ANALYSIS OF SELECTED PHYSICAL AND PHYSIOLOGICAL VARIABLES HIGHLY CORRELATED WITH PLAYING ABILITY OF INTER-COLLEGIATE LEVEL VOLLEYBALL PLAYERS

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Abstract

The intension of the study was to investigate the selected physical and physiological variables highly correlated with playing ability of inter-collegiate level volleyball players. To attain this aim, the investigator selected one hundred ninety two inter-collegiate level Anna University volleyball players as subjects. Random group design was used for this investigation, as it is considered most suitable. The age of the selected subjects ranged from eighteen to twenty five years. In this study one criterion (volleyball playing ability) and nine determinant variables are included. Pearson product moment correlation was utilized to verify the association between criterion (volleyball playing ability) and determinant variables. The relationship between criterion and determinant variables as well as inter-correlations among determinant variables was calculated by using Pearson product-moment correlation formula. To test the hypothesis 0.05 level of confidence was fixed. The selected physical fitness and physiological variables such as muscular endurance, explosive power, VO_2 max, vital capacity, anaerobic power, agility and speed of the volleyball players were highly correlated with playing ability of inter-collegiate level Anna university volleyball players.

Keywords: *Physical Fitness, Physiological and Volleyball players*

INTRODUCTION

Volleyball is a dynamic and intermittent team sport consisting of fast and short displacement movements, in which the speed, jumping and changes of direction are an integral part of the demands of the game. These demands require well-developed physical conditioning as they are necessary to succeed during volleyball competitions, although the requirements may vary depending on the level of competition of the athletes **(Sheppard et al., 2009)**. Therefore, the capacity of athletes to acquire and maintain well-developed physical performance variables before and during the competition season is crucial for optimal performance. Athletes aim to further improve or at least maintain the physical performance characteristics developed in the preparation period throughout the competition season **(Ferioli et al., 2018; Marques et al., 2008)**. Nevertheless, increased match load and prolonged rallies can induce significant degradation in the physical performance characteristics of the players by increasing both physiological and psychological stresses that trigger fatigue **(Haneishi et al, 2007)**.

The study of physiological areas has been an important part of knowledge that helps to learn about the special characteristics of a wide variety of sports. In this way, it is necessary to distinguish the real physiological work areas to develop correct and specific sport training. For this reason, not only in beach volleyball, but also in other sports, like boxing (**Alvarez et al., 2014; Pascual et al., 2015**) , there are studies that establish work areas. On one hand, there is evidence, that internal load patterns in different sports are related to the quantity of volumes and intensities found during training or actual game situations and that they improve the performance of players (**Gonzalez et al., 2016**). On the other hand, there are few studies related to the physiological response in beach volleyball players. Due to the interest of researchers working in these areas different studies have been conducted to establish physiological responses (**Davies, 2000; Lorenz et al., 2002**). A study on the impact analysis and neuromuscular factors in beach volleyball games, in the recovery of players has also been published (**Magalhaes etal., 2011**). These physiological responses have a direct relationship with different factors such as the rules of the game (**Giatsis, 2003**), the field, the number of players and the environmental conditions (**Palao et al., 2014**). Another factor influencing the physiological response is the role that the player adopts and that sets the pattern of the tactical game (**Seweryniak et al., 2013**). The present study mainly focuses on selected physical fitness and physiological variables. As far as the performance of volleyball team is concerned, above said variables are vital. The researcher reviewed number of journals, books, e-resources, unpublished thesis, dissertations and coaching manuals in which it was observed that the standard skills of volleyball players are based on these selected physical fitness and physiological variables. Based on these observations, the investigator selected this investigation.

METHODOLOGY

Selection of Subject

The study under investigation was intended to identify the factors influencing the playing ability of inter collegiate volleyball players from selected physical and physiological variables. To achieve the purpose of the study investigator, selected one hundred and ninety two intercollegiate level men volleyball players from different colleges in Tamilnadu state, India. The subjects were in the age group of 18 – 25 years and were selected from those teams that entered the pre quarter final in the inter zonal intercollegiate tournaments held at Paavai engineering college of Anna university in the year 2019-2020.

