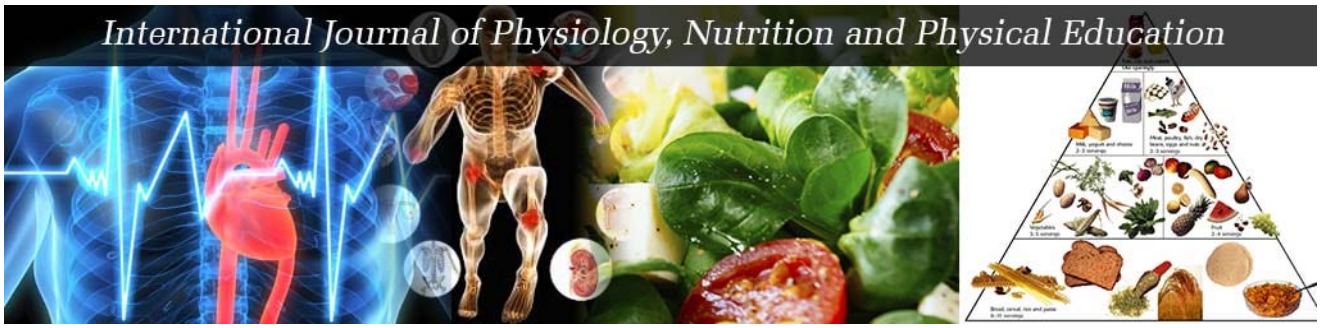

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The association between anthropometric, physiologic and physical fitness variables with 5000m running performance for junior female athletes

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Abstract
The major aim of this study was to investigate the association between anthropometric, physiologic and physical fitness measures (independent variables) and 5000m running performance (dependent variable) for junior female athletes according to the IAAF's scoring tables of athletics based on time. For the purpose of this study a total of 18 female junior 5000m athletes whose age ranging 17-19 years were selected from two national athletics training centeres namely Tirunesh Dibaba and Ethiopian Youth Sport Academy. Through both the critical and allied literature pertaining to the problem under consideration the following anthropometric, physiologic and physical fitness variables were selected – Anthropometric variables: standing height, body weight, body mass index, sum of 6 skinfold measure (for upper body), sum of 8 skinfold measure (for upper and lower body), percent body fat, upper arm girth, upper thigh girth, waist girth, gluteal girth, mid-thigh girth calf girth total arm length and total leg length. Physiologic variables: V02max, resting heart rate, systolic blood pressure and diastolic blood pressure and physical fitness variables: 40m speed test, 300m time trial for special endurance and 12 minutes run general endurance. The skin fold measurements were taken at the following sites: biceps, triceps, subscapular, pectoral, iliac crest, abdominal, front thigh and medial calf. For the purpose of achieving the objectives of this study, the data thus collected was manipulated through SPSS (statistical package for social science) version 20. Particularly for the purpose of investigating the relationship between the selected anthropometric, physiologic and physical fitness measurements (independent variables) with athletes' running performance in 5000m (dependent variable) a Pearson's Product moment Coefficient Correlation with a significant level of .05 was employed. Multiple Regression Analysis was computed to find out the contribution of each anthropometric, physiologic and physical fitness variable in predicting running performance for women 5000m athletes. The result indicated that a significant association at .05 level was found between athletes standing height, body weight, percent body fat, sum of 6 skinfold measures, sum of 8 skinfold measures, calf girth, and total leg length from the anthropometric variables, vo2max and resting heart rate form the physiological variable and; 300m time trial for special endurance and 12 minutes run general endurance. Besides, the linear multiple regression analysis indicated that the mixture of anthropometric and physical fitness variables namely standing height, body weight, percent body fat, 300m special endurance test and 12 minutes run general endurance test were significant predictors of running performance for female 5000m athletes accounting 95.7% of variability in performance.

Keywords: Anthropometry, Physiology, Physical fitness, running performance

1. Introduction
The world of games and sports has crossed many milestones, as a result of different achievements in general and their application in the field of sports in particular. Scientific investigation into performance of sportsman has been playing an increasingly important role to attain excellence of performance in different sports. Now the sports-man have been able to give outstanding performance because of involvement of new scientifically substantiated training methods and means of execution of sports exercise such as sports techniques and tactics, improvement of sports grass, and equipment, as well as other components and condition of the system of sports training.

In addition to all the mentioned variables above Physiological and Anthropometric measurement and motor fitness variable play a vital role in almost all games and sports. Sportsmen concentrate on the development of speed, strength, agility, flexibility, endurance etc. as a part of preparation in their respective sports.

General motor abilities assist a sportsman in learning specific skills from a solid base over which he can develop excellence in measurement and motor fitness variable play a vital role in almost all games and sports. Sportsmen concentrate on the development of speed, strength, agility, flexibility, endurance etc. as a part of preparation in their respective sports. General motor abilities assist a sportsman in learning specific skills from a solid base over which he can develop excellence in the particular game he is involved. Performance in certain events and activities has already reached miracle increase in speed performance by .01 seconds seems to be different and challenging task. In the present era development of science and technologies has revolutionized the field of sports. Every day the new records are being established in different sports activities. International level competitions sports presence bringing honour for their countries in the field of physical education and sports as also affected from such developments of science and technologies over the last century, and sports has captured an important place in the world. This is so because the application to the field of sports and physical education has enabled modern youth to develop physical capabilities beyond anything earlier imagined.

Physical characteristics and body composition have been known to be fundamental to excellence in athletic performance (Mathur & Salokun, 1985) [6]. Specific athletic events require different body types and weights for maximal performance (American Dietetic Association, 1987) [4]. Today it has been widely accepted by the experts that top performance in sports is achieved if an athlete possesses the basic anthropometric characteristics suitable for the event. There are numerous factors which are responsible for the performance of a sportsman. The physique and body composition, including the size shape and form are known to play a significant role in this regard. At present, sportsman for superior performance in any sports is selected on the basis of physical structure and body size. Structural measurement include anthropometric measurements which consist of objective measurement of structures such as height, weight, width, depth and the circumference of the various part of body. Therefore, the athletes in a particular sport must possess such typical characteristics which are of advantage to their performance (Gopal, 2012) [8].

Many factors have been identified as having an influence on success in distance running. Performance in middle- and long-distance running also influenced by a variety of physiological factors. In addition to a high maximal oxygen uptake (VO2max), endurance performance is related to peripheral muscle factors, the oxygen cost of running, or fractional use of VO2max. As a result, suggested that, top-class and highly trained marathon runners are different in terms of VO2max, but they did not develop a discriminate model (Manuel Rabadána; Víctor Díazb; Francisco J. Calderónb; Pedro J. Benitob; Ana B. Peinadob;).

According to sited in (R. Rafael, Omri Inba, the physiological characteristics and capabilities of the elite athlete are developed from a combination of genetic predisposition and arduous physical training.

Thus, this study has investigated the anthropometric, physiologic and physical fitness variable which had significant association with running performance in female 5000m and identifies which anthropometric, physiologic and physical fitness variables predict performance for performance for that distance.

2. Methodology

The present study was carried out in order to examine the association between some selected anthropometric, physiologic and physical fitness variables with running performance in junior female 5000m athletes and to predict which amomg the Anthropometric, physiologic and physical fitness variables predict running performance in female 5000m athletes.

Totally 18 female athletes under the age category of 17-19 years were selected from two athletics training centers in Ethