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MULTILINEAR REGRESSION MODEL OF JUMP SERVE IN U-23 MEN'S VOLLEYBALL

ALI AZEEZ ANEED AL-MUJBILEE[1], MOHD ARSHAD BARI[1]*, ARIF MOHAMMAD[2]

[1]*Department of Physical Education, Aligarh Muslim University, Aligarh, INDIA.*
[2]*Department of Teacher Training and Non-formal Education, Jamia Millia Islamia, New Delhi, INDIA.*
***Email:** arshadbari.bari@gmail.com*

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ABSTRACT

The main goal of this study was to look into the fundamentals of the jump volleyball serve technique that contribute to higher levels of performance, as well as to identify the major kinematic parameters of the jump serve that influence the outcome of the volleyball serve, such as how it's played and how selected independent kinematic variables affect the ball velocity. Biomechanical evaluation and kinematics investigation were completed on Indian National Male volleyball players. Analysis of work based on the collected data of volleyball players (U-23 men). Ten (10) male volleyball players (U-23) from the district of Aligarh, U.P., India, participated in this study. The subject's volleyball serves were recorded using three synchronized Nikon D-7000 video cameras in a field setting. Each volleyball player completed three jump service trials. Out of the three, the best service was chosen for further kinematics analysis with motion analysis software. Variables considered for serve were height, weight, age, shoulder extension angle and elbow extension angle at cocking phase, maximum elbow extension and maximum shoulder extension at acceleration phase, maximum elbow extension angular velocity, maximum shoulder internal rotation/flexion angular velocity, wrist, shoulder and elbow angles and wrist angular velocity at ball contact phase, spike height, takeoff to line distance, approach distance, approach velocity, height of C.G. and ball velocity. The established regression model with the outcome variable of serving ball velocity was subjected to multiple regression analysis. The results of this study demonstrate that the chosen model is quite significant.
***Keywords:** Biomechanics, kinematics, jump serve, multilinear regression model.*

1. INTRODUCTION

In a game of volleyball, service can be considered the first offensive action of each rally (Depra, Brenzikofer, Goes, & Barros, 1998). Serve is the only skill which is performed by a player entirely individually. Furthermore, there is no requirment of any cooperation by other team members to perform a service, as well as this skill is not impeded by the opposing team to any extent. Thus the player who is going to serve have the options to choose the type of serve he/she is going to use, where he/she want to direct the serve, and how much force they want to apply in the volleyball (López-Martinez, & Palao, 2009). In top level volleyball competitions men prefer to use three types of serve which are - power jump serve, jump float serve and standing float serve (Benerink, Bootsma, & Zaal, 2015; Moras et al., 2008; Palao, Santos, & Ureña, 2004). Statistical studies in the field documented that from 1990s onwards

Correspondence: Mohd Arshad Bari (Ph.D.), Assistant Professor, Department of Physical Education, Aligarh Muslim University, Aligarh, Uttar Pradesh, INDIA, Email: arshadbari.bari@gmail.com

the sharing percentage of jump serve remarkably increased in top level volleyball competitions (Agelonidis, 2004).

At international level volleyball competitions serve strategies are planned considering the strategies of block and defence of opponent team. As reported by Papageorgiou and Spitzley (2003) that one of the aims of serve is to facilitate our own players to come-up with double block and, thus, resulting to increase the chances to play the ball up in defence. One of the advantage of good and appropriate serve is to withhold the opposing team the chances to use the first tempo and attack (Fellingham, Hinkle, & Hunter, 2013; Zetou, Moustakidis, Tsigilis, & Komninakidou, 2007). Wise (2002) in her book writes that “serve is the first element of defence, as a good serve drives the opposing team further from the net, and this facilitates better organisation of block and defence”. Technically, a combination of good serve with strong line of blocking and defence makes it difficult for opposing team to score a point in volleyball (López, 2013).

Just scoring a point is not only objective of serve (Quiroga et al., 2010), Marelic and co-authors (2005) studied in this line to know how many points a team can achieve in each set using a certain element of the game in order to win a set. Their study revealed that 1.6 points per set can be earned directly from serves (Marelić, Rešetar, Zadražnik, & Đurković, 2005). In addition to gain a point from serve, a good serve can distrubt the reception abilitity of opposing team and giving them fewer choices to attack (Quiroga et al., 2010). When the oppoents have difficulties in serve reception, their chances to win the match are lesser (Patsiaouras, Moustakidis, Charitonidis, & Kokaridas, 2011). A good serve has a strong correlation with scoring of points which results winning of the matches (Silva, Lacerda, & João, 2014).