Selection of Variables

Criterion Variable: The subjective rating of the experts, who were designated to evaluate the volleyball playing ability of the selected subjects.

Physical Fitness Variables: The following physical fitness variables namely speed, agility, flexibility, explosive power and muscular endurance were selected.

Physiological Variables: The following physiological variables namely vital capacity, VO_2 max, anaerobic power and resting pulse rate were selected.

Collection of Data

The playing ability of the subjects was assessed by judges rating and the selected physical fitness and physiological variables were measured through standard test and measurements.

Statistical Techniques

In this study one criterion (volleyball playing ability) and nine determinant variables are included. Pearson product moment correlation was utilized to verify the association between criterion (volleyball playing ability) and determinant variables. The relationship between criterion and determinant variables as well as inter-correlations among determinant variables was calculated by using Pearson product-moment correlation formula. To test the hypothesis 0.05 level of confidence was fixed.

Result

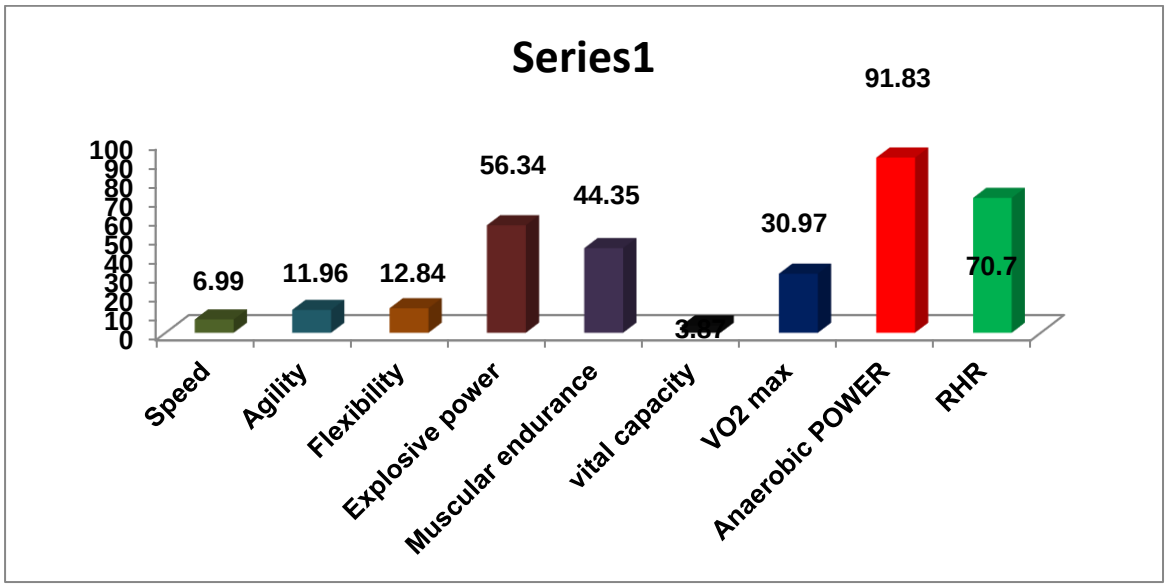
The range, minimum, maximum, mean and standard deviation values on selected physical fitness, physiological and playing ability of volleyball players are in presented table-I.

Table I

S. No	Variables	N	Range	Min	Max	Mean	SD
1	Playing Ability	192	09	70	79	73.62	2.07
2	Speed	192	1.41	6.19	7.6	6.99	0.35
3	Agility	192	2.58	11.04	13.62	11.96	0.66
4	Flexibility	192	07	11	18	12.84	1.99
5	Explosive Power	192	16	49	65	56.34	4.58
6	Muscular Endurance	192	23	32	55	44.35	5.98
7	Vital Capacity	192	1.07	3.29	4.36	3.87	0.28
8	VO_2 max	192	12.52	26.04	38.56	30.97	3.11
9	Anaerobic Power	192	15	83	98	91.83	3.35
10	Resting Pulse Rate	192	04	68	72	70.70	1.18

The obtained mean and standard deviation values on playing ability and selected physical fitness and physiological variables of playing ability (73.62 ± 2.07), speed (6.99 ± 0.35), agility (11.96 ± 0.66), flexibility (12.84 ± 1.99), explosive power (56.34 ± 4.58), and muscular endurance (44.35 ± 5.98), vital capacity (3.87 ± 0.28), VO_2 max (30.97 ± 3.11), anaerobic power (91.83 ± 3.35) and resting pulse rate (70.70 ± 1.18) of the inter-collegiate volleyball players were calculated and it is graphically displayed in figure-I.

