Journal of Advances and Scholarly Researches in Allied Education
Vol. 16, Issue No. 4, March-2019, ISSN 2230-7540

Prediction of Swimming Performance on the Basis of Selected Anthropometric Variables

Mr. Amit Tomar[1]* Dr. Tarak Nath Pramanik[2]

[1] Ph.D. Research Scholar, University Of Delhi

[2] Assistant Professor, I.G.I.P.E.S.S, University Of Delhi

Abstract – Swimming is a popular sport and early starting specialization although performance and success in elite swimmers depend on various factors. Purpose of this study was to predict 50 m swimming performance on the basis of selected anthropometric variables. A total of 20 swimmers aged 18-30 years, with at least 1 year of swimming experience were chosen. They underwent measurement of height, arm span, leg length, torso length, hand length, hand breadth, foot length, foot breadth and fat percentage and finally the recording of the 50m sprint swimming time in freestyle swimming. Multiple linear regression was used as statistical technique. In results, height, torso length, hand length and hand breadth were contributory variable in model. Variable selected in the regression equation explain 74.8% of the total variability in the swimming performance which is good. Since F value for this regression model is highly significant (f=0.038), 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, height, torso length, hand length and hand breadth are appropriate in estimating the 50 m swimming performance of swimmers.

- X -

INTRODUCTION

Sports talent is the sum total of pre-requisites (and possibilities of their development) possessed by a person which will enable him to achieve high performance in a sport in future. The pre-requisites include physical abilities, physiological profile, biochemical function, technical skills, physique, personality, motives and interest. High performance sports necessitate specific biological profiles of children, with outstanding motor functions, strong physiological and psychological traits. To determine children's potential for motor functions at a given age, we must consider the status of their physical growth and maturation. Swimming which was considered to be only a survival activity has now developed into one of the most popular Competitive Sport at the International and Olympic level. This perhaps is one of the few sports wherever increasing performance is evident now and then and swimmers have attained incredible standards at a relatively much younger age.

Understanding the physical and anthropometric factors that underpin performance in the sport of swimming is important in relation to talent development and targeting training programs effectively (Mevaloo & Shahpar, 2008). Anthropometry is the science of measuring the size and proportions of the human body. Anthropometry' means the measurements of man, whether living or dead, and consists primarily in the measurements of the dimensions of the body. In all the games, height, weight, and other Anthropometric variables play a vital role in the player's performance. The physical structure, especially the height and arm length, have definite and decisive advantage in many games. Similarly, segmental length of individual body parts, the arm length specifically, is of considerable advantage in selected events in athletics and in certain games. Anthropometric characteristics play a crucial role in the performance of swimmers (Arazi, Mirzaei & Nobari, 2015). Some of the variables that can commonly affect performance are body weight, body height, limb length, and circumference of limbs (Jenkins, 1997; Bouchard, Malina & Pérusse, 1997; Arazi, Mirzaei & Nobari, 2015). Geladas, Nassis & Pavlicevic, (2005) reported that 100 m freestyle swimming performance was best predicted by a combination of anthropometric and physical tests ($r = −0.22$ to $−0.31$) in a sample of 263, 12–14 year old swimmers. Thus, there is a need to better understand how these factors might influence swimming performance in adolescent swimmers. 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).

Therefore, the objective of this research was to predict swimming performance of national level swimmers on the basis of anthropometric 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 anthropometric variables and the swimming time. But, , there is very few literature available which gives a prediction on swimming performance on the basis of anthropometric variables, especially in Indian population. For this purpose, this present study aims to predict swimming performance of national level swimmers on the basis of anthropometric 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 anthropometric 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. Anthropometric variables height, arm span, leg length, torso length, hand length, hand breadth, foot length, foot breadth and fat percentage 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	Height	Anthropometric wall scale	cm
3	Arm span	Anthropometric Tape	cm
4	Leg Length	Anthropometric Tape	cm
5	Torso Length	Small Bone Caliper	cm
6	Hand length	Small Bone Caliper	cm
7	Hand Breadth	Small Bone Caliper	cm
8	Foot length	Small Bone Caliper	cm
9	Foot Breadth	Small Bone Caliper	cm
10	Fat Percentage	Wilmore and Behnkes formula	percentage

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 anthropometric 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 anthropometric variables with national level swimmers performance.

