"Body and Performance"

Relation of Anthropometric Measurements and Body Composition to Performance in state Sub-junior Swimmers

1. Introduction

Swimming

If we look back as to from when swimming has been practiced we could go back to Egypt, they have recorded swimming as an activity from as early as 2500 BCE followed by Greek and Roman civilizations where swimming was a part of their martial training and a part of the school curriculum for the male students. It is said that in the late 17th century Britain people had water therapy and use to swim on the seashores. Swimming got its popularity throughout the world in the 19th century both as recreation and sport. The first swimming championship was a 400 metre race, held in Australia in 1846 and annually thereafter. The Federation International de Natation Amateur (FINA) was founded in 1909.

Through swimming, the entire body and cardiovascular system get an excellent way to workout. Swimming for an hour burns as many calories as running, and also without an impact on the bones and joints.

Health benefits of swimming

In swimming the whole body moves against the resistance of water which works as an excellent workout.

- It keeps the heart rate up while also taking some of the impact of stress off the body
- It builds endurance, muscle strength and cardiovascular fitness
- It maintains a healthy weight, healthy heart and healthy lungs
- The muscles are toned and strength is developed
- An overall body workout, as nearly all of the muscles, are used during swimming.

Other benefits of swimming

- A relaxing and peaceful form of exercise
- It improving coordination, balance, and posture
- Swimming provides a good low-impact therapy for some injuries and conditions
- It provides a pleasant way to cool down on a hot day
- As water is abundantly available in many places one can swim in swimming pools, beaches, lakes, dams, and rivers. By making sure that the environment one chooses to swim in is safe.

Anthropometry

Anthropometry first developed in the 19^{th} century as a method employed by physical anthropologists for the study of human variation and evolution in both living and extinct populations. Anthropometry is the science of systematically recording measurements of the human body in terms of the dimensions of bone, muscle, and adipose tissue, by measurements of body weight, height, triceps skinfold, calf circumference, abdominal circumference, elbow breadth, and subscapular skinfold. This provides information about the distribution of body fat and skeletal muscle mass.

Body Composition

Body composition is used to find out the percentages of fat, bone, water, and muscle in human bodies. There can be two people of same sex and body weight but could look completely different from each other as they have a different body composition. Body composition and growth are key components of health in both individuals and populations. Body composition also players a vital role for a professional athlete.

The body is composed of two types of mass: Body fat and non-fat mass.

- Body fat is found in muscle tissue, under the skin, or around the internal organs. Some amount of fat is necessary for overall health. This fat which helps protect internal organs, stores fuel for energy, and regulates important body hormones is known as essential fats. But the excess storage of fat in the body is called non-essential fat.

- Non-fat mass includes bone, water, muscle, organs, and tissues. It is also called lean tissue, which are metabolically active, that is they burn calories for energy, while body fat is not.

Anthropometry, Body Composition and Sports Performance

Swimming is one of the most popular competitive sport, and to be at the top it is not just luck or chance. Competitive sports performance in all the games are influenced by various factors such as physical, physiological, psychological abilities including nutrition, technique, tactics, etc.
Is there an impact or anthropometry and body composition on sports performance.

Statement of the problem

The purpose of this study is to find out the relationship of Anthropometric measurement and body composition to the performance of the state level female and male swimmers of Karnataka state.

Delimitation

- The study was delimited to male and female swimmers between the age 10-18 and 10-14 years respectively.
- Swimmers of Karnataka state
- The study was further delimited to the following Anthropometric measurements - height, weight, sitting height, buttocks -knee-length, low leg length, arm length, foot length, chest circumference, and shoulder circumference.
- Body composition of swimmers through skinfold measurement of four sites.
- Performance of swimmers in various competitions (performance of any of the four strokes)

Limitations

- Non availability of sophisticated instruments
- Lack of motivational method

Hypothesis

H_1 - It was hypothesized that there will not be any relationship between the anthropometric measurements to the performance of male and female swimmers.