Figure – I: Diagram Showing the Mean Value on Playing Ability and Selected Physical Fitness and physiological Variables of Volleyball Players



To determine the relationship between criterion and determinant variables and also to find out the interrelationship between the determinant variables Pearson product moment correlation was used and the obtained results are given in table-II.

Table –II: Inter Correlation Matrix

	VPA	SP	AG	FLX	EXP	ME	VC	VO2	AP	RPR
VPA		.157*	-.408**	.721**	.835**	.860**	.735**	.575**	.384**	-.617**
SP			-.329**	.120	.121	.087	.055	.006	-.003	-.063
AG				-.576**	-.535**	-.529**	-.558**	-.520**	-.131	.469**
FLX					.824**	.887**	.984**	.947**	.116	-.854**
EXP						.854**	.839**	.741**	.270**	-.736**
ME							.900**	.794**	.251**	-.743**
VC								.948**	.119	-.875**
VO2									-.014	-.853**
ANP										.012
RPR										

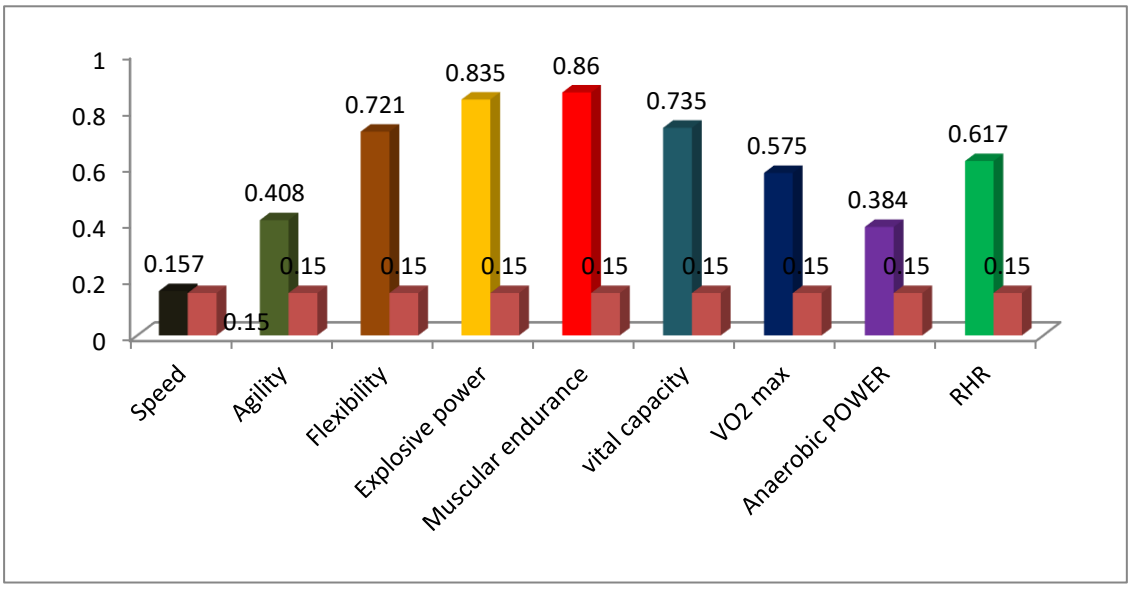
**The required table 'r' value is 0.15 at 0.05 level of confidence.*

Table –III: Abbreviations

VPA	Volleyball Playing Ability	ME	Muscular Endurance
SP	Speed	VC	Vital Capacity
AG	Agility	VO2	VO2 max
FLX	Flexibility	ANP	Anaerobic Power
EXP	Explosive Power	RPR	Resting Pulse Rate

The correlation analysis proved that the selected determinant variables speed (0.157), agility (-0.408), flexibility (0.721), explosive power (0.835), muscular endurance (0.860), vital capacity (0.735), VO2 max (0.575), anaerobic power (0.384) and resting pulse rate (-0.617) were significantly correlated with the volleyball playing ability, because these correlation values are more than the necessary (0.15) value (0.05 level).

