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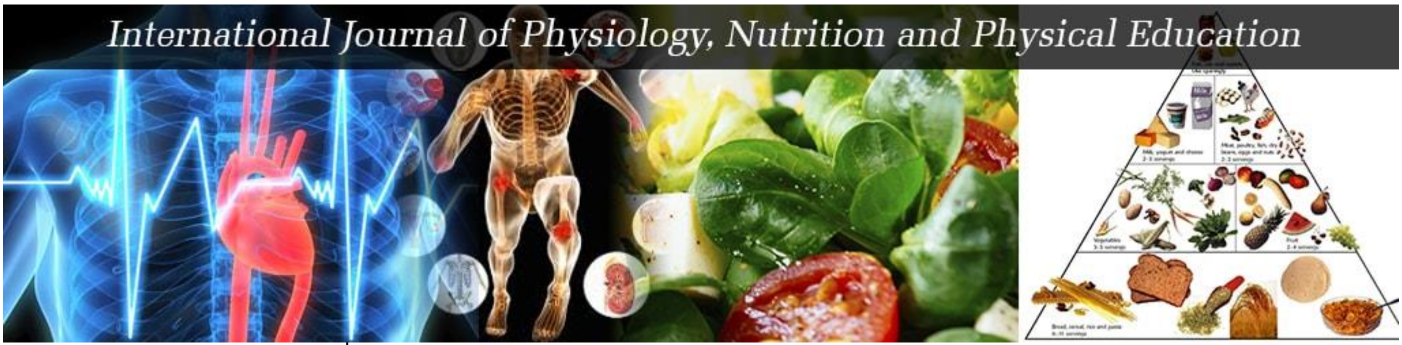

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Anthropometric variables as predictor of performance in swimming

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Abstract
The purpose of the study was to predict the swimming performance on the basis of selected anthropometric variables. To achieve this aim, a total of one hundred (N=100) swimmers for both the stroke namely fifty of butterfly stroke and fifty of crawl stroke swimmers of Madhya Pradesh state were selected as subject for this study. Body weight, standing height, arm length, arm stretch in standing position, arm span, hand breadth, leg length, ball of foot circumference, foot length, foot breadth were the selected anthropometric variables. The performance of butterfly stroke and crawl stroke 50 mt. event was measured in seconds. To find out the relationship of selected anthropometric variables with the swimming performance Pearson's product moment correlation was deployed and to predict the performance of swimmers on the basis selected anthropometric variables regression analysis was used by step-wise method. For butterfly stroke swimming performance three models and regression equation were developed, among all three models the third model in which arm span standing position, standing height, ball of foot circumference was observed 45.1% which was highest in comparison to first two models. Hence third model is most suitable and adaptable for butterfly stroke performance in swimming and in predicting the performance of crawl stroke swimming the third model in which foot length, arm length and standing height was observed 49.2% which was highest among all three models. Hence it is suitable for predicting the crawl stroke performance in swimming on the basis of selected anthropometric variables.

Keywords: Anthropometric variables, performance, swimming

Introduction
The history of swimming is very old, positively it can get alleyway back in prehistoric times. Bible, Iliad and Odyssey are all the swimming literature. Swimming is an art because it is practiced by humans, amphibians and practically all four-legged ones born with swimming capacity. There are instances which give them the ability to get the ability to swim very fast, or provide them to walk on the surface. Everyone just wishes to enter the water and to swim like animals, because the animals just enter the water and float wherever they want. But in swimming, humans have experienced that they have been physically enriched by physically as well as swimming. Human swimming is the human self-driving force through water or other liquids, usually for survival, sports, entertainment or exercise. Human can achieve the movement through the coordinated movement of human organs or body or both. Humans can catch their respiration under water and within a few weeks of birth; they can swim the normal locomotive as an evolutionary reaction. It is actually in fact that this procure of swimmers is very much with art, if not, not so much, there is abundance of all living beings in the aquatic world. He is limited, of course, he can swim in the distance, the depth in which he can descend, he can make the pace, and even when he can drown, Humans can swim in different types of situations, they can assume, act or can perform temporary movements in different directions. It can float on the back or water on the surface of the water. He can easily swim from behind. They are capable of any kind of efficiency from front and back in any way, or roam like a rolling log on their long axis. But above all there are many different movements of their organs that move themselves in water. One of the goals of scientific research is to predict future events or outcomes from current or past data. Sodhi and Sidhu have studied that the body's physic and body structure, inclusive shape and form, play an important role in the performance of a player in any sport or event, which is his viability, skill, training motivation

and various other factors. Gare and Carter said that after a thorough study of the anthropological measurements of Olympic athletes, special type of body size and size are required in top level performance in a particular event. He found a high relation between the special incident in which he played the role of an athlete and formed the structure. Anthropometric measurement plays an important role in swimming. Various anthropometric measurements are provide advantage to the swimmers in their optimum performance like tall height swimmers can cover more distance in comparison to short height swimmers. Longer the arm length more the leverage which helps in longer arm pulls to overcome maximum distance. More palm width help to remove more water in single arm pull.

