level and inter-varsity-level players, with national players demonstrating superior values in each parameter [21]. These variations are likely a reflection of higher skill levels, greater physical conditioning, and more refined technique in elite players. In handball, the number of jump shots is the highest that is used during a match as compared to other types of shots. The significant contrast in the angle of the shoulder joint might be due to personal throwing style, differences in flexibility among the players of different age groups and their released angle so that the chance of scoring is high.

6. CONCLUSION

The study found significant differences between the two groups in the shoulder joint angles ($P<0.05$), while no significant differences were observed in the elbow and wrist joints ($P>0.05$). This suggests that the kinematics of the throwing arm were largely similar across groups, except for the shoulder joint during the vertical jump shot in handball, likely due to consistent technique among players. These findings also imply that differences in generated speed may be influenced by other kinematic factors, and future analysis of joint movement ranges could help identify potential injury risks.

INFORMED CONSENT STATEMENT

The participants were fully aware of the nature of the study and have given their voluntary agreement to participate in this study.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

The authors would like to acknowledge the participants involved in this study.

DISCLOSURE STATEMENT

No potential conflict of interest was reported.

REFERENCES

Serrien, B., Clijsen, R., & Blondeel, J. (2015). Differences in ball speed and three-dimensional kinematics between male and female handball players during a standing throw with run-up. BMC Sports Sci Med Rehabil, 7, 27. https://doi.org/10.1186/s13102-015-x

Plummer, H. A., & Oliver, G. D. (2017). The effects of localised fatigue on upper extremity jump shot kinematics and kinetics in team handball. Journal of sports sciences, 35(2), 182–188. https://doi.org/10.1080/02640414.2016.1160143

Gorostiaga, E. M., Granados , C., Ibáñez , J., & Izq. (2005). Differences in physical fitness and throwing velocity among elite and amateur male handball players. International journal of sports medicine, 26(3), 225–232. https://doi.org/10.1055/s-2004-820974

Milanese, C., Piscitelli, F., Lampis, C., & Zancan. (2011). Anthropometry and body composition of female handball players according to competitive level or the playing position. Journal of sports sciences, 29(12), 1301–1309. https://doi.org/10.1080/02640414.2011.591419

Jöris , H. J., van Muyen , A. J., & van Ingen Schenau. (1985). Force, velocity and energy flow during the overarm throw in female handball players. Journal of biomechanics, 18(6), 409–414. https://doi.org/10.1016/0021-9290(85)90275-1

Van Den Tillaar, R., & Cabri, J. M. (2012). Gender differences in the kinematics and ball velocity of overarm throwing in elite team handball players. Journal of sports sciences, 30(8), 807–813. https://doi.org/10.1080/02640414.2012.671529

Wagner, H., Pfusterschmied, J., & von Duvillard, S. (2011). Performance and kinematics of various throwing techniques in team-handball. Journal of sports science & medicine, 10(1), 73–80.

Zebis, M. K., & Bencke, J. (2018). Biomechanical Aspects in Handball: Lower Limb. Handball Sports Medicine: Basic Science, Injury Management and Return to Sport, 61-68. https://doi: 10.1007/978-3-662-55892-8_5

Setuain, I., Bikandi, E., Amú Ruiz, F., Urtasun, F., & Izquierdo, M. (2019). Horizontal jumping biomechanics among elite female handball players with and without anterior cruciate ligament reconstruction: an ISU based study. BMC Sports Sci Med Rehabil 11, 30, https://doi.org/10.1186/s13102-019-0142-8

Setuain, I., Bencke, J., Alfaro-Adrián, J., & Izquierdo, M. (2018). A Biomechanical Perspective on Rehabilitation of ACL Injuries in Handball. In L. Laver, P. Landreau, R. Seil, & N. Popovic, Handball Sports Medicine (pp. 493-504). Berlin: Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-662-55892-8_34

Wagner, H., Fuchs, P. X., & von Duvillard, S. P. (2018). Specific physiological and biomechanical performance in elite, sub-elite and in non-elite male team handball players. The Journal of sports medicine and physical fitness, 58(1-2), 73-81. https://doi.org/10.23736/S0022-4707.16.06758-X

Hussein, S. A., Ivanov, V. A., & Vyaltsev, A. S. (2016). Control of the biomechanical characteristics in handball with the use of technical means. Bulletin of the Moscow State Regional University, (3), 98-113. doi: 10.18384/2310-7189-2016-3-98-113

Lucy, P., Kevin, B., & Clare, M. (2014). Biomechanical characteristics of handballing maximally in Australian football. Sports Biomechanics, 13(4), 307-319. doi: 10.1080/14763141.2014.981201

Markovic, S. (2016). Biomechanics of handball, Retrieved from https://www.researchgate.net/publication/317759484_Biomechanics_of_handball on 4/11/2023

Singh, L., & Gill, G. S. (2018). Relationship of biomechanical analysis and performance of handball players. International Journal of Yogic, Human Movement and Sports Sciences, 3(1), 37-38.

Elfil, M., & Negida, A. (2017). Sampling methods in Clinical Research; an Educational Review. Emergency (Tehran, Iran), 5(1), e52.

Park, M. S., Brock, A., Mortimer, V., Taussky, P., Couldwell, W. T., & Quigley, E. (2017). GoPro Hero Cameras for Creation of a Three-Dimensional, Educational, Neurointerventional Video. J Digit Imaging 30, 561–565 https://doi.org/10.1007/s10278-017-9948-7

Ghosh, P., & Mondal, P. (2017). Effect on kinematics parameters of jump shot in handball. International Journal of Physical Education, Sports and Health, 4(4), 453-456.

Šibila, M., Pori, P., & Bon, M. (2002). Basic Kinematic Differences Between Two Types Of Jump Shot Techniques In Handball.

Wagner , H., Buchecker, M., von Duvillard, S. P., & Müller, E. (2010). Kinematic Comparison of Team Handball Throwing With Two Different Arm Positions. International journal of sports physiology and performance. 5, 469-83. 10.1123/ijspp.5.4.469

Akl, A.-R., Hassan, I., Hassan, A., & Bishop, P. (2019). Relationship between Kinematic Variables of Jump Throwing and Ball Velocity in Elite Handball Players. Applied Sciences. 9(16), 3423. https://doi.org/10.3390/app9163423.