H_2 - It was hypothesized that there will not be any relationship between the body composition to the performance of male and female swimmers.

Significance of the Study

- This will help the coaches and physical education teachers to select the swimmers for particular events
- Will help in formulating the training program for the swimmers.
- Will avoid unnecessary wastage of time through trial and error methods in the selection of swimmers

2. Methodology

The study was conducted on 23 male swimmers of 10-14 years and 24 female swimmers of 10-18 years were selected as subjects from the state of Karnataka. The swimmers were subjected to the same measurements; there were 10 items of anthropometric variables and 4 body composition measures by skin fold thickness.

The following anthropometric variables and body composition variables were selected for the purpose of this study

Table 1: Anthropometric Variables

Sl. No.	Variables	Unit of measurement
1.	Standing Height/Stature	Centimeters
2.	Weight/Body Mass	Centimeters
3.	Sitting Height	Centimeters
4.	Arm Length	Centimeters
5.	Arm Span	Centimeters
6.	Lower Leg Length	Centimeters
7.	Buttocks-Knee Length	Centimeters
8.	Foot Length	Centimeters
9.	Chest Circumference	Centimeters
10.	Shoulder Circumference	Centimeters

Table 2: Body Composition

Sl. No.	Variables	Unit of measurement
1.	Biceps skin-fold thickness	Millimeter
2.	Triceps skin-fold thickness	Millimeter
3.	Sub-scapular skin-fold thickness	Millimeter
4.	Suprailiac skin-fold thickness	Millimeter

Criterion Measurements

Anthropometric Variables

Standing Height/Stature: The subject was barefoot, standing erect with heels together and the arms naturally by the sides. The heals, buttocks, upper back and back of the head in contact with the wall. The subject is instructed to look straight ahead and take a deep breath and stand tall while a hardboard was held on the head, slightly pressing the head and touching the scale marked on the wall at a right angle. The subject was asked to step out and the reading was recorded to the nearest centimeter.

Weight/Body Mass: A standard weighing machine having accuracy recording to the nearest 50gm. The weight was recorded nearest to half a kilogram.

Sitting Height: The vertical distance from the point vertex to the sitting plane. /the subject is asked to sit stretched upwards with the arms downwards and hand on the thighs, with the lower legs hanging downwards at 90^{o}, the back of the knee touching the edge of the table. Holding the position of the head in F.H. plane, the subject stretches up and sits straight and tall as possible, once the subject takes a deep breath, bringing down the moving arm of the anthropometry on the top of the head, crushing the hair and making firm contact with the vertex.

Arm Length: A flexible steel tape was used. The subject was asked to stand erect, the measurement was taken from acromion to the tip of the third finger. Measurement was to the nearest centimeter.

Arm Span: The distance between the tips of the middle fingers of each hand when both arms are extended laterally and maximally to the level of the shoulder. A flat surface was used for the

subject to outstretch the arms and the back of the subject against the wall with the feet together, along with this, a tape was used to measure.

Lower Leg Length: The straight distance from the landmark tibial medial to sphysion. Leg length is measured vertically from the bottom outside edge of the foot in the center of the instep to a line drawn horizontally through the mid gluteal bulge at the point tangency to a vertical line contacting the buttocks. The tape is placed at the center of the instep and measured to the tip of iliac crest. The leg length is recorded correct to the nearest half centimeter.

Buttocks-Knee Length: Measures the straight distance from the trochanterion to height tibiale (lateral).

Chest Circumference: Measures the size of cross-sectional and circumferential dimensions of the body with the help of a tape.

Shoulder Circumference: Measured with little pressure, without compressing the skin. Anteriorly, the tape passes approximately over the junction between the sermon and the second costal cartilage.

Biceps skin-fold thickness: The thickness of a vertical fold raised on the anterior aspect of the arm, over the belly of the biceps muscle. The skin is raised 1 cm superior to the line marked for the measurement of triceps skinfold thickness and arm circumference. The subject stands with the upper extremity relaxed at the side, the palm directed interiorly. The caliper jaws are applied at the marked level. The measurement is recorded in millimeters.