Studies in the field of biomechanics, pyschology and anthtopomentry related with serve, stated that many biomechanical, anthropometrical and psychological factors affect the speed, direction, and distance of the ball’s flight. Further, these studies releaved that, these factors are deep and will achieve success if they are applied appropriately (Mohammadi & Malek, 2012). Thus, without proper techniques and time, the opponent can not work effectively.

As the primary goal is to have to be an ace or score for the team and to make it as difficult as possible for the opposing team. Four primary features of the service team determine the level of difficulty presented now: ball speed, flight time, trajectory prediction (the amount of random movement in the flight path) (Kunstlinger, Ludwig, & Stegemann, 1987). It is a service-determining goal, similar to attacking and blocking, and can have a significant impact on the team’s performance of service are scored immediately, a point that is not only important, but rather, the effect of the service on the game’s subsequent development. Thus, it has been observed that good service (performance power or execution of a strategic intent), reception performance and the opposite side of the offending option. First reducing tempo attacks and increasing the second tempo attacks. This effect, blocking the performance of the service options of the attack, leads to an increase in triple blocks, which will facilitate the defense.

Volleyball games are now organized recreationally as well as a competitive sport for individuals of all ages and all sexes. Service is found a critical feature for game performance in volleyball, and several studies have been conducted to determine the specific characteristics of service and their effects on the opposing team. To this end, specific variables of service have been analyzed, such as service sector (Travlosa, 2010), direction of service (Marcellino et al., 2011), type of service (Costa et al., 2012), in-game role of the server (Afonsoa et al., 2012) & even some more kinematics/kinetic type variables such as service speed or situational variables, such as set number and moment in set when the service is executed (Marcelinoa et al., 2012). The main goal of this study is to analyze and understand several facets of volleyball serve, including how it is played, how its ball velocity effected by independent selected kinematics variables, inconsistencies in performances and the established regression model with the outcome variable of serve ball velocity was subjected to multiple regression analysis.

2. METHODS AND MATERIALS

2.1 Participants of the Study

A total of ten (10) male volleyball players below the age of 23 years were selected as subjects for this study. Their level of participations was - All India, Zonal Intervarsity, Inter Collegiate, and State volleyball championships. The mean (SD) values of their age, height and weight were - 22.20 years (± 0.41), 182.60 cm (± 4.00), and 80.70 kg (± 07.46), respectively. All these recruited volleyball players were belonging to District Aligarh of India. They all have more than 8 years of playing experience, and do not have any injury from last 6 months on the date of data collection. An informed consent was signed by each participant prior to data collection.

2.2 Variables

The selection of variables for jump serve were finalized after the review of the related literature and discussion with subject experts. Along with height, weight, and age, the other variables considered for serve were - shoulder extension angle and elbow extension angle at cocking phase; maximum elbow extension and maximum shoulder extension at acceleration phase; maximum elbow extension angular velocity, maximum shoulder internal rotation/flexion angular velocity, wrist, shoulder and elbow angles and wrist angular velocity at ball contact phase; spike height, takeoff to line distance, approach distance, approach velocity, height of C.G. and ball velocity.

2.3 Video-graphic Equipment and Filed Settings

The subject's volleyball serves were recorded using three synchronized Nikon D-7000 video cameras (Nikon Corporation, Thailand). Cameras were mounted on a rigid tripod and bolted to the location's surface. To ensure the greatest possible precision in reconstructing the two-dimensional coordinates, the cameras' locations were selected such that their optical axes intersected perpendicularly on both planes, respectively the sagittal plane and the frontal plane as shown in the Figure 1.

