Spatio-temporal Analysis Of Volleyball Serve

[1]Mohd Tanveer Khan, [2]Ikram Hussain, [3]Fuzail Ahmad
[1]Research Scholar, [2]Professor, [3]Assistant Professor
Department of Physical Education, Aligarh Muslim University, Aligarh

---

***Abstract* - The purpose of the study was to analyze the spatio-temporal analysis of volleyball serve. Fifteen (15) Indian International male volleyball players were selected from different institutions, training centers and training camps with their mean age, height, weight and training experiences in time as 23.53±6.47 years, 1.96±0.05 meters, 86.07±7.94 kg., 7.73±4.99 years respectively. Two volleyball serves skill were video recorded by using two synchronized Legaria SF10 Cannon Camcorder. The shutter speed of the camcorder (camera) was set at 1/2000 and frame rate of 50 Hz. The kinematic parameters were selected as three different phases; Approach phase, Arm Cocking & Arm Acceleration phase, and Follow Through phase. The parameter of first phase was TSLA. Second phase parameters were as SEAC, EEAC, MHTC, ABAC, SEAN, EEAN, SSHN. Third phase parameter were as BVF and ARBF. All parameter of three different phases were analyzed on two different volleyball serve variations i.e. jump float serve and jump topspin serve. The video recordings were analyzed by using Silicon Coach Pro8 motion analysis software to obtain data. The result of the study revealed that only two variables: EEAN and MHTC showed significant different in second phase. In third phase, ARBF showed significant different. The statistical analysis was done with the help of t-test by using SPSS v.21. with level of significance fixed at 0.05.**

***keywords* - Kinematics spatio-temporal variables, Jump float and jump topspin serve, Motion analysis software.**

I. INTRODUCTION

The game of volleyball is played by millions of people around the world (Huang & Hu, 2007). William G. Morgan was the founding father of Mintonette in 1895 at Holyoke, Massachusetts, which was letter known as volleyball game (Matias & Greco, 2011; Fédération International de Volleyball [FIVB]). Volleyball serve is the first skill weapon in which rally game start and aces plays a dominant role that directly influences the rally system to lead winning or losing set and match. In volleyball game, serve are performed with many variations i.e. float serve with jump and standing position, spike serve, jump topspin serve and so on. The float serve has little or no spin, a very unstable travels through the air with a wavering, breaking, sinking action, moving from side to side and up and down like a knuckleball. The wavering action occurred due to Bernoulli's effect. This theory states that when a flying stream of gas speeds up, its pressure decreases, and vice versa. If an air foil is made to move through air, the stream of air entering the region just above, the air foil is forced to flow into a constricted area and its speed increases. When the speed increases, the pressure decreases (Singh, Pharswan, Singh, 2016). Previous researches also revealed that serve spike height too has great contribution to get more benefit in line of different body segments velocity, different angles and angular velocity time duration and one thing has notable to look space of opponent court with jump serve. Higher jumping ability is the key point of the player to look at area of opposition court open to the attacker (Hussain, Khan & Mohammad 2011; Enoka 1971) and it also increases the time during which attack is possible (Baudin 1980). The potency of this serve is mainly due to its speed, giving the receivers with a very small fraction of time to react (Coleman, 2006). From the concept and result derived from previous studies describing different factors affecting volleyball serves, the present study was designed to investigate the influence of kinematics parameters on spatio-temporal analysis of volleyball serves.

II. METHOD & PROCEDURE

Fifteen (15) male volleyball players were selected as subject for the study from different institution, training centers and training camps, where they were undergoing training with their mean age, height, weight and training experiences in time, 23.53±6.47 years, 1.96±0.05 meters, 86.07±7.94 kg. and 7.73±4.99 years respectively. Two high speed HD cameras i.e. Legaria SF10 Cannon were used to capture whole selected motion while the skill serve at moment execution in sagittal plane. The shutter speed of the camera was set at 1/2000 and frame rate of 50 Hz. The location of first camera was set-up perpendicular to sagittal plane on the right side of the subject at a distance of 13 meters, mounted at height of 1.53m from the ground. The second camera was set-up perpendicular to sagittal plane on the right side of the volleyball pole at a distance of 25 meters, mounted at height of 1.55m from the ground.

