The Contribution of Anthropometric Characteristics to Physical Ability and 100-m Freestyle Swimming Performance

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Abstract. The anthropometric characteristics proved to be a predictor of the physical ability and 100 m freestyle swimming performance. Some swimming clubs in Indonesia, especially in Pati Regency have not applied anthropometric measurements to obtain anthropometric data of athletes. The purpose of this study was to know the contribution of anthropometric characteristics to physical ability and 100 m freestyle swimming performance. This research is a quantitative research with test and measurement. Anthropometric are measured using anthropometers. Physical abilities are measured using a dynamometer (hand strength, hand grip) and a standing board jump (power limb). The population of all members of the swimming club Tirta Amarta Pati. The sample amounted to 15 male swimmers with purposive sampling technique. The data were tested by separate regression and multiple regression to test the relation and contribution value of anthropometric characteristics to physical ability and 100 m freestyle swimming performance. Results: anthropometry has a mixed correlation to the physical capabilities and 100 m freestyle swimming performance. Contribution percentage value is big, medium and not too mean. This study notes the anthropometric characteristics of the athlete pool as well as the anthropometry sections that are important for the physical abilities and 100 m freestyle swimming performance. In short, anthropometric characteristics predict physical abilities and 100 m freestyle swimming performance. Anthropometric tests are used to identify gifted young swimmers. Trainers should pay attention to important anthropometry characteristics as a reference in the determination of the exercise program policy.

Keywords: Anthropometry, Physical Ability and 100m Freestyle Swimming Performance

1 Introduction

Some studies have found that anthropometric characteristics have been shown to be a critical factor in performance. According to Martin-Matillas [1] various factors such as physical fitness, motor skills, mental abilities, tactical exercises and anthropometry

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profiles affect the performance and success of the athlete. This study indicates that the performance and success of athletes is also determined by anthropometric characteristics. In short, anthropometric characteristics serve as a reference in predicting the achievement of maximum physical ability and its effects on performance and success. In another study, it was revealed that the length of upper extremity, leg strength and grip strength were found as a determinant factor to 100 m freestyle swimming performance in 12-14 year old male swimmers [2]. In the study, it became clear that anthropometric characteristics were related to physical abilities and performance.

Anthropometry literally means body measurement. Anthropometry comes from "anthro" which has human meaning and "metri" which means size. Anthropometry is a study of the measurement of the human body dimension of bone, muscle and adipose or fat tissue. According Wignjosoebroto [3], anthropometry is a study related to the measurement of the dimensions of the human body. Anthropometric fields include various sizes of the human body such as weight, position when standing, when stretching the arms, body circumference, leg length, and so on.

According Sugiyanto [4], physical ability is the ability to function organ organs in performing physical activities. Physical ability is very important to support and develop psychomotor activities. According to Wahjoedi [5] in Khetut [6] muscle strength is the force, force or tension that a muscle or group of muscles can gain in a maximum-load contraction, muscle strength is the maximum amount of stress that the muscle can do in a single contraction. According to Sajoto [7] muscle power is the ability of a person to use the maximum power that is done in the shortest time.

Performance is to judge how a person has worked against a predetermined target [8]. A person's performance is a combination of ability, effort and opportunity that can be judged from his work [9]. In sports swimming, performance is generally measured using the time records obtained when traveling a certain distance.

Some clubs in Indonesia, especially in Pati Regency, have not applied anthropometric measurements to attempt to obtain data on anthropometric characteristics of athletes. The anthropometric data of athletes is useful in determining the policy of trainers in delivering an exercise program in enhancing certain components of physical ability that affect performance. An antromometric data tested for its contribution to physical and performance capabilities can indicate how the correlation and contribution of each part of the body to physical and performance capabilities. Thus, the trainer can obtain data about which parts of the body are most influential on physical ability and performance. After knowing the data, the trainer can predict the important parts of the body as well as add to the exercises that focus on improving physical abilities in the area.

This study aims to find out the anthropometry characteristics of swimming athletes at Tirta Amarta Pati Swimming Club and to know how much contribution of anthropometry characteristics to physical ability and 100 m freestyle swimming performance.