Triceps skin-fold thickness: Measured in the midline of the posterior aspect of the arm, over the triceps muscle. The subject stands with the arms hanging loose and comfortable by the side. The caliper is used to measure and is recorded in millimeters.

Sub-scapular skin-fold thickness: The measure of subcutaneous adipose tissue and skin thickness on the posterior aspect of the torso. The subject stands comfortably with upper extremity relaxed the thickness is recorded in millimeters.

Suprailiac skin-fold thickness: The suprailiac skinfold is measured in the midaxillary line immediately superior to the iliac crest. The subject stands erect with feet together. Arms by the side slightly abducted. The thickness is recorded in millimeters.

Before the conduct of the tests, the subjects were assembled on the testing venue, the help of the coaches was taken to collect the necessary data. The purpose of the test was explained and a demonstration of the procedure was given before recording the necessary measurements. Efforts were made to ensure accuracy and uniformity in collecting data.

To find out the relationship between anthropometric measurements and body composition Pearson's product moment correlation was employed.

3. Results

All anthropometric measurements were recorded in centimeters, except body weight was recorded in kilograms. The skinfold thickness measurements were recorded in millimeters and the performance of the swimmers in each stroke of 50m was recorded in seconds.

Table 3

Inter co-relation matrix of Anthropemetric measurements, Body composition to performance of state level Male swimmers

		A	B	C	D	E	F	G	H	I	J	K	L	M
		Height	**Weight**	**Body Fat**	**LBM**	**Sitting Height**	**Buttocks Knee Length**	**Lower Leg Length**	**Arm Length**	**Arm Span**	**Chest Circum ference**	**Shoulder Circum ference**	**Foot Length**	**Perfor mance**
A	**Height**													
B	**Weight**	0.920*												
C	**Body Fat**	0.288	0.323											
D	**LBM**	0.896*	0.975*	0.108										
E	**Sitting Height**	0.890*	0.892*	0.17	0.896*									
F	**Buttocks Knee Length**	0.851*	0.890*	0.432*	0.832*	0.829*								
G	**Lower Leg Length**	0.903*	0.930*	0.301	0.906*	0.854*	0.948*							
H	**Arm Length**	0.878*	0.920*	0.238	0.913*	0.835*	0.862*	0.950*						
I	**Arm Span**	0.893*	0.930*	0.197	0.930*	0.826*	0.843*	0.944*	0.979*					
J	**Chest Circum ference**	0.784*	0.877*	0.309	0.854*	0.736*	0.754*	0.788*	0.843*	0.839*				
K	**Shoulder Circum ference**	0.637*	0.686*	0.890	0.706*	0.590	0.609*	0.682*	0.760*	0.762*	0.738*			
L	**Foot Length**	0.863*	0.890*	0.256	0.869*	0.769*	0.765*	0.859*	0.895*	0.910*	0.738*	0.622*		
M	**Perform ance**	-0.143	-0.144	-0.436*	-0.045	-0.096	-0.265	-0.090	-0.043	-0.074	-0.178	-0.041	-0.78	

r.05(df 21) = 0.413

4. Discussion

Discussion on significant correlation between means of selected anthropometric variables of male swimmers:

It is evident from table 3, that there is a significant correlation between the variables B, D, E, F, G, H, I, J, K and L in relation to A. But none of these variables though showing a positive correlation did not give any significance to performance. There was a negative correlation found between performance and height.

There is a significant correlation found between D, E, F, G, H, I, J, K and L in relation to B. But none of these variables though showing a positive correlation did not give any significance to performance. There was a negative correlation found between performance and weight.

There is only a single significant correlation found between F and C and also a negative correlation which is significant was found between performance and body fat, which states that, may be in the male swimmers body fat is a contributing factor for an increased performance.

