Prediction of Swimming Performance on the Basis of Selected Physical Variables

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Abstract – Swimming is ability of man to keep in place in water or to move on the water surface by horizontal movements of his own locomotion. Swimming performance is determined by various factors. Purpose of this study was to predict 50 m swimming performance on the basis of selected physical variables. A total of 20 swimmers aged 18-30 years, with at least 1 year of swimming experience were chosen. They underwent testing of leg explosive strength, shoulder strength, abdomen strength, shoulder flexibility, trunk-hip flexibility and ankle flexibility and finally the recording of the 50m sprint swimming time in freestyle swimming. Multiple linear regression was used as statistical technique. In results, statistically significant negative correlations (p<0.05) between shoulder strength and 50 m swimming performance. Shoulder strength was contributory variable in model. Variable selected in the regression equation explain 20.7% of the total variability in the swimming performance which is low but quite good. Since F value for this regression model is highly significant (f=0.044), the model is reliable. At the same time, all the regression coefficients in this model are highly significant(p<0.05); and therefore, it may be interpreted that variable selected in the model, namely, shoulder strength is quite appropriate in estimating the 50 m swimming performance of swimmers.

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INTRODUCTION

Swimming represents ability of man to keep in place in water or to move on the water surface by horizontal movements of his own locomotion (Pivač, 1999). Sports or competitive swimming is one of cyclic sports in which the form and manner of performance are dominated by relatively simple movements, which are always the same and which are alternately repeated during swimming a certain technique (Jorgić et al., 2010). Swimming performance is determined by the interaction of morphological, physiological, psychological and technical factors, based on individual genetic endowment, and continuously modulated by the training process (Gabbett et al., 2007).

Power and strength sports require the ability to generate high amount of force in relatively short period of time (Haff & Nimphius, 2012). The ability of high rate of force development is the central to success in activities that rely on jumping, change of direction, and/or sprinting performance (Haff & Nimphius, 2012). And swimming is a sport which involves all of these activities. Swimming depends on the power developed by both the upper and the lower limbs, especially in short distance events (Chelly et al., 2010). Swimming performance is a multifactorial phenomenon (Sadowski et al., 2012). Swimmers' physical characteristics have been examined to determine the characteristics of successful sprint swimmers (Wells et al., 2006).

Multiple linear regression is used to estimate the relationship between two or more independent variables and one dependent variable (Bevans, 2020). If performance was taken as a continuous variable, multiple linear regression (MLR) is the most common statistical technique (Fernández Romero et al., 2010; Gabbett & Georgieff, 2007; Malina et al., 2007; Solanellas & Rodríguez, 1996).

Therefore, the objective of this research was to predict swimming performance of national level swimmers on the basis of physical variables. The swimmers that were used in this research were members of National or Youth National Teams during the study period. Many studies have been conducted to establish the relationship between the physical variables and the swimming time. But, , there is very few literature available which gives a prediction on swimming performance on the basis of physical variables, especially in Indian population. For this purpose, this present study aims to predict swimming performance of national level swimmers on the basis of physical variables.

MATERIALS AND METHODS

Subjects

Total of 20 national level swimmers of 50m from free style of swimming i.e. freestyle (n=20),; aged 18-30 years (mean age ±S.D 23.52 ± 27.59 years) with at least 1 year of competitive swimming experience participated in the study. Long distance swimmers or swimmers with any knee, back or shoulder injury of past 6 months were excluded. All the participants and their parents or coaches gave their consent for participation in the study. The study was approved by the institutional ethical committee.

Selection of Variables

The study was taken to physical variables. Therefore, based on literary evidence and scholar's own understanding swimming performance scores calculated from the timing in 50 meters free style swimming was the dependent variable. Physical variables Leg Explosive Strength, Shoulder Strength, Abdomen Strength, Shoulder Flexibility, Trunk-Hip Flexibility and Ankle Flexibility were the independent variable.

Criterion measures

For measuring dependent variable and independent variables various tools and tests used are shown in table 1.

Table 1

List of Criterion Measures and Unit of Measurement

S. No.	Variable	Criterion Measure	Unit
1	Swimming performance	50 m	Sec
2	Leg Explosive Strength	Standing Broad Jump test	m
3	Shoulder Strength	Medicine-Ball Throw test	m
4	Abdomen Strength	bend knee sit – ups test	scores
5	Shoulder Flexibility	Anthropometric rod	cm
6	Trunk-Hip Flexibility	Sit and Reach Test	cm
7	Right foot Flexibility	Goniometer	Degree
8	Left foot Flexibility	Goniometer	Degree

Statistical Analysis

IBM SPSS (Statistical Package for the Social Sciences) software version 20 was used for statistical analysis. To predict swimming performance on the basis of physical variables of national level swimmers multiple regression analysis was used and the level of significance was set at 0.05. Descriptive statistics and Pearson product moment correlation was also analyzed in study to see relationship of physical variables with national level swimmers performance.

RESULTS

Multiple regression was applied to predict swimming performance of national level swimmers on the basis of selected physical variables and got following results.