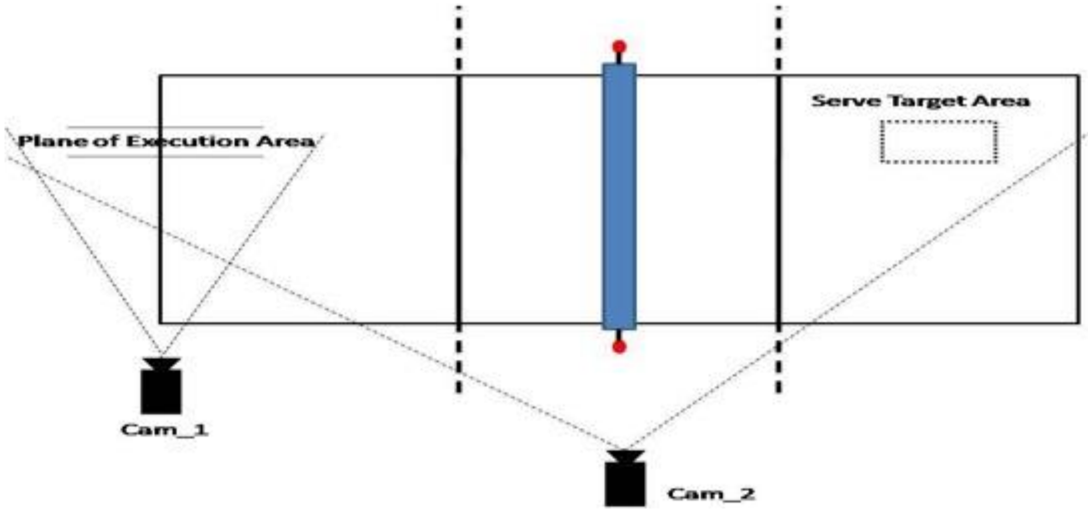

Figure 1: Shown Experimental set-up for data collection of different two types of serve skill in volleyball.

The subjects have performed 15 consecutive trails of each serve. All the trails were video recorded and analyzed the mean value was considered for statistical analysis. The selected kinematics variables of the study were considered as contribute to the effectiveness of the techniques of jump float serve and jump topspin. The serve skills were divided into three different phases: Approach phase, Arm cocking & arm acceleration phase, and Follow through phase. In the first phase, the parameter selected was Third Stride Length during Approach Phase (TSLA). In the second phase, the parameters selected were Shoulder Extension Angle during Arm Cocking Phase (SEAC), Elbow Extension Angle during Arm Cocking Phase (EEAC), Max Height Gain of Toss Ball during Arm Cocking Phase (MHTC), Angle of Body Arc during Arm Cocking Phase (ABAC), Shoulder Extension Angle during Arm Acceleration Phase (SEAN), Elbow Extension Angle during Arm Acceleration Phase (EEAN), Serve Spike Height during Arm Acceleration Phase (SSHN). In the third phase, the parameter selected were Ball Velocity during Follow Through Phase (BVF) and Angle of Release the Ball during Follow Through Phase (ARBF). The videograph was analyzed by using Silicon Coach Pro8 motion analysis software. The statistical analysis was done by using t test further employed SPSS v.21. to organized the data to reach on finding of the result and set at $p < .05$ level of significance.

III. RESULT

In section of result, summarizing partially, but not reporting them in full detail regarding different two types of serve skill. It should be a relatively brief overview of the findings of the study.

Table 01: The statistical analysis of the selected kinematic variables of volleyball serve between jump float serve and jump topspin serve during Approach Phase.

S.No.	Variables	Type of Serve	Mean	SD	Mean Difference	P-value
1	Trird Stride Length during Approach Phase (TSLA)	Jump Float Serve	92.36	14.79	8.47	0.53
		Jump Topspin Serve	83.90	16.13		

Level of significant set at 0.05.

In table 01, the selected kinematic parameters were showed during Approach Phase of two different serve i.e. Jump Float Serve and Jump Topspin Serve. The kinematics parameter: Third stride length during approach phase (TSLA), mean & SD of jump topspin 92.36±1479 where P-Value was 0.53. TSLA variable showed insignificant difference at 0.05 level of significance.