2 Method

This research is a quantitative research with survey method with data collection technique using test and measurement. The experiment was conducted in Swimming Club Tirta Amarta Pati precisely in Swimming Pool of Tirta Pati threshold in February 2018. Independent variable of this research is anthropometry, while the dependent variable of this research is physical ability and swimming performance. Characteristics of anthropometry including somatotype were measured using an anthropometer set. Physical ability is measured using a dynamometer (hand strength and hand grip) and a standing board jump (power limb). The population is taken from all members of the swimming club Tirta Amarta Pati. The sample amounted to 15 male swimmer with purposive sampling technique according to age criteria 12-14 years and gender only men. The data are tested by separate regression and multiple regression to test whether there is relationship between independent variable anthropometry characteristic to physical ability and 100 m freestyle swimming performance and how big contribution value. Before tested regression, normality test using kolmogorov-smirnov test. To facilitate data analysis, researchers used the IBM SPSS Statistics 20 program and the statistical significance level was accepted as $p < 0.05$

3 Results and Discussion

3.1 Data Analys

Table 1. Descriptive Analysis

Model	Min	Max	Mean	Standard Deviation
Age (year)	11	15	12,6	0,99
Table 1. Continuation				
Model	Min	Max	Mean	Standard Deviation
Height (cm)	133,8	166	148,85	11,15
weight (kg)	28	62,8	45,23	10,25
Upper Arm Length (cm)	22,6	34	27,71	3,61
Lower Arm Length (cm)	19	30	23,03	2,86
Hand Length (cm)	15,2	19	16,97	1,33

Leg Length (cm)	68,7	89,3	78,21	6,63
Relax Upper Arm Circumference (cm)	21	30,5	26,30	2,86
Flexion and Tense Upper Arm Circumference (cm)	21,5	31,5	26,90	2,95
Lower Arm Circumference (cm)	18,5	25,5	22,70	2,10
Wrist Circumference (cm)	12,5	17	14,87	1,33
Thigh Circumference (cm)	39	55,5	48,60	4,52
Calf Circumference (cm)	23,5	36	30,40	3,43
Endomorph	4,6	7,9	5,64	0,95
Mesomorph	3,6	6,8	5,02	1,03
Ectomorph	0,5	7,0	4,66	2,15
Arm Strenght (kg)	6	21	13,60	5,08
Hand Grip Strenght (kg)	14,8	40,5	23,51	8,08
Limb Power (cm)	130	210	170,40	24,22
100m Freestyle Swimming (seconds)	69,63	104,89	81,20	10,25

3.2 Correlation Test

Table 2. Correlation Analysis Between 7 Characteristics of Anthropometry (Upper Arm Length, Lower Arm length, Hand Length, Relax Upper Arm Circumference, Flexion and Tension Arm Circumference, Lower Arm Circumference, Wrist Circumference) With Physical Ability (Arm Strength).

Model	Pearson Correlation	Sig. (2-Tailed)
Upper Arm Length	,533*	,041
Lower Arm Length	,668**	,006
Hand Length	,665**	,007
Relax Upper Arm Circumference	,577*	,024

Flexion and Tension Upper Arm Circumference	,588*	,021
Lower Arm Circumference	,640*	,010

Table 2. Continuation

Model	Pearson Correlation	Sig. (2-Tailed)
Wrist Circumference	,578*	,024

Table 3. Correlation Analysis Between 7 Characteristics of Anthropometry (Upper Arm Length, Lower Arm length, Hand Length, Relax Upper Arm Circumference, Flexion and Tension Arm Circumference, Lower Arm Circumference, Wrist Circumference) With Physical Ability (Hand Grip Strength)

Model	Pearson Correlation	Sig. (2-Tailed)
Upper Arm Length	,748**	,001
Lower Arm Length	,647**	,009
Hand Length	,825**	,000
Relax Upper Arm Circumference	,639*	,010
Flexion and Tension Upper Arm Circumference	,649**	,009
Lower Arm Circumference	,742**	,002
Wrist Circumference	,772**	,001

Table 4. Correlation Analysis Between 3 Characteristics of Anthropometry (Leg Length, Thigh Circumference, Calf Circumference) To Physical Ability (Limb Power)