Objectives of the study

The objectives of the study were

1. To describe the characteristics of the swimmers.
2. To determine the relationship of selected anthropometric variables with performance.
3. To predict the performance and to develop a regression equation model for talent identification.

Methodology

Selection of subjects and collection of data

For the purpose of the study a total of one hundred (N=100) state level swimmers of Madhya Pradesh including fifty for both stroke namely crawl stroke and butterfly stroke were selected as subject. Their age group ranged from 14-17 years. It was assumed that all swimmers were well trained and position holder in division level. The anthropometric measurement was collected during the state swimming championship held at De was and Bhopal and swimming performance was the best timing given in 50 mt. event in the competition by swimmers was recorded.

Statistical Technique

To describe characteristics of the swimmers descriptive statistics were used, to find out the relationship of selected anthropometric variables with performance of different stroke swimmers Pearson's product moment correlation was deployed and to predict the performance of swimmers on the basis of selected anthropometric variables regression analysis was used.

Result and Discussion

The results and findings of the present study were analyzed and presented in different tables as follows-

Table 1: Descriptive statistics Value of Selected Anthropometric Variables and

Variables	Strokes	Mean	S.D.	Min.	Max
Body Weight	Butterfly Stroke	74.98	6.91	64.00	96.90
	Crawl stroke	52.28	11.36	40.00	80.30
Standing Height	Butterfly Stroke	174.08	4.55	162.00	182.00
	Crawl stroke	161.06	7.98	149.00	182.00
Arm Length	Butterfly Stroke	74.52	4.03	67.00	82.00
	Crawl stroke	71.07	5.40	61.00	82.00
Arm Stretch in standing position	Butterfly Stroke	217.44	4.48	207.00	230.00
	Crawl stroke	212.56	7.29	200.00	230.00
Arm Span	Butterfly Stroke	177.10	4.65	166.00	189.00
	Crawl stroke	172.77	9.03	156.50	189.00
Hand Breadth	Butterfly Stroke	8.22	0.69	7.00	9.00
	Crawl stroke	8.45	0.55	7.00	9.50
Leg length	Butterfly Stroke	88.10	3.73	80.50	97.00
	Crawl stroke	83.49	7.64	70.00	102.00
Ball of foot circumference	Butterfly Stroke	23.79	0.89	22.00	26.00
	Crawl stroke	23.58	1.34	20.00	26.00
Foot length	Butterfly Stroke	24.89	1.39	23.00	27.00
	Crawl stroke	25.13	1.65	21.00	28.00
Foot breadth	Butterfly Stroke	9.33	0.95	8.00	11.00
	Crawl stroke	9.11	1.02	7.50	11.00
Performance	Butterfly Stroke	36.25	4.47	26.85	44.87
	Crawl stroke	32.75	2.68	26.30	39.90

Table 1 shows stroke wise anthropometric characteristics of swimmers with the help of descriptive statistics (Mean and standard deviation) of all the variables in the study. Body weight, standing height, arm length, arm stretch in standing position and arm span, mean and standard deviation were 74.98±6.91, 174.08±4.55, 74.52±4.03, 217.44±4.48, 177.10±4.65 respectively. For hand breadth, leg length, ball of foot circumference foot length, foot breadth, mean and standard deviation were 8.22±0.69, 88.10±3.73, 23.79±0.89, 24.89±1.39, 9.33±0.95 in case of butterfly stroke swimmers. For swimming performance mean and standard deviation was 36.25±4.47 respectively.

In case of Crawl stroke swimmers body weight, standing height, arm length, arm stretch in standing position, arm span were 52.28±11.36, 161.06±7.98, 71.07±5.40, 212.56±7.29 and172.77±9.03 respectively. For hand breadth, leg length, ball of foot circumference, foot length, foot breadth, mean and standard deviation were 8.45±0.55, 83.49±7.64, 23.58±1.34, 25.13±1.65 and 9.11±1.02. For swimming performance mean and standard deviation was 32.75±2.68 respectively.