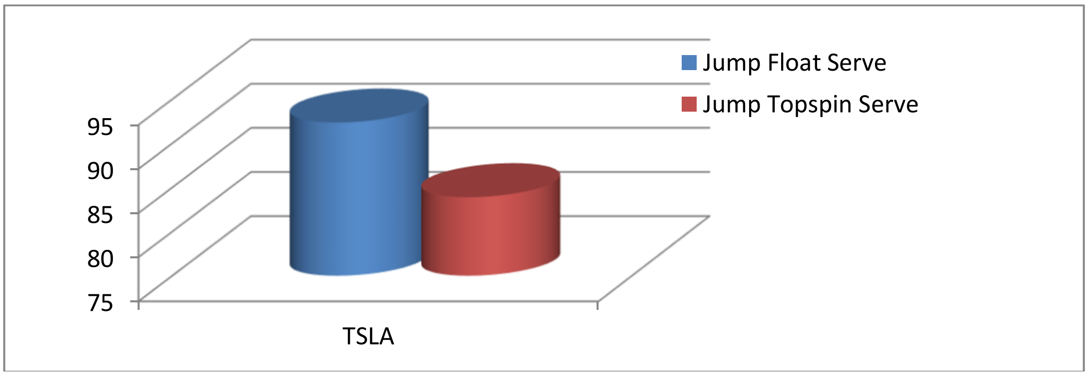

Figure 2: Illustration showing the Spatio-temporal variable: TSLA of mean values of Jump Float Serve and Jump Topspin Serve during Approach Phase (length in cm).

Table 02: The statistical analysis of the selected kinematic variables of volleyball serve between jump float serve and jump topspin serve during Arm Cocking & Arm Acceleration Phase.

S.No.	Variables	Type of Serve	Mean	SD	Mean Difference	P-value

1	Shoulder Extension Angle during Arm Cocking Phase (SEAC)	Jump Float Serve	02.00	0.17	0.12	0.79
		Jump Topspin Serve	01.88	0.15		
2	Elbow Extension Angle during Arm Cocking Phase (EEAC)	Jump Float Serve	01.32	0.32	0.22	**0.00***
		Jump Topspin Serve	01.10	0.15		
3	Max Height Gain of Toss Ball during Arm Cocking Phase (MHTC)	Jump Float Serve	312.00	47.11	342.66	**0.00***
		Jump Topspin Serve	654.66	126.40		
4	Angle of Body Arc during Arm Cocking Phase (ABAC)	Jump Float Serve	02.72	0.15	0.14	0.48
		Jump Topspin Serve	02.58	0.12		
5	Shoulder Extension Angle during Arm Acceleration Phase (SEAN)	Jump Float Serve	02.93	0.10	0.01	0.56
		Jump Topspin Serve	02.93	0.09		
6	Elbow Extension Angle during Arm Acceleration Phase (EEAN)	Jump Float Serve	01.64	0.26	0.18	0.90
		Jump Topspin Serve	01.82	0.25		
7	Serve Spike Height during Arm Acceleration Phase (SSHN)	Jump Float Serve	280.24	14.76	41.24	0.31
		Jump Topspin Serve	321.48	42.70		

Level of significant set at 0.05.

In table 02, the selected kinematic parameters were showed during Arm Cocking & Arm Acceleration Phase, and two different serve i.e. Jump Float Serve and Jump Topspin Serve. The kinematic parameters: Elbow Extension Angle during Arm Cocking Phase (EEAC), mean & SD of jump float serve 01.32±0.32, jump top spin 01.10±0.15 where P-Value was 0.00. EEAC variable showed significant difference at 0.05 level of significance. Max Height Gain of Toss Ball during Arm Cocking Phase (MHTC), mean & SD of jump float serve 312.00±47.11, jump top spin 654.66±126.40 where P-Value was 0.00. MHTC variable showed significant difference at 0.05 level of significance. Shoulder Extension Angle during Arm Cocking Phase (SEAC), mean & SD of jump float serve 02.00±0.17, jump topspin serve 01.88±0.15 where P-Value was 0.79. SEAC variable showed insignificant difference at 0.05 level of significance. Angle of Body Arc during Arm Cocking Phase (ABA), mean & SD of jump float serve 02.72±0.15, jump top spin 02.58±0.12 where P-Value was 0.48. ABA variable showed insignificant difference at 0.05 level of significance. Shoulder Extension Angle during Arm Acceleration Phase (SEAN), mean & SD of jump float serve 02.93±0.10, jump top spin 02.93±0.09 where P-Value was 0.56. SEAN variable showed insignificant difference at 0.05 level of significance. Elbow Extension Angle during Arm Acceleration Phase (EEAN), mean & SD of jump float serve 01.64±0.26, jump top spin 01.82±0.25 where P-Value was 0.90. EEAN variable showed insignificant difference at 0.05 level of significance. Serve Spike Height during Arm Acceleration Phase (SSHN), mean & SD of jump float serve 280.24±14.76, jump top spin 321.48±42.70 where P-Value was 0.31. SSHN variable showed insignificant difference at 0.05 level of significance.