Figure-2
Diagram Showing the Correlation Coefficient Values between Volleyball Playing Ability of Physical Fitness and Physiological variables



Analysis of Variance Results

The analysis of variance for the influence of predictor variables on volleyball playing ability among volleyball players is given in table -IV.

Table –IV: Variance for the Influence of Predictor Variables

Model	Sum of Squares	df	Mean Square	F

1	Regression	607.356	1	607.356	540.14
	Residual	213.644	190	1.124	
	Total	821.000	191		
2	Regression	638.049	2	319.025	329.57
	Residual	182.951	189	.968	
	Total	821.000	191		
3	Regression	677.782	3	225.927	296.57
	Residual	143.218	188	.762	
	Total	821.000	191		
4	Regression	682.602	4	170.650	230.58
	Residual	138.398	187	.740	
	Total	821.000	191		
5	Regression	686.139	5	137.228	189.26
	Residual	134.861	186	.725	
	Total	821.000	191		
6	Regression	689.803	6	114.967	162.11
	Residual	131.197	185	.709	
	Total	821.000	191		
7	Regression	693.847	7	99.121	143.43
	Residual	127.153	184	.691	
	Total	821.000	191		

The found 'F' values of 540.14, 329.57, 296.57, 230.58, 189.26, 162.11 and 143.43 are highly significant of (0.05 levels). It established that all chosen determinant variables have collectively influenced the volleyball player's playing ability.

Since the ANOVA 'F' values are very much significant, the computations of multiple regressions were performed. Multiple regression equation was calculated only because the multiple correlations were adequately high to warrant prediction from it. Then, the correlation identified the independent variables to be included and their order in the regression equation.

Multiple correlations were computed by step-wise argument method and the results are presented in table – V.

Table –V: Multiple Correlations

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.860[a]	.740	.738	1.06040
2	.882[b]	.777	.775	.98387
3	.909[c]	.826	.823	.87281

4	.912[d]	.831	.828	.86029
5	.914[e]	.836	.831	.85150
6	.917[f]	.840	.835	.84212
7	.919[g]	.845	.839	.83129
a. Predictors: (Constant), Muscular Endurance				
b. Predictors: (Constant), Muscular Endurance, Explosive power				
c. Predictors: (Constant), Muscular Endurance, Explosive power, VO_2 max				
d. Predictors: (Constant), Muscular Endurance, Explosive power, VO_2 max, Vital capacity				
e. Predictors: (Constant), Muscular Endurance, Explosive power, VO_2 max, Vital capacity, Anaerobic power				
f. Predictors: (Constant), Muscular Endurance, Explosive power, VO_2 max, Vital capacity, Anaerobic power, Agility				
g. Predictors: (Constant), Muscular Endurance, Explosive power, VO_2 max, Vital capacity, Anaerobic power, Agility, Speed				

From Table – V it was found that the multiple correlations co-efficient for predictors, such as muscular endurance, explosive power, VO_2 max, vital capacity, anaerobic power, agility and speed was 0.919 which produce highest multiple correlations with volleyball playing ability. 'R' square values show that the percentage of contribution of predictors to the volleyball playing ability (Dependent variables) is in the following order.

1. About 74.00 % of the variation in the volleyball playing ability was explained by the regression model with one predictor such as muscular endurance.

2. About 77.70 % of the variation in the volleyball playing ability was explained by the regression model with two predictors such as muscular endurance and explosive power. An additional 3.70 % of the variance in the volleyball playing ability was contributed by explosive power.