Model	Pearson Correlation	Sig. (2-Tailed)
Leg Length	,684**	,005
Thigh Circumference	,291	,292
Calf Circumference	-,183	,514

Table 5. Correlation Analysis Between 13 Characteristics of Anthropometry (Upper Arm Length, Lower Arm length, Hand Length, Leg Length, Relax Upper Arm Circumference, Flexion and Tension Arm Circumference, Lower Arm Circumference, Wrist Circumference, Thigh Circumference, Calf Circumference, Endomorph, Mesomorph, Ectomorph) To 100m Freestyle Swimming Performance

Model	Pearson Correlation	Sig. (2-Tailed)
Upper Arm Length	-,541*	,037
Lower Arm Length	-,408	,131
Leg Length	-,358	,190
Relax Upper Arm Circumference	-,271	,329
Flexion and Tension Upper Arm Circumference	-,273	,326
Table 6. Continuation		
Model	**Pearson Correlation**	**Sig. (2-Tailed)**
Lower Arm Circumference	-,430	,110
Wrist Circumference	-,214	,445
Thigh Circumference	-,321	,243
Calf Circumference	-,119	,672
Endomorph	,513	,051
Mesomorph	,113	,690
Ectomorph	-,245	,379

3.3 Multiple Regression Test

Table 6. Summary Model Table Multiple Regression Test Between 7 Characteristics of Anthropometry (Upper Arm Length, Lower Arm length, Hand Length, Relax Upper Arm Circumference, Flexion and Tension Arm Circumference, Lower Arm Circumference, Wrist Circumference) With Physical Ability (Arm Strength)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,853a	,727	,454	3,75454

Table 7. Summary Model Table Multiple Regression Test between 7 Characteristics of Anthropometry (Upper Arm Length, Lower Arm length, Hand Length, Relax Upper Arm Circumference, Flexion and Tension Arm Circumference, Lower Arm Circumference, Wrist Circumference) With Physical Ability (Hand Grip Strength)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,900[a]	,810	,620	4,98385

Table 8. Summary Model Table Multiple Regression Test Between 7 Characteristics of Anthropometry (Leg Length, Thigh Circumference, Calf Circumference) With Physical Ability (Limb Power)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,774[a]	,598	,489	17,31734

Table 9. Summary Model Table Multiple Regression Test Between 13 Characteristics of Anthropometry (Upper Arm Length, Lower Arm length, Hand Length, Leg Length, Relax Upper Arm Circumference, Flexion and Tension Arm Circumference, Lower Arm Circumference, Wrist Circumference, Thigh Circumference, Calf Circumference, Endomorph, Mesomorph, Ectomorph) With 100m Freestyle Swimming Performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,934[a]	,873	-,785	13,69472

3.4 Separate Regression Test

Table 10. Summary Model Table Separate Regression Test between 7 Characteristics of Anthropometry (Upper Arm Length, Lower Arm length, Hand Length, Relax Upper Arm Circumference, Flexion and Tension Arm Circumference, Lower Arm Circumference, Wrist Circumference) With Physical Ability (Arm Strength)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate

Upper Arm Length	,533[a]	,284	,229	4,46160
Lower Arm Length	,668[a]	,447	,404	3,92273
Hand Length	,665[a]	,442	,399	3,94087
Relax Upper Arm Circumference	,577[a]	,333	,281	4,30855
Flexion and Tension Upper Arm Circumference	,588[a]	,346	,296	4,26410
Lower Arm Circumference	,640[a]	,409	,364	4,05390
Wrist Circumference	,578[a]	,335	,283	4,30229

Table 11. Summary Model Table Separate Regression Test between 7 Characteristics of Anthropometry (Upper Arm Length, Lower Arm length, Hand Length, Relax Upper Arm Circumference, Flexion and Tension Arm Circumference, Lower Arm Circumference, Wrist Circumference) With Physical Ability (Hand Grip Strength)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Upper Arm Length	,748[a]	,559	,525	5,56930
Lower Arm Length	,647[a]	,419	,375	6,39110
Hand Length	,825[a]	,681	,657	4,73452
Relax Upper Arm Circumference	,639[a]	,408	,362	6,45284
Flexion and Tension Upper Arm Circumference	,649[a]	,421	,376	6,38328
Lower Arm Circumference	,742[a]	,550	,515	5,62577