RESULTS

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

Table 2

Descriptive Statistics for Anthropometric Variables of Swimmers on 50m Performance

	Mean	Std. Deviation	N
50 m Performance	25.95	0.41	20
Height	180.60	3.81	20
Arm Span	184.66	8.83	20
Leg Length	85.76	8.00	20
Torso Length	61.86	1.66	20
Hand Length	19.17	0.91	20
Hand Breadth	10.19	0.69	20
Foot Length	25.99	1.12	20
Foot Breadth	9.80	0.54	20
Fat Percentage	20.96	4.00	20

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

Fig. 1. Graphical Representation of Descriptive Statistics for Anthropometric Variables of Swimmers on 50 m Performance

Table 3

Correlation Matrix for Anthropometric Variables

	1	2	3	4	5	6	7	8	9	10
50 m Performance	1	-.360	.261	.248	-.346	.381	.179	.241	.218	.044
Height		1	.506	.479	.302	.414	.240	.527	.412	.269
Arm Span			1	.670**	.013	.865**	.676**	.645**	.580**	.504
Leg Length				1	-.005	.748**	.392	.592**	.500	.415
Torso Length					1	.178	-.077	.202	.148	-.191
Hand Length						1	.716**	.744**	.598**	.326
Hand Breadth							1	.603**	.625**	.283
Foot Length								1	.752**	.215
Foot Breadth									1	.426
Fat Percentage										1

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3 shows that there is no significant correlation between performance and selected anthropometric variables. Other anthropometric variables show significant correlation with each other

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	.865a	.748	.522	.285	.748	3.304	9	10	.038

a. Predictors: (Constant), fat percentage, torso length, hand breadth, height, leg length, foot breadth, foot length, arm span, hand length

Regression model have been presented in Table 4. For this model, the value of R^2 is 0.748, 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, nine independent variables, fat percentage, torso length, hand breadth, height, leg length, foot breadth, foot length, arm span, hand length have been identified; and therefore, the regression equation shall be developed by using these variable only. Since R^2 for this model is 0.748, these nine independent variables explain 74.8% 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	Sig.
1	Regression	2.415	9	.268	3.304	.038b
	Residual	.812	10	.081		
	Total	3.228	19			

a. Dependent Variable: performance
b. Predictors: (Constant), fat percentage, torso length, hand breadth, height, leg length, foot breadth, foot length, arm span, hand length

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 Anthropometric Variables in Model Along with Their t Values

Model		Unstandardized Coefficients: B	Unstandardized Coefficients: Std. Error	Standardized Coefficients: Beta	t	Sig.	Correlations: Zero-order	Correlations: Partial	Correlations: Part
1	(Constant)	37.041	3.633		10.197	.000			
	Height	-.057	.025	-.529	-2.265	.047*	-.360	-.582	-.359
	Arm span	-.002	.019	-.052	-.128	.901	.261	-.040	-.020
	Leg length	-.015	.016	-.295	-.963	.358	.248	-.291	-.153
	Torso length	-.144	.054	-.578	-2.648	.024*	-.346	-.642	-.420
	Hand length	.556	.247	1.233	2.250	.048*	.381	.580	.357
	Hand breadth	-.446	.176	-.748	-2.527	.030*	.179	-.624	-.401
	Foot length	.033	.119	.089	.276	.788	.241	.087	.044
	Foot breadth	.333	.224	.434	1.482	.169	.218	.424	.235
	Fat percentage	-.017	.022	-.169	-.785	.451	.044	-.241	-.125

*significant at 0.05 level

Regression coefficients in the model have been shown in Table 6. In this model, t values for regression coefficients height, torso length, hand length and hand breadth is significant as the significance value (p value) associated with them is less than 0.05. Thus, it may be concluded that the variables height, torso length, hand length and hand breadth 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, hand length is the most contributory predictor in this model followed by hand breadth, torso length and height.