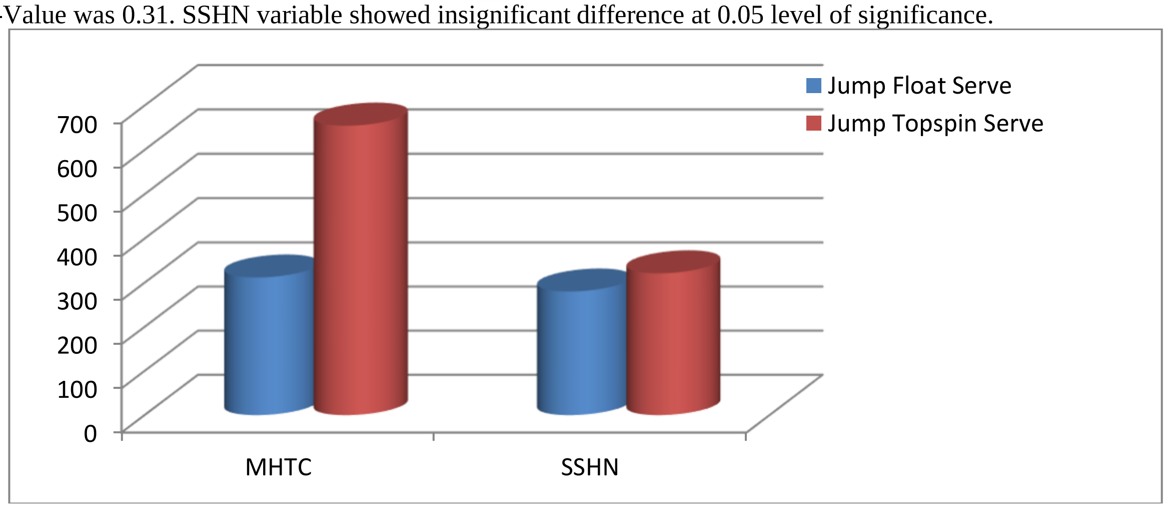

Figure 3: Illustration showing the Spatio-temporal variables: MHTC and SSHN of mean values of Jump Float Serve and Jump Topspin Serve during Arm Cocking & Arm Acceleration Phase (Height in cm).