Table 2: Pearson's product moment correlation of selected anthropometric variables with butterfly stroke and crawl stroke performance of swimmers

S. No.	Variables Correlated	Correlation Coefficient (R)	
		Butterfly Stroke	Crawl Stroke
1	Body Weight	.030	-.042
2	Standing Height	.045	-.097
3	Arm Length	-.064	-.369*
4	Arm stretch in standing position	-.546*	-.028
5	Arm Span	-.463*	-.313*
6	Hand Breadth	-.229	-.371*
7	Leg Length	-.234	-.144
8	Ball of foot Circumference	.226	-.337*
9	Foot Length	-.094	-.609*
10	Foot Breadth	-264	-.336

Table 2 shows that there is significant relationship between butterfly stroke swimming performance and anthropometric variables i.e. Arm stretch in standing position and arm span found significant at .05 level and on the other hand there is an insignificant relationship between butterfly stroke swimming performance and anthropometric variables i.e. body weight, standing height, arm length, hand breadth, leg length, ball of foot circumference, foot length, and foot breadth.

Relationship between crawl stroke swimming performance and anthropometric variables i.e. arm length, arm span, hand breadth, ball of foot circumference and foot length were found significant at .05 level. On the other hand insignificant relationship found between crawl stroke swimming performance and anthropometric variables i.e. body weight, standing height, arm stretch in standing position, leg length and foot breadth.

Table 3: Model summary showing Pearson's correlation between selected anthropometric variables with butterfly stroke swimming performance

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.546[a]	.298	.283	3.78201	.298	20.350	1	48	.000
2	.657[b]	.432	.408	3.43775	.134	11.095	1	47	.002
3	.696[c]	.485	.451	3.30976	.053	4.705	1	46	.035

a. Predictors: (Constant), arm stretch standing position
b. Predictors: (Constant), arm stretch standing position, standing height
c. predictors: (constant), arm stretch standing position, standing height, ball of foot circumference

There are three regression model have been presented in table-3. In the third model value of R square is .485 which maximum and therefore third model was selected to develop regression equation. It also can be seen from table that in third model there are three independent variables *viz*. Arm stretch in standing position, Standing Height and Ball of Foot Circumference have been identified so regression equation will be developed these three independent variables only. Since R square value for third model is shows that 45.1% of Butterfly stroke swimming performance is obtained by these three independent variables.

Table 4: Shows that the utility of the linear regression model.

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	291.075	1	291.075	20.350	.000[b]
	Residual	686.573	48	14.304		
	Total	977.649	49			
2	Regression	422.198	2	211.099	17.862	.000[c]
	Residual	555.450	47	11.818		
	Total	977.649	49			
3	Regression	473.741	3	157.914	14.415	.000[d]
	Residual	503.908	46	10.955		
	Total	977.649	49			

a. Dependent Variable: Performance
b. Predictors: (Constant), arm stretch standing position
c. Predictors: (Constant), arm stretch standing position, standing height
d. Predictors: (Constant), arm stretch standing position, standing height, ball of foot circumference

Table 4 shows that the utility of the linear regression model. The third model has found useful in estimating the butterfly stroke swimming performance on the basis of selected anthropometric variables i.e. Arm stretch in standing position, Standing height and Ball of foot circumference, since F value (14.415)has found significant ($P<0.05$).

Table 5: Shows that the quantification of relationship between selected anthropometric variables with butterfly stroke swimming performance.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	154.493	26.217		5.893	.000
	arm stretch standing position	-.544	.121	-.546	-4.511	.000
2	(Constant)	127.929	25.130		5.091	.000
	arm stretch standing position	-.754	.126	-.756	-5.963	.000
	standing height	.415	.125	.423	3.331	.002
3	(Constant)	110.521	25.490		4.336	.000
	arm stretch standing position	-.757	.122	-.759	-6.218	.000
	standing height	.356	.123	.363	2.897	.006
	ball of foot circumference	1.189	.548	.238	2.169	.035

Table 5 shows that the quantification of relationship between selected anthropometric variables with butterfly stroke swimming performance. The above table reviewed that significance of regression model. For both the model anova value is significant as the P value is less than .05 Thus, it may be concluded that the variables; arm span inn standing position, standing height and ball of foot circumference explain the butterfly stroke swimming performance of the swimmers.