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 = 37.041 + 0.556 × (hand length) - 0.446× (hand breadth) -0.114× (torso length) + 0.057× (height)

DISCUSSION

The aim of this study was to develop a regression model to predict swimming performance of national players based on selected anthropometric variables and to find out the contribution of selected anthropometric variables in swimming performance of national players. From the above results it was found that height, torso length, hand length and hand breadth plays contributory role in 50 m swimming performance of national level swimmers. The outcomes of this study support previous investigations, indicating that anthropometrics are highly related to youth swimmers' performance (Geladas, Nassis & Pavlicevic, 2005; Jürimäe et al., 2007; Nevill, Oxford & Duncan, 2015; Sammoud et al., 2018; Nasirzade, Ehsanbakhsh, Argavani, Sobhkhiz & Aliakbari, 2014).

Basically, the most significant linear anthropometric predictor of swimming performance is height (Sekulic, Zenić & Zubcević, 2007). The linear relationship between height and swimming performance can be explained simply. A more pronounced height defines longer extremities (Živičnjak et al., 1997), while longer extremities allow one to: perform fewer arm strokes for the same distance (Potdevin, Bril, Sidney & Pelayo, 2006; Zenić & Zubčević, 2005), but also to achieve a higher moment of force (MF) in the single stroke because of the law of levers (MF=F. a). In our case, the F is force applied during a single arm stroke, and a is the distance between a single joint and connection-point of the active muscles on the bone (lever). It seems that anthropometrics are highly related with young swimmers' performance. . For instance, arm span (AS) is one of the best performance predictors (Lätt et al., 2010), while positive correlations between hand and foot size with performance also exist (Helmuth, 1980). Faster swimmers are taller, with higher AS and surface areas, higher SL, v, SI and CV. These features are positively related to young swimmers' performance (Jürimäe et al., 2007; Vitor and Böhme, 2010). Previous reports have found that sprint swimming performance is related to body mass, lean body mass, body height and arms span (Geladas et al., 2005; Grimston and Hay, 1986; Jürimäe et al., 2007, Silva et al., 2007). In our study, swimming time was significantly related to body height and arm span. The significant association between body height and swimming performance in the present study could be explained by the fact that tall swimmers seems to glide better through the water (Geladas, Nassis & Pavlicevic, 2005; Toussaint and Hollander, 1994) and taller swimmers usually show a larger arm span, which benefits swimming efficiency i.e. larger stroke length (Saavedra et a., 2010)

CONCLUSION

To conclude, it may be interpreted that the above regression equation is reliable as the value of R^2 is 0.748. In other words, the variables selected in the regression equation explain 74.8% of the total variability in the swimming performance which is 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, height, torso length, hand length and hand breadth is appropriate in estimating the 50 m swimming performance of swimmers.

REFERENCES

Arazi, H., Mirzaei, B., & Nobari, H. (2015). Anthropometric profile, body composition and somatotyping of national Iranian cross-country runners. *Turkish Journal of Sport and Exercise*, *17*(2), 35. https://10.15314/tjse.49873

Bouchard, C., Malina, R., & Pérusse, L. (1997). *Genetics of fitness and physical performance*. Champaign, Il.: Human Kinetics.

Gabbett, T., Georgieff, B., & Domrow, N. (2007). The use of physiological, anthropometric, and skill data to predict selection in a talent-identified junior volleyball squad. *Journal of Sports Sciences*, *25*(12), pp. 1337-1344. https://doi.org/10.1080/02640410601188777

Geladas, N., Nassis, G., & Pavlicevic, S. (2005). Somatic and Physical Traits Affecting Sprint Swimming Performance in Young Swimmers. *International Journal of Sports Medicine*, *26*(2), pp. 139-144. HTTPS://10.1055/S-2004-817862

Grimston, S.K., & Hay, J.G. (1986). Relationship among anthropometric and stroking characteristics of college swimmers. Medicine and Science in Sport and Exercise 18, pp. 60-68

Helmuth, HS. (1980) Anthropometric survey of young swimmers. Anthropol Anz.; 38: pp. 17–34.