Wrist Circumference	,772[a]	,596	,565	5,32918

Table 12. Summary Model Table Separate Regression Test Between 3 Characteristics of Anthropometry (Leg Length, Thigh Circumference, Calf Circumference) With Physical Ability (Limb Power)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Leg Length	,684[a]	,468	,428	18,32791
Thigh Circumference	,291[a]	,085	,014	24,04976
Calf Circumference	,183[a]	,034	-,041	24,71410

Table 13. Summary Model Table Separate Regression Test Between 13 Characteristics of Anthropometry (Upper Arm Length, Lower Arm length, Hand Length, Leg Length, Relax Upper Arm Circumference, Flexion and Tension Arm Circumference, Lower Arm Circumference, Wrist Circumference, Thigh Circumference, Calf Circumference, Endomorph, Mesomorph, Ectomorph) With 100m Freestyle Swimming Performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Upper Arm Length	,541[a]	,293	,239	8,94418
Lower Arm Length	,408[a]	,166	,102	9,71166
Hand Length	,431[a]	,186	,124	9,59656
Leg Length	,358[a]	,128	,061	9,93137
Relax Upper Arm Circumference	,271[a]	,073	,002	10,23966
Flexion and Tension Upper Arm Circumference	,273[a]	,074	,003	10,23468

Lower Arm Circumference	,430[a]	,185	,122	9,60334
Wrist Circumference	,214[a]	,046	-,028	10,39203
Thigh Circumference	,321[a]	,103	,034	10,07433
Calf Circumference	,119[a]	,014	-,062	10,56170
Endomorph	,513[a]	,263	,206	9,13162
Mesomorph	,113[a]	,013	-,063	10,56985
Ectomorph	,245[a]	,060	-,012	10,31382

4 Discussion

In this study, the average age of swimmers was 12.9 ± 0.99. The mean age in this study was slightly higher than the mean age in the [10] and slightly lower than that of [2]. While the mean height and weight in this study was slightly lower than that of [10] and [2].

Significant positive correlations were found between 7 anthropometric characteristics (upper arm length, lower arm length, hand length, relaxed upper arm circumference, flexed and tensile upper arm circumference, arm circumference, arm circumference) with physical ability (arm strength). 7 anthropometric characteristics (upper arm length, lower arm length, hand length, relaxation upper arm, upper flexion and tension, flexion of the forearm, wrist circumference) are also positively correlated with physical ability (hand grip strength).

The dependent variable of physical ability (limb power) is positively correlated with independent variables of leg length and thigh circumference. on the contrary, the dependent variable of physical ability (power of the limb) is negatively correlated with the calf circumference. Regarding the dependent variable 100 m freestyle swimming performance with 13 anthropometric characteristics (upper arm length, lower arm length, hand length, limb length, relaxation upper arm, upper flexion and tension, flexion, arm circumference, wrist circumference, thigh circumference, calf circumference, endomorph, mesomorfi, ectomorfi) there is a varied correlation. Negative correlations occur between the dependent variables of 100m freestyle performance with the upper arm length, the length of the forearm, the length of the hand, the length of the limbs, the relaxation of the upper arm, the flexion and tension flexion, the circumference of the forearm, the circumference of the wrist, calf and ectomorfi. While a positive correlation occurs between the dependent variable performance of the 100m freestyle pool with endomorph and mesomorfi. Regarding the positive correlation between the dependent variable performance of 100m freestyle pool with endomorph and mesomorfi is consistent with the [10]

Adjusted R Square results from separate regression tests between 7 anthropometric characteristics (upper arm length, lower forearm length, hand length, relaxation upper arm, flexion and tension flexed upper arm, arm circumference, wrist circumference)

with physical ability (arm strength) shows the percentage contribution of each independent variable to the dependent variable of physical ability (arm strength). From the table, we get Adjusted R Square value of upper arm length of 0.229, lower arm length of 0.404, hand length of 0.399, relaxed upper arm circumference of 0.281, flexural flexion and tension of 0.296, forearm circumference of 0.364, hand of 0.283. Thus, the contribution of the upper arm length is 22.9%, the forearm length is 40.4%, the hand length is 39.9%, the relaxation upper arm rim is 28.1%, the flexion and tension flex arm circumference is 29, 6%, forearm circumference of 36.4%, wrist circumference of 28.3%. At the same time, the combination of 7 anthropometric characteristics (upper arm length, lower forearm length, hand length, relaxation upper arm, flexion and tension flex arm circumference, arm circumference, circumference of wrist) contributed 45.4% physical ability (arm strength).