There is a significant correlation found between E, F, G, H, I, J, K and L in relation to D. There was negative correlation found between performance and LBM.

There is a significant correlation found between F, G, H, J and L in relation to E. But none of these variables though showing a positive correlation did not give any significance to performance and there is a negative correlation found between performances and sitting height.

There is a significant correlation found between G, H, I, J and L in relation to F. There is also a negative correlation found between performance and Buttocks-Knee length.

There is a significant positive correlation found between H, I, J, K and L in relation to G. A negative correlation was found between performance and Arm Length.

There is a significant positive correlation found between J, K and L in relation to I and no significant correlation was found between performance and Arm Span.

There is a significant positive correlation found between K and L in relation to J and no significant correlation found to the performance, though a negative correlation is found between performance and Chest circumference.

There is a significant positive correlation found between L and K and no significant correlation to the performance, and also a negative correlation was found between performance and Shoulder circumference. Another negative correlation is shown in the table between performance and foot length.

Discussion on significant correlation between the means of selected anthropometric and body composition variables to the performance of male swimmers:

Further, Table-3 shows that there is a significant relation between performance and body fat in the male swimmers, this explains that the body fat becomes an important factor which assists in better performance, moderate levels of fat actually aids performance by providing additional buoyancy and insulation provided by the fat to a reduced heat loss.

An important consideration in a persons floating is the capacity of the lungs, heavily muscled and who has heavy bones, but who has little amount of fat, the floatation given by air in the lungs is critical and the swimming styles adopted will be modified to meet this drawback. Usually men have less amount of fat content in the body compared to the women increase % of fat may contribute to me performance as according to the correlation matrix. There were other significant correlations found but none has got direct relation to the increase of performance in both male and female swimmers.

Table 4

Inter co-relation matrix of Anthropometric measurements, Body composition to performance of state level Female swimmers

		A	B	C	D	E	F	G	H	I	J	K	L	M
		Height	**Weight**	**Body Fat**	**LBM**	**Sitting Height**	**Buttocks Knee Length**	**Lower Leg Length**	**Arm Length**	**Arm Span**	**Chest Circum ference**	**Shoulder Circum ference**	**Foot Length**	**Perfor mance**
A	**Height**													
B	**Weight**	0.494*												
C	**Body Fat**	0.180	0.367											
D	**LBM**	0.454*	0.930*	0.005*										
E	**Sitting Height**	0.692*	0.436*	0.015	0.458*									
F	**Buttocks Knee Length**	0.205*	0.249*	0.97	0.227	0.167								
G	**Lower Leg Length**	0.390	0.464*	0.127	0.470*	0.336	0.220							
H	**Arm Length**	0.420*	0.547*	-0.91	0.634*	0.550*	0.149	0.793*						
I	**Arm Span**	0.452*	0.594*	-0.190	0.718*	0.610*	0.229	0.703*	0.927*					
J	**Chest Circum ference**	0.256	0.853*	0.373	0.791*	0.256	0.147	0.436*	0.489*	0.839*				
K	**Shoulder Circum ference**	0.317	0.906	0.430*	0.821*	0.349	0.212	0.442*	0.505*	0.762*	0.934*			
L	**Foot Length**	0.462*	0.178	-0.077	0.220	0.564*	0.151	0.526*	0.532*	0.910*	0.054	0.008		
M	**Perform ance**	-0.362	-0.283	0.084	-0.329	0.486*	-0.630	-0.384	-0.459*	-0.074	-0.054	-0.131	-0.195	

r.05(df 21) = 0.404

Discussion on significant correlation between means of selected anthropometric variables of female swimmers:

It is evident from table 4, that there is a significant correlation between the variables B, D, E, H, I, and L in relation to A. Though the variables show a significant positive correlation, it foils to show any significance to performance. Also there is a negative correlation found between performance and height.

There is a significant correlation found between D, E, G, H, I and J in relation to B. Though the variables show a significant positive correlation, it fails to show any significance to performance. There is a negative correlation found between performance and weight.