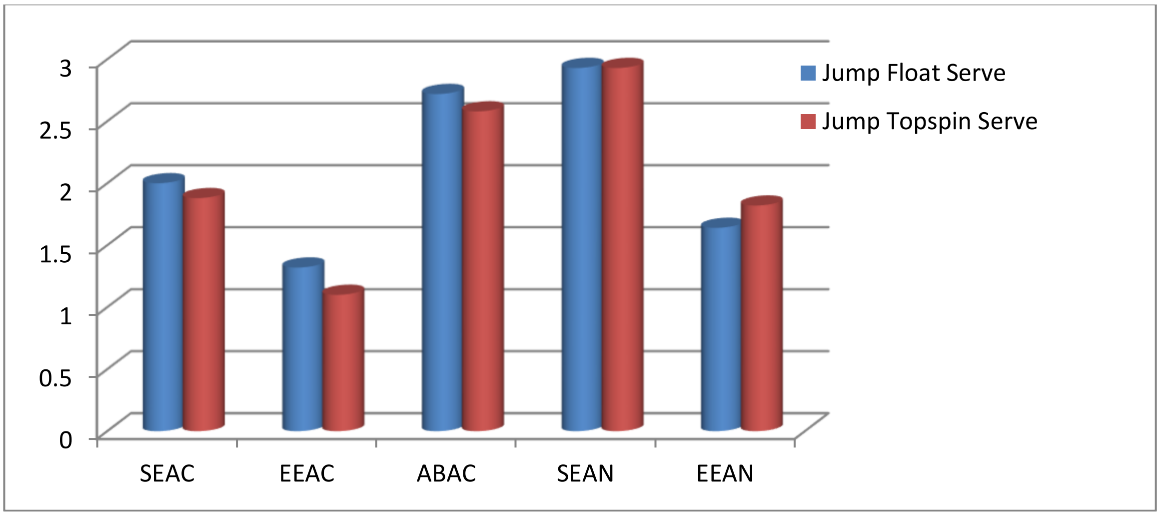

Figure 4: Illustration showing the Angle of joints variables: SEAC, EEAC, ABAC, SEAN, and EEAN of mean values of Jump Float Serve and Jump Topspin Serve during Arm Cocking & Arm Acceleration Phase (angle in radian).

Table 03: The statistical analysis of the selected kinematic variables of volleyball serve between jump float serve and jump topspin serve during Follow through phase.

S.No.	Variables	Type of Serve	Mean	SD	Mean Difference	P-value
1	Ball Velocity during Follow Through Phase (BVF)	Jump Float Serve	16.83	2.54	5.17	0.82
		Jump Topspin Serve	22.00	2.17		
2	Angle of Release the Ball during Follow Through Phase (ARBF)	Jump Float Serve	0.19	0.06	0.04	**0.04***
		Jump Topspin Serve	0.16	0.02		

Level of significant set at 0.05.

In table 03, the selected kinematic parameters were showed during Follow Through Phase of two different serve i.e. Jump Float Serve and Jump Topspin Serve: parameters such as Ball Velocity during Follow Through Phase (BVF), mean & SD of jump float serve 16.83±2.54, jump topspin serve 22.00±2.17 where P-Value was 0.82. BVF variable showed insignificant difference at 0.05 level of significance. Angle of Release the Ball during Follow Through Phase (ARBF), mean & SD of jump float serve 16.83±2.54, jump topspin serve 22.00±2.17 where P-Value was 0.04. ARBF variable showed significant difference at level of significance.

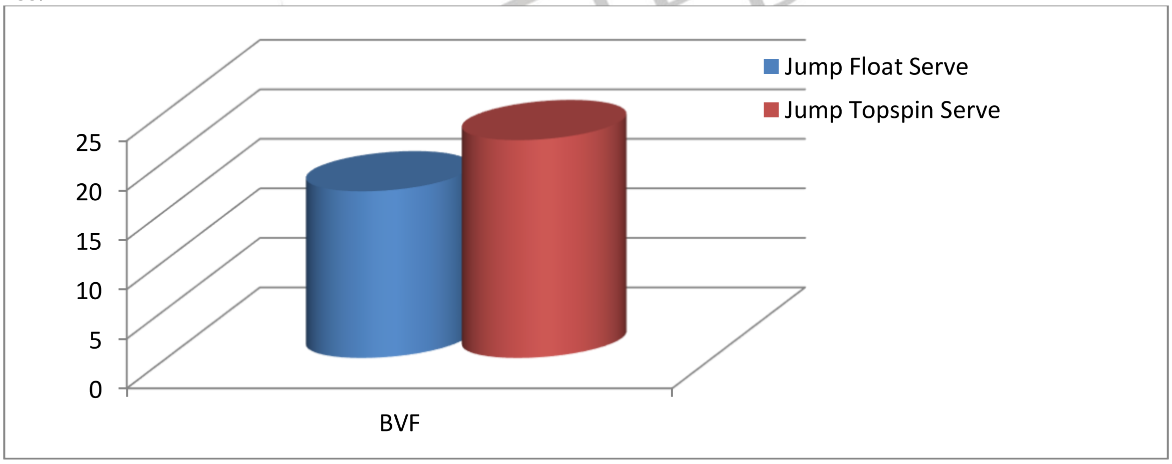

Figure 5: Illustration showing the Linear velocity variable: BVF of mean values of Jump Float Serve and Jump Topspin Serve during Follow Through Phase (velocity in meter/s).