3. About 82.60 % of the variation in the volleyball playing ability was explained by the regression model with three predictors such as muscular endurance and explosive power and vital capacity. An additional 4.90 % of the variance in the volleyball playing ability was contributed by vital capacity.

4. About 83.10 % of the variation in the volleyball playing ability was explained by the regression model with four predictors such as muscular endurance, explosive power, vital capacity and VO_2 max. An additional 0.50 % of the variance in the volleyball playing ability was contributed by VO_2 max.

5. About 83.60 % of the variation in the volleyball playing ability was explained by the regression model with five predictors such as muscular endurance, explosive power, vital capacity, VO_2 max, and anaerobic power. An additional 0.50 % of the variance in the volleyball playing ability was contributed by anaerobic power.

6. About 84.00 % of the variation in the volleyball playing ability was explained by the regression model with six predictors such as muscular endurance, explosive power, vital capacity, VO_2 max, anaerobic power and agility. An additional 0.40 % of the variance in the volleyball playing ability was contributed by agility.

7. About 84.50 % of the variation in the volleyball playing ability was explained by the regression model with six predictors such as muscular endurance, explosive power, vital capacity, VO_2 max, anaerobic power, agility and speed. An additional 0.50 % of the variance in the volleyball playing ability was contributed by speed

Multiple regression equation was calculated and the obtained results are presented in table – VI.

Table –VI : Multiple Regression Equation

Model		Unstandardized Coefficients		Standardized Coefficients	t
		B	Std. Error	Beta	
1	(Constant)	60.410	.574		105.29
	Muscular Endurance	0.298	.013	.860	23.24
2	(Constant)	55.814	.974		57.27
	Muscular Endurance	0.188	.023	.542	8.20
	Explosive Power	0.168	.030	.372	5.63
3	(Constant)	57.876	.910		63.57
	Muscular Endurance	0.264	.023	.763	11.53
	Explosive Power	0.207	.027	.457	7.64
	VO_2 max	-0.246	.034	-.369	-7.22
4	(Constant)	54.812	1.499		36.57
	Muscular Endurance	0.222	.028	.641	7.94
	Explosive Power	0.186	.028	.411	6.65
	VO_2 max	-0.404	.071	-.607	-5.73
	Vital Capacity	2.846	1.115	.389	2.55
5	(Constant)	51.042	2.262		22.56
	Muscular Endurance	0.214	.028	.617	7.64
	Explosive Power	0.176	.028	.388	6.27
	VO_2 max	-0.360	.073	-.540	-4.94
	Vital Capacity	2.614	1.109	.357	2.35

	Anaerobic Power	0.046	.021	.075	2.20
6	(Constant)	46.588	2.973		15.66
	Muscular Endurance	0.215	.028	.620	7.76
	Explosive Power	0.183	.028	.405	6.57
	VO_2 max	-0.355	.072	-.533	-4.93
	Vital Capacity	2.773	1.099	.379	2.52
	Anaerobic Power	0.048	.021	.078	2.32
	Agility	0.255	.112	.081	2.27
7	(Constant)	41.531	3.604		11.52
	Muscular Endurance	0.215	.027	.619	7.86
	Explosive Power	0.179	.028	.395	6.47
	VO_2 max	-0.329	.072	-.495	-4.59
	Vital Capacity	2.667	1.086	.364	2.45
	Anaerobic Power	0.054	.021	.087	2.62
	Agility	0.357	.118	.114	3.01
	Speed	0.454	.188	.077	2.41

From the Table – VI, the following regression equations were derived for playing ability of volleyball players. Regression equation is obtained scores form = PA.

$$\mathbf{Y^1 = C + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4 + b_5 x_5 + b_6 x_6 + b_7 x_7}$$

(Volleyball Playing Ability (VPA) = 60.410 + 0.215 (Muscular endurance) + 0.179 (Explosive power) – 0.225 (VO_2 max) + 2.667 (Vital capacity) + 0.054 (Anaerobic power) + 0.357 (Agility) + 0.454 (Speed)). The regression equation for the volleyball playing ability includes muscular endurance, explosive power, vital capacity, VO_2 max, anaerobic power, agility and speed. As the multiple correlations on volleyball playing ability with the combined effect of these independent variables are highly significant, it is apparent that the obtained regression equation has a high predictive validity.