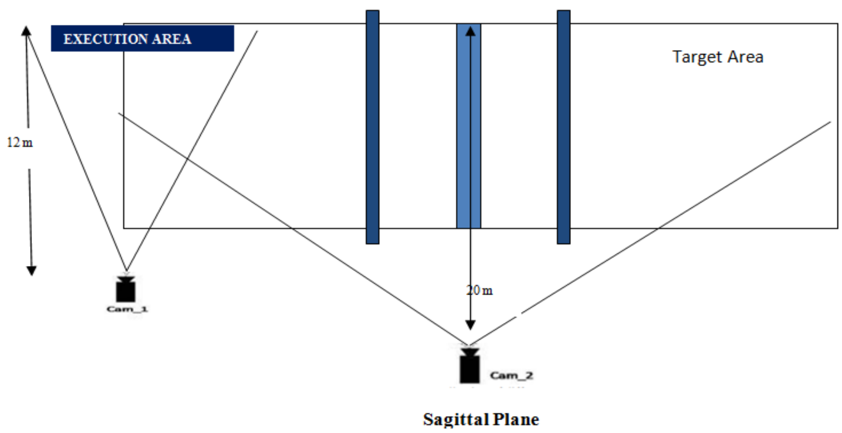

Figure 1: Field setting

2.4 Filming Procedure

The film recording was conducted after the subject's preparation i.e. after a complete warm-up. To perform volleyball service as per the study's requirements, all subjects are instructed to wear specified kit (tight-fitting spandex/shorts). After all field settings and preparation, the subjects were asked to perform three trails and these trials were recorded for analyses purpose. A calibration wand (1.21 meter) was used for all subjects during the data collection. During the film analysis, specific video fields were selected.

2.5 Data Reduction and Statistical Analysis

Out of three trials, one of the best trial was selected for the analyses. The identified trails were played with the help of Siliconcoach Pro8 (The Tarn Group, Dunedin, New Zealand) software to make separate clips of each player for separate volleyball serve. This software provides to identify the angles, velocity (linear and angular), ball velocity, and number of frames. Each clip was played in the software and its digitization was done based on the pre-determined variables.

As far as statistical analysis was consider obtained data was entered in the SPSS v.23 (IBM) and multiple linear regression analysis was performed. Results are presented in the following head.

3. RESULTS AND DISCUSSION

The main purpose of this investigation was to find out the jump serve regression model for U-23 men's volleyball players based on the biomechanical variables of jump serve. Following are the results of the analysis.

3.1 A description of the multiple linear regression analysis of U-23 men's volleyball players' jump serve

Multiple linear regression analysis was used in this case. Three (03) regression models were created and the associated R-square (R^2) values were determined.

Table 1: Summary of regression models (U-23 Men's volleyball players' jump serve)

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
1	0.99[a]	0.99	0.99	0.38
2	1.00[b]	0.99	0.99	0.30
3	0.99[c]	1.00	1.00	0.21

a. Predictors: (Constant), approach velocity
b. Predictors: (Constant), approach velocity (AV), shoulder extension angles at cocking phase
c. Predictors: (Constant), approach velocity (AV), shoulder extension angles at cocking phase, height of C.G.
d. Dependent Variable: Ball velocity

Model 1, which incorporates only one parameter (approach velocity), predicts velocity with R square of 0.99, indicating that the variables account for 99 percent of the difference in velocity of volleyball; whereas, Model 2, which incorporates two parameters (approach velocity, shoulder extension angles at cocking phase), predicts velocity with a R square of 0.99, indicating that the variables account for 99 percent of the difference in velocity of volleyball; and the Model 3, which incorporates three parameters (approach velocity, shoulder extension angles at cocking phase, height of C.G.), predicts velocity with an R square of 1.00, indicating that the variables account for 100 percent of the difference in velocity of volleyball.

Table 2: Significance of the regression model (U-23 Men's volleyball players' jump serve)

ANOVA[a]						
		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Model 1	Regression	94.96	1	94.96	664.51*	0.00[b]
	Residual	1.14	8	0.14		
	Total	96.10	9			
Model 2	Regression	95.47	2	47.73	526.58*	0.00[c]
	Residual	0.64	7	0.09		
	Total	96.10	9			
Model 3	Regression	95.83	3	31.94	713.20*	0.00[d]
	Residual	0.27	6	0.05		
	Total	96.10	9			

a. Dependent Variable: ball velocity
b. Predictors: (Constant), approach velocity
c. Predictors: (Constant), approach velocity, shoulder extension angles at cocking phase
d. Predictors: (Constant), approach velocity, shoulder extension angles at cocking phase, height of C.G.
*p<0.05

The regression equation based on Model 1 is significant (F=664.51, p=0.00, p<0.05), as seen in Table 2. The velocity of volleyball can be estimated/predicted by using the approach velocity. The regression equation based on Model 2 is also significant (F= 526.58, p =0.00, p < 0.05). Here, as result revealed, the velocity of volleyball can be estimated/predicted by using the approach velocity, shoulder extension angles at cocking phase. The regression equation based on Model 3 is also significant (F= 713.20, p =0.00, p < 0.05), as the result, the velocity of volleyball can be estimated/predicted by using the approach velocity, shoulder extension angles at cocking phase, height of C.G.