Jenkins, C. (1997). Kenyan Running: Movement culture, geography and global chance. *African Affairs*, *96*(383), pp. 296-298. https://10.1093/oxfordjournals.afraf.a007841

Jürimäe, J., Haljaste, K., Cicchella, A., Lätt, E., Purge, P., Leppik, A. and Jürimäe, T., 2007. Analysis of Swimming Performance from Physical, Physiological, and Biomechanical Parameters in Young Swimmers. *Pediatric Exercise Science*, 19(1), pp. 70-81.

Jürimäe, J., Haljaste, K., Cicchella, A., Lätt, E., Purge, P., Leppik, A., & Jürimäe, T. (2007). Analysis of swimming performance from physical, physiological and biomechanical parameters in young swimmers. Pediatr Exerc Sci. ;19: pp. 70–81.

Lätt, E., Jürimäe, J., Mäestu, J., Purge, P., Rämson, R., Haljaste, K., Keskinen, KL., Rodriguez FA., & Jürimäe T (2010). Physiological, biomechanical and anthropometrical predictors of sprint swimming performance in adolescent swimmers. J Sports Sci Med. ;9: pp. 398–4

Mevaloo, S., & Shahpar, F. (2008). Talent identification programmes. In *"Medicine Congress. Enhancing Performance: The Healthy Aquatic Athlete"*. Manchester: 17th FINA World Sport.

Nasirzade, A., Ehsanbakhsh, A., Argavani, H., Sobhkhiz, A., & Aliakbari, M. (2014). Selected anthropometrical, muscular architecture, and biomechanical variables as predictors of 50-m performance of front crawl swimming in young male swimmers. *Science & Sports*, *29*(5), pp. e75-e81. doi: 10.1016/j.scispo.2013.09.008

Nevill, A., Oxford, S. and Duncan, M., 2015. Optimal Body Size and Limb Length Ratios Associated with 100-m Personal-Best Swim Speeds. *Medicine & Science in Sports & Exercise*, 47(8), pp. 1714-1718.

Potdevin, F., Bril, B., Sidney, M., & Pelayo, P. (2006). Stroke Frequency and Arm Coordination in Front Crawl Swimming. *International Journal of Sports Medicine*, *27*(03), pp. 193-198. DOI: 10.1055/s-2005-837545

Saavedra, J.M., Escalante, Y., & Rodriguez F.A. (2010) A multivariate analysis of performance in young swimmers. Pediatric Exercise Science 22, pp. 135-151

Sammoud, S., Nevill, A., Negra, Y., Bouguezzi, R., Chaabene, H. and Hachana, Y., 2018. 100-m Breaststroke Swimming Performance in Youth Swimmers: The Predictive Value of Anthropometrics. *Pediatric Exercise Science*, 30(3), pp. 393-401.

Sekulic, D., Zenić, N., & Zubcević, N. (2007). Non linear anthropometric predictors in swimming. *Collegium Antropologicum*, *31*(3), pp. 803-809

Silva, A.J., Costa, A.M., Oliveira, P.M., Reis, V.M., Saavedra, J., Perl, J., Rouboa A., & Marinho, D.A. (2007) The use of neural network technology to model swimming performance. Journal of Sports Science and Medicine 6, pp. 117-125

Toussaint, H., & Hollander, P. (1994) Energetics of competitive swimming: implications for training programmes. Sports Medicine 18, pp. 384-405

Vitor, FM., & Böhme, MT. (2010) Performance of young male swimmers in the 100 meters front crawl. Pediatr Exerc Sci. ; 22: pp. 278–287.

Zenić, N., & Zubčević, N. (2005). Ability grouping – advances in a swimming curriculum. *Kinesiology*, *337*(2), pp. 173-181.

Živičnjak, M., Szirovicza, L., Pavicic, L., Narančić, N., Milicic, J., & Rudan, P. (1997). The Aging Process - An Analysis of the Latent Structure of Body Morphology (in Males). *Collegium Antropologicum*, *21*, pp. 117-126.

Corresponding Author

Mr. Amit Tomar*

Ph.D. Research Scholar, University Of Delhi