There is a significant correlation found between D and K in relationship to C. Though the variables show a significant positive correlation, it fails to show any significance to performance. Also, there is a negative correlation found between arm length and body fat, arm span and body fat also foot length and body fat.

There is a significant correlation found between E, G, H, I, J and K in relation to D. Though the variables show a significant positive correlation, it fails to show any significance to performance. Also there is a negative correlation found between performance and LBM.

There is a significant correlation found between H, I, and L in relation to E. Also there is a significant positive correlation between performance and sitting height. This study shows that sitting height may have a contributing factor for an increased performance. The increased upper body length may give a good reach for a swimmer to perform well, also giving an aerodynamic shape and this also allows the swimmer to reduce drag in the water.

There is a significant positive correlation found between H, I, J, K and L in relation to G. Though the variables show a positive correlation, it fails to show any significance between performance and Lower Leg Length.

There is a significant positive correlation found between I, J, K and L in relation to H. Also there is a significant negative correlation found between performance and Arm length. It explains that arm length could be a contributing factor for better performance. The final touch to the wall becomes the important part for a swimmer as it may give him the best timing for an early touch.

There is a significant correlation between J, K and L in relation to I. Also there is a significant negative correlation found between performance and Arm Span. It may be possible for a greater performance for a swimmer with a good Arm span. As the arms are the most useful part for a swimmer and the arm span may give the swimmer a greater reach and a greater pulling length in the water, this may increase the speed in water and contributing to the swimmer.

There is a significant positive correlation found between K and J. A negative correlation found between performance and Chest circumference. Although negative correlation was found between performance and Shoulder circumference and also performance and Foot Length.

Discussion on significant correlation between the means of selected anthropometric and body composition variables to the performance of female swimmers:

Further, Table - 4 shows that there is a significant relation between performance and sitting height, performance and arm length and performance and arm span in the female swimmers.

The table explains that if the sitting height is more, it shows an increase in the performance, this may be because of the greater reaching ability as the upper body length increases the body may possess a good aero dynamic shape which helps to reduce drag and increases the speed of the body to move through water.

Another significant relation is that the arm length contributes to the increase in performance the greater the arm length, the swimmer may be able to give a great reach and is able to get more distance of pull in the water and also this helps to lot in the finishing where 'touch' becomes the important factor of winning in second's time.

There is also a significant relation between performance and Arm span. The longer the arms the better the performance given as the swimmer can get a longer distance of pull on each arm and this may allow the body to increase the speed of the body moving inside the water.

5. Summary, Conclusion and Recommendations

Summary: This study was undertaken to find out the relationship of anthropometric measurements and body composition to the performance of state level male and female swimmers. Selected anthropometric measurements such as height, weight, sitting height, buttocks-knee-length, lower leg length, arm length, arm span, chest circumference, shoulder circumference, foot length and skinfold thickness of triceps, biceps, subscapular and suprailiac also with performance in various strokes of freestyle, breast stroke, butterfly stroke and back stroke (50 m) a total of 47 swimmers, 23 male and 24 female from BAC were selected as subjects.

Pearson's product moment correlation method was used for the statistical calculation to find the significant correlation between swimming performance and selected anthropometric measurements and body composition.

Conclusions:

1. Body fat was the most reliable single body composition component which significantly correlated with swimming performance in male swimmers.

2. Sitting height, arm length and arm span was the most reliable anthropometric measurement which significantly correlated with swimming performance in female swimmers.

3. No other component and anthropometric measurements were found significant to the swimming performance in both male and female swimmers.

Recommendations:

1. A similar study may be undertaken involving other anthropometric measurements of the body.

2. Similar study may be undertaken on the national level swimmers.
3. Study may be undertaken by taking performance as the criterion of back stroke breast stroke, free style and butterfly stroke swimmers separately.
4. Study can be undertaken by taking elite swimmers as subjects.

6. References

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