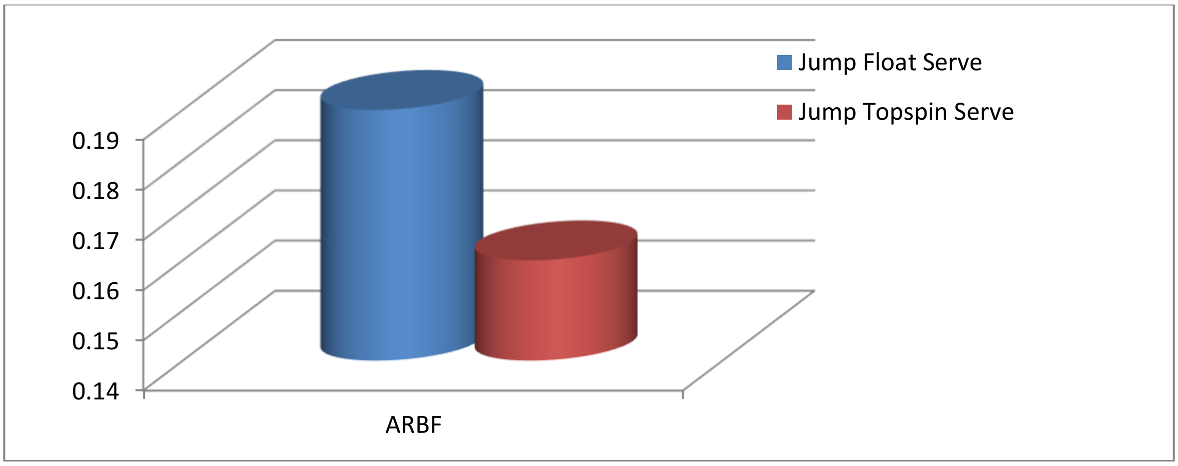

Figure 6: Illustration showing the Angle of joint variable: BVF of mean values of Jump Float Serve and Jump Topspin Serve during Follow Through Phase (angle in radian).

IV. DISCUSSION

The main objective of this research was to analysis the spatio-temporal analysis of volleyball serve variation as jump float serve and jump topspin serve. EEAC variable showed significant different between jump float and jump topspin serve. Similar study was conducted by Singh & Rathore, 2102 and found that elbow joint has significant relationship during hitting the ball. Coleman, 1997 have study on volleyball jump serve and found that elbow and humerus extention were significant factors while jump serve action. MHTC variable showed significant different between jump float and jump topspin serve. On the basis of theory of volleyball jump serve, justified MHT variable that there are biomechanical performance enhancing benefits in regards to the distance of the ball toss, as it provides the server with time, whilst the ball is in flight to generate horizontal velocity through the run up (Tilp, Wagner, & Müller, 2008). By analyzing player movements throughout the entire skill, we can see that by throwing the ball out of the hitting hand players have a greater range of motion in regards to their hitting arm and trunk position, meaning they are able to create a longer lever arm, thus generating greater velocity for the hit (Tant & Witte 1991). ARBF showed significant different between jump float and jump topspin serve. On the basis of theory of volleyball serve justified about angle of release, In throwing or hilling skill games, 45 degree is appropriate angle to achieve maximum distance. Sports in which height or flight time is important have a higher angle of release (Lincham, 2005). When serving overhead in volleyball a taller athlete has advance over a shorter athlete because they have a higher height of release. The taller athlete is able to get over the ball and have a lower angle of release in comparison to a shorter athlete (Martin, 2006).

V. CONCLUSION

In conclusion, both types of serve act as a similar in terms of biomechanical characteristics of spatio-temporal analysis of volleyball serve. But the major variables: EEAC, MHTC and ARBF variables showed significant difference with each other. Our study advises to coaches, trainers and physical educationist to look into these significant variables which have potential to affect the volleyball serve and enhance the performances of the volleyball players.

VI. ACKNOWLEDGMENT

I feel honor to express my heartiest gratitude to coaches, Mr. Mithlesh Kumar Singh (ONGC, Team Manager, Dehradun), Mr. Rajesh Kumar, (Volleyball Coach, Kurukshetra University, Kurukshetra), Mr. Naresh Kumar (Volleyball Coach, Karan Stadium, Karnal), Mr. Mohd. Shafeeque (Volleyball Coach, SAI Training Centre, Mastuana Sahib, Sangrur) and also acknowledge from core of my heart to all volleyball players for the kind cooperation and support during data collection for this research paper.