DISCUSSION ON THE FINDINGS

In this study, the volleyball playing ability was predicted from 192 intercollegiate level volleyball players with the help of selected predictor variables such as speed, agility, flexibility, explosive power, muscular endurance, vital capacity, VO_2 max, anaerobic power and resting pulse rate. The volleyball playing ability was determined by subjective rating by three experts and was used as the criterion variable. The step wise selection in multiple regression method was used to determine the prediction equation **(Thomas and Nelson, 1990).**

The step wise regression selection method begins with the squared multiple correlation of all the predictor variables with independent variables. The predictor variables are deleted from the regression equation one at a time, and the last two R square due to deletion of the variable, is studied, that is, each variable is treated as if it was entered last in the equation. Thus, it is possible to find out which variables add least when entered last in the equation, and the loss in R square is compared against a criterion of meaningfulness as well as significance. Thus, when a variable does not add meaningfully or significantly to prediction it is deleted, and when no variable is deleted, the analysis is terminated.

In the present study, for a multiple correlation of 0.919 with the following ten variables were excluded from a total of variables, namely i) Muscular endurance, ii) Explosive power iii) VO_2 max, iv) Vital capacity v) Anaerobic power, vi) Agility and vii) Speed with the probability. Hence, muscular endurance, explosive power, VO_2 max, vital capacity, anaerobic power, agility and speed were included in the equation with the multiple correlations (R) of 0.919, beyond which the size of the multiple correlation no longer increases to any extend **(Thomas and Nelson, 1990).**

Among the physical fitness variables studied explosive power and muscular endurance were found as the best predictors of volleyball playing ability with significant correlations. **Falvo, et.al. (2006)** reported that power is an integral aspect of many sports. Although there were insufficient studies to predict volleyball playing ability among volleyball players, **Antony Isabel Rani (2008)** stated that volleyball playing ability had a significant relationship with serving, overhead pass, grip strength, agility, leg explosive power, height and arm length. **Soundara Rajan and Kolanji. (2021)** has showed that the volleyball playing ability had a significant relationship with height, weight, leg length, thigh girth, explosive power and speed. **Govindaiah and Muni, (2019**) has reported that the volleyball playing ability of volleyball men players had positive correlation with agility, muscular strength, explosive power, flexibility and cardiovascular endurance. **Gangey and Kerketta (2016)** has found that the volleyball playing ability had a significant relationship with agility, coordination and reaction time of the volleyball players. **Sudhakara, (2017)** has proved that volleyball playing ability had significant relationship with speed, strength endurance, flexibility, agility and explosive power of the volleyball players.

Among the physiological variables studied, anaerobic power and VO_2 max were found as the best predictors of volleyball playing ability with significant correlations. **Bentley et al. (2007)** has showed that vital capacity, breath holding time and anaerobic

power are indicators for endurance and aerobic capacity and found to be best predictors of volleyball playing ability. Thus, the findings of this research are in agreement with previous researches. **Mustafa and Mergul, (2022)** has shown that the volleyball playing ability had significant relationship with VO_2 max, anaerobic power, explosive power, agility of female volleyball players competing in the regional division. **Benkins Dinesh and Glady Kirubakar (2014)** has shown that the volleyball playing ability could be predicted from physiological variable, such as vital capacity, breath holding time and anaerobic power of volleyball players.

Conclusion

Among the selected determinant variables muscular endurance, explosive power, VO_2 max, vital capacity, anaerobic power, agility and speed of the volleyball players were highly correlated with volleyball playing ability. The predictor variables namely muscular endurance, explosive power, VO_2 max, vital capacity, anaerobic power, agility and speed can be used to predict the volleyball playing ability of the Inter-collegiate level volleyball players. The ability of a player in a team game like volleyball depends largely in physical fitness and physiological parameters of the players. Now-a-days science is very much interested in estimating the optimum physical fitness and physiological make-up of a player. So the scanning and selection of a particular volleyball player may be achieved successfully to a great extent by measuring physical fitness and physiological variables.

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