Table 2

Descriptive Statistics for physical Variables of Swimmers on 50 m Performance

Variables	Mean	Std. Deviation	N
50 m Performance	26.30	0.47	20
Shoulder Flexibility	9.81	2.35	20
Leg Explosive Strength	223.35	13.80	20
Shoulder Strength	656.15	74.25	20
Abdominal Strength	47.15	5.02	20
Trunk Hip Flexibility	42.75	7.82	20
Right Foot Flexibility	73.35	7.59	20
Left Foot Flexibility	72.90	7.17	20

Table 2 shows mean, standard deviation and numbers of subject for physical variables of swimmers on 50 m Performance.

Table 3

Correlation Matrix for Physical Variables

Variables	1	2	3	4	5	6	7	8
Performance	1	.065	.095	-.455*	-.155	.087	-.323	-.430
Shoulder Flexibility		1	-.268	-.254	-.064	-.198	.364	.313
Leg Explosive Strength			1	-.297	-.081	.543*	-.190	-.268
Shoulder Strength				1	-.222	-.101	.039	.132
Abdominal Strength					1	.224	.079	.166
Trunk Hip Flexibility						1	-.029	.137
Right Foot Flexibility							1	.873*
Left Foot Flexibility								1

***. Correlation is significant at the 0.05 level**

Table 3 shows that there is significant negative correlation between performance and shoulder strength and significant positive correlation between right foot flexibility and left foot flexibility. Other variables do not show any significant correlation with 50 m swimming performance.

Table 4

Model Summary Along with the Values of R and R^2

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.455a	.207	.163	.42709	.207	4.701	1	18	.044

a. Predictors: (Constant), Shoulder Strength

Regression model have been presented in Table 4. For this model, the value of R^2 is 0.207, which is maximum; hence, this model shall be used to develop the regression equation. It can be seen from Table 4 that in the this model, one independent variables, shoulder strength have been identified; and therefore, the regression equation shall be developed by using this variable only. Since R^2 for this model is 0.207, these seven independent variables explain 20.7% variability in the swimming performance of swimmers. Thus, this model is quite appropriate to estimate swimming performance.

Table 5

ANOVA Table Showing F Values for the Model

	Model	Sum of Squares	df	Mean Square	F	p value
1	Regression	.857	1	.857	4.701	.044b
	Residual	3.283	18	.182		
	Total	4.141	19			

a. Dependent Variable: Performance

b. Predictors: (Constant), Shoulder Strength

In Table 4, F values for this model have been shown. Since F value for this model is quite high and significant, it may be concluded that the model selected is highly efficient.

Table 6

Regression Coefficients of Physical Variables in Model Along with Their t Values

		Unstandardized Coefficients		Standardized Coefficients		
	Model	B	Std. Error	Beta	t	p value.
1	(Constant)	28.182	.871		32.353	.000
	Shoulder strength	-.003	.001	-.455	-2.168	.044

a. Dependent Variable: performance

Regression coefficients in the model have been shown in Table 6. In this model, t values for regression coefficients shoulder strength is significant as the significance value (p value) associated with them is less than 0.05. Thus, it may be concluded that the variables shoulder strength significantly explain the variations in the swimming performance. Larger the absolute value of Beta coefficient more is the contribution of that variable in the model. Thus, shoulder strength is the most contributory predictor in this model.

Regression equation: Using regression coefficients (B) of the model shown in the Table 6, the regression equation can be developed which is as follows:

Swimming performance = 28.182 − 0.003 × (shoulder strength)

DISCUSSION

From the above results it was found that shoulder strength plays contributory role in 50 m swimming performance of national level swimmers. It was also observed from results that shoulder strength had significant negative correlation with swimming performance which means that shoulder strength is inversely proportional to swimming performance. Swimming requires several different shoulder motions, most being performed during circumduction in clockwise and counter-clockwise directions with varying degrees of internal and external rotation and scapular protraction and retraction (Shamus & Shamus, 2001). Freestyle requires a combined motion of scapular retraction and elevation, with humeral abduction and external rotation during the recovery (Shamus & Shamus, 2001). During the pull-through phase, the scapula is protracted while the humerus is adducted, extended, and internally rotated. Stroke power is achieved through the shoulder adductors, extenders, and internal rotators with the serratus anterior and latissumus dorsi being the key propulsion muscles for swimmers (Shamus & Shamus, 2001). During the arm pull of the stroke, one of the most important joints is the shoulder joint (Awatani et al., 2018). Swimming power (SP) is indicated as propulsion, and SP is calculated using the traction force (F) when pulling the resistive force equipment and swimming velocity (SV) during swimming (Toussaint & Vervoorn,1990; Ria,1990; Mori et.al. 2015).

CONCLUSION

To conclude, it may be interpreted that the above regression equation is quite reliable as the value of R^2 is 0.207. In other words, the variables selected in the regression equation explain 20.7% of the total variability in the swimming performance which is low but quite good. Since F value for this regression model is highly significant, the model is reliable. At the same time, all the regression coefficients in this model are highly significant; and therefore, it may be interpreted that variable selected in the model, namely, shoulder strength is quite appropriate in estimating the 50 m swimming performance of swimmers.

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