Table 4: Coefficients of the regression model (U-23 Men's volleyball players' jump serve)

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	*t*	*Sig.*
Model 1	(Constant)	-5.20	1.09		-4.77	0.00
	Approach Velocity	9.89	0.38	0.99	25.78	0.00
Model 2	(Constant)	-5.10	0.87		-5.87	0.00
	Approach Velocity	10.18	0.33	1.02	30.92	0.00
	Shoulder extension angles at cocking phase	-0.34	0.14	-0.08	-2.37	0.03
Model 3	(Constant)	2.32	2.66		0.87	0.41
	Approach velocity	10.48	0.26	1.05	41.15	0.00
	Shoulder extension angles at cocking phase	-0.54	0.12	-0.13	-4.40	0.01
	Height of C.G.	-4.49	1.57	-0.08	-2.86	0.03

a. Dependent variable ball velocity

The Regression equation is estimated on the basis of the above mentioned table as following.

Model -1. *Ball velocity= (9.89) approach velocity – 5.20*
Here, the approach velocity coefficient was found statistically significant using with (p= 0.00, p<0.05).
Model -2. *Ball velocity= (10.18) approach velocity + (– 0.34) shoulder extension angles at cocking phase – 5.10*

Here, the approach velocity and shoulder extension angles at cocking phase coefficient were found statistically significant using with (p= 0.00, and p= 0.03, p<0.05).

1. Ball velocity has a positive effect with approach velocity, when shoulder extension angles at cocking phase is kept constant.
2. Ball velocity has a negative effect with shoulder extension angles at cocking phase, when approach velocity is kept constant.

Model -3. *Ball velocity= (10.48) approach velocity + (-0.54) shoulder extension angles at cocking phase + (-4.49) height of C.G. + 2.32*

Here, the approach velocity and shoulder extension angles at cocking phase and height of C.G. coefficient were found statistically significant using with (p= 0.00, and p= 0.03, p=0.03 p<0.05).

1. Ball velocity has a positive effect with approach velocity, when shoulder extension angles at cocking phase and height of C.G. are kept constant.
2. Ball velocity has a negative effect with shoulder extension angles at cocking phase when, approach velocity and height of C.G are kept constant.
3. Ball velocity has a negative effect with height of C.G, when approach velocity and shoulder extension angles at cocking phase are kept constant.

For the jump serves of U-23 men volleyball players, multiple linear regression analysis was utilized to generate regression modules. The corresponding R-square (R2) values for three (03) regression models were computed. Approach velocity, shoulder extension angles during cocking phase, and height of C.G. were incorporated into a stepwise multiple regression model out of 14 kinematic variables.

To estimate the ball velocity during jump service of U-23 men's volleyball players, the best fit model was chosen as ball velocity = (10.48) approach velocity + (-0.54) shoulder extension angles at the cocking phase + (-4.49) height of C.G. + 2.32. The approach velocity and shoulder extension angles during the cocking phase, as well as the height of the C.G., are all shown here. The coefficients were found to be statistically significant (p = 0.00 and p = 0.03, respectively, p=0.03).

When shoulder extension angles at cocking phase and height of C.G. were kept constant, ball velocity had a positive effect on approach velocity, a negative effect height of C.G. when approach velocity and shoulder extension angles at cocking phase were kept constant, and a negative effect height of C.G. when approach velocity and shoulder extension angles at cocking phase were kept constant. At the 0.05 level of significance, the models were found to be statistically significant. Model 3, which includes three independent variables (approach velocity, shoulder extension angles during the cocking process, and C.G. height), predicted ball velocity with an R-square of 1.00, indicating that the chosen independent variable caused a 100% difference in ball velocity when compared to Models 1 and 2.

3.2 Selection of the appropriate model of regression

The study's findings revealed that Models-1, Model-2, and Model-3 were statistically significant at the 0.05 level of significance. Model-3, which includes three independent variables (approach velocity, shoulder extension angles during the cocking phase, and C.G. height), predicted velocity with an R-square of 1.00, indicating that the selected independent variable caused 100% variation in ball velocity, whereas Models 1 and 2 showed 99% variation in ball velocity, respectively.

3.3 Jump serve regression model for U-23 Men's Volleyball players: Model-03

Ball velocity= (10.48) approach velocity + (-0.54) shoulder extension angles at cocking phase + (-4.49) height of C.G. + 2.32

4. CONCLUSION

The study's findings Jump serve regression model for U-23 men's volleyball players includes three independent variables (approach velocity, shoulder extension angles during the cocking phase, and C.G. height), predicted velocity with an R-square of 1.00, indicating that the selected independent variable caused 100% variation in ball velocity.

Ball velocity= (10.48) approach velocity + (-0.54) shoulder extension angles at cocking phase + (-4.49) height of C.G. + 2.32

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