Adjusted R Square results from a separate regression test between 7 anthropometric characteristics (upper arm length, lower arm length, hand length, upper arm relaxation rings, flexion and tension flexed upper arm, arm circumference, wrist circumference) with physical ability (grip strength hand) shows the percentage of contribution of each independent variable to the dependent variable of physical ability (hand grip strength). From the table, the Adjusted R Square Adjusted Ratio value is 0.525, the forearm length is 0.375, the length of the hand is 0.657, the upper relaxation of the upper arm is 0.362, the flexion and tension flex circumference is 0.376, the forearm circumference is 0.515, the circumference of the wrist hands of 0.565. Thus, the contribution of the upper arm length is 52.5%, the length of the forearm is 37.5%, the hand length is 65.7%, the relaxation upper arm rim is 36.2%, the flexion and tension flex arm circumference is 37, 6%, forearm circumference of 51.5%, wrist circumference of 56.5%. At the same time, the combination of 7 anthropometric characteristics (upper arm length, lower arm length, arm length, relaxation upper arm, flexion and tension flex arm circumference, arm circumference, wrist rim) contributed 62% (hand grip strength).

Adjusted R Square results from separate regression tests between 3 anthropometric characteristics (leg length, thigh circumference, calf circumference) with physical ability (limb power) indicate a variable percentage of contributions. From the table, obtained value Adjusted R Square limb length of 0.428, thigh circumference of 0.014, calf circumference of -0.041. Thus, limb length contribution was 42.8%, thigh circumference of 1.4%, calf circumference of -4.1%. While together, a combination of 3 anthropometric characteristics (leg length, thigh circumference, calf circumference) contributed 48.9% of physical ability (limb power).

Adjusted R Square results from a separate regression test between 13 anthropometric characteristics (upper arm length, arm length, hand length, tungki length, relaxation upper arm, upper flexion and tension flexion, arm circumference, wrist circumference, thigh circumference, calf circumference, endomorph, mesomorfi, ectomorfi) with a 100m freestyle pool performance show the percentage contribution variation. Adjusted R Square value of upper arm is 0,239, length of forearm 0,102, hand length 0,124, length of leg 0.061, relaxation upper arm circumference 0,002, flexion and tension flexural arm circumference 0,003, forearm circumference 0,112, circumference wrist of -0.028, thigh circumference of 0.034, calf circumference of -

0.062, endomorfi of 0.206, mesomorfi of -0.063, ectomorfi of -0.012. Thus, the contribution of the upper arm length was 23.9%, the length of the forearm by 10.2%, the hand length by 12.4%, the limb length by 6.1%, the upper relaxation arm rim by 0.2%, the circumference flexed and tense upper arms of 0.3%, forearm circumference of 11.2%, wrist circumference of -2.8%, thigh circumference of 34, calf circumference of -6.2%, endomorph of 20.6% , mesomorfi of -6.3%, ectomorfi of -12%. While together, a combination of 13 anthropometric characteristics (upper arm length, lower arm length, hand length, leg length, upper arm circumference relaxation, flexed and tensile upper arm circumference, lower arm circumference, wrist circumference, thigh circumference, calf circumference, endomorph, mesomorfi, ectomorfi) -78.5% against a 100m freestyle pool performance.

5 Conclusions

Conclusions from this study, anthropometric characteristics can be used as predictors of physical ability and 100 m freestyle swimming performance. Anthropometric tests can be used to identify gifted young swimmers by assessing their anthropometric characteristics to match the physical capabilities and 100 m freestyle swimming performance. Trainers should take into account the important anthropometric characteristics for the physical abilities and 100 m freestyle swimming performance as a reference in the determination of exercise program policies.

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