Regression equation using regression coefficient (B) of all three model are shown in table 5, the regression equation can be developed as follows:

Regression Equation/Model-1

Y (Butterfly Stroke) = 154.493+ (-.544) (arm stretch in standing position)

Regression Equation/Model-2

Y (Butterfly Stroke) = 127.929 + (-.754) (arm stretch in standing position) +.356 (Standing Height)

Regression Equation/Model-3

Y (Butterfly Stroke) = 110.521 + (-.757) (arm stretch in standing position) +.415 (Standing Height) +1.189 (Ball of foot circumference)

Table 6: Regression Model Summary of Anthropometric Variables in Relation to Crawl Stroke Swimming Performance of Swimmers

Model Summary									
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	.609[a]	.370	.357	2.15011	.370	28.241	1	48	.000
2	.658[b]	.433	.409	2.06173	.063	5.203	1	47	.027
3	.702[c]	.492	.459	1.97232	.059	5.358	1	46	.025

a. Predictors: (Constant), foot length
b. Predictors: (Constant), foot length, Arm Length
c. Predictors: (Constant), foot length, Arm Length, standing height

Table 6 shows that there are three regression models have been presented. In third model the value of R Square is .492 which is maximum and therefore this model was selected to develop regression equation. It also can be seen from that in third model there are three independent variables i.e. Foot length, Arm length and Standing height have been indentified so regression equation will be developed these three independent variables only. Since R square value for third model is shows that 49.2% of crawl stroke swimming performance is obtained by these three independent variables.

Table 7: Shows that in ANOVA table three models have been found useful in estimating the Crawl stroke swimming performance on the basis of three independent variables

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	130.557	1	130.557	28.241	.000[b]
	Residual	221.904	48	4.623		
	Total	352.461	49			
2	Regression	152.676	2	76.338	17.959	.000[c]
	Residual	199.785	47	4.251		
	Total	352.461	49			
3	Regression	173.519	3	57.840	14.869	.000[d]
	Residual	178.942	46	3.890		
	Total	352.461	49			

a. Dependent Variable: Performance
b. Predictors: (Constant), foot length
c. Predictors: (Constant), foot length, arm length
d. Predictors: (Constant), foot length, arm length, standing height

Table 7 shows that in ANOVA table three models have been found useful in estimating the Crawl stroke swimming performance on the basis of three independent variables. i.e. Foot length, Arm length and Standing height, since F value (14.869) has found significant ($P<0.05$).

Table 8: The regression coefficient in these models has been shown in this table

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	57.566	4.679		12.303	.000
	foot length	-.987	.186	-.609	-5.314	.000
2	(Constant)	64.469	5.412		11.912	.000
	foot length	-.903	.182	-.557	-4.962	.000
	Arm Length	-.127	.056	-.256	-2.281	.027
3	(Constant)	51.339	7.680		6.685	.000
	foot length	-.804	.179	-.495	-4.482	.000
	Arm Length	-.314	.097	-.633	-3.245	.002
	standing height	.149	.064	.442	2.315	.025

a. Dependent Variable: Performance

The regression coefficient in these models has been shown in table 8. The above table reviewed that significance of regression model. For all three models ANOVA value is significant as the P value is less than .05. Thus it may be concluded that the variables; foot length, arm length and standing height significantly explains the crawl stroke swimming performance of the swimmers.

Regression equation using coefficient (B) of all three models are shown in table 8, the regression equation can be developed as follows:

Regression Equation/Model-1
Y (Crawl Stroke) = 57.566 + (-.987) (Foot length)

Regression Equation/Model-2
Y (Crawl Stroke) = 64.469 + (-.903) (Foot length) + (-.127) (Arm length)

Regression Equation/Model-3
Y (Crawl Stroke) = 51.339 + (-.804) (Foot length) + (-.314) (Arm length) + .149 (Standing height)

Conclusion

Results of the study clearly revealed that anthropometric variables are positively correlated with the performance of swimmers and few anthropometric variables were not found significantly correlated. Arm stretch in standing position, Standing Height and Ball of Foot Circumference are only anthropometric variables which predicted the performance of butterfly stroke and crawl stroke swimming performance was predicted by foot length, arm length and standing height. On the basis of findings it may be concluded that practically only two or three anthropometric variables are not responsible for the performance in swimming because a swimmer has to use his full body to swim in the water or to propel in water. All the anthropometric variables play a key role to swim in the water, so we can say that all the anthropometric variables are very much important for giving the performance in swimming but only Arm stretch in standing position, Standing Height and Ball of Foot Circumference are predicting the performance in butterfly stroke the reason may be in butterfly stroke the body stretch in its full so the arm stretch in standing position and standing height is important and the kick used in butterfly stroke by swimmers ball of foot circumference is very important because of its strength and its girth if it will be strong than butterfly kick will also be strong and crawl stroke was predicted by foot length, arm length and standing height reason may be a swimmer used their full body and arm to pull water behind so the arm length play a vital role to pull water and foot length is also act like fins if foot length is good it will help the swimmers to swim fast.

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