VII. REFERENCES

[1] Coleman, S. G. (1997). A three dimension kinematics analysis of the volleyball jump serve. University of Edinburgh, Scotland, UK, www.sportsscience.com

[2] Charalabos, I., Savvas, L., Sophia, P., Theodoros, I., (2013). Biomechanical differences between jump topspin serve and jump float serve of elite Greek female volleyball players. Romanian Sports Medicine Society, Medicina Sportiva, vol. IX, no 2, 2083-2086.

[3] Enoka, R. M. (1971). The effect of different lengths of run-up on the height to which a spiker in volleyball can reach. New Zealand journal of health, physical education and recreation 4(3):5-15.

[4] FIVB. (n.d.-a). The Game - Volleyball - Service. Retrieved October 2, 2013, from http://www.fivb.org/TheGame/TheGame_Volleyball.htm

[5] Huang, C., & Hu, L. H. (2007). Kinematic analysis of volleyball jump top spin and float serve. In H. J. Menzel, & M. H. Chages (Eds.), XXV International Symposium on Biomechanics in Sports (pp. 333–336). Ouro Preto – Brazil.

[6] Hussain, I., Khan, A., and Mohammad, A. (2011). A comparison of selected biomechanical parameters of spike serves between intervarsity and intercollegiate volleyball players. journal of education and practice 2(2): 18-24.
[7] Hussain, I., Khan, A., Mohammad, A., (2012). A kinematics comparison of tennis service in volleyball between interuniversity and inter collegiate male volleyball players. Academic sports scholar, vol. 1, issue. 10, 01-04.
[8] Hussain, I., Mohammad, A. and Khan, A. (2011). Kinematic factors and volleyball spike jump performance of two different level male volleyball players. Proceeding of national seminar on scientific support in sport, dept. of physical health and sports education, Aligarh Muslim University, Aligarh, India, on January 30-31, 2011.
[9] Hussain, I., Mohammad, A., Khan, A., (2013). Videographical analysis of arm swing on spike jump performances of two different functional classes' volleyball players. European acedimic research, vol. 1, issue 6, 1035-1047.
[10] Kenny, B., & Gregory, C. (2006). Volleyball: Steps to success. Campaign, IL: Human Kinetics.
[11] Lee, K. T., & Chin, S. T. (2004). Strategies to serve or receive the service in volleyball. Mathematical methods of operations research, 59(1), 53–67.
[12] Matias, C. J. A., & Greco, P. J. (2011). De Morgan ao voleibol moderno: o sucesso do Brasil e a relevância do levantador [From Morgan to modern volleyball: The success of Brazil and the relevance of the setter]. Revista Mackenzie de Educação Física e Esporte, 10(2), 49- 63.
[13] Singh, A.B., & Rathore, V.S., (2012). Relationship between linear and angular kinematics with jump serve in volleyball. Golden research thoughts, vol. 1, issue. 12, 1-4.
[14] Singh, P., Pharswan, A. & Singh, V. (2016). Analysis of selected kinematic variables with the performance of volleyball players in float serve. International journal of multidisciplinary research and development, online ISSN: 2349-4182, print ISSN: 2349-5979, volume 3, issue 3, 29-32.
[15] Tillman, M. D., Haas, C. J., Brunt, D., & Bennett, G. R. (2004). Jumping and landing techniques in elite women's volleyball. Journal of Sports Science and Medicine 3(1):30-36.
[16] Young, W., (2015). The Volleyball Jump Serve – A Biomechanical Analysis. Unpublished journal. https://biomechanicsofthevolleyballserve.wordpress.com/2015/06/18/hello-world/
[17] https://www.google.com/search?q=Tips_on_Serving_in_VB&rlz=1C1CHBD_enIN853IN853&oq=Tips_on_Serving_in_VB&aqs=chrome..69i57.1474j0j7&sourceid=chrome&ie=UTF-8 [online asses date 2/24/2018 11:58 AM]
[18] https://prezi.com/bq7qfdepzgl5/projectile-motion/ [online asses date 7/15/2019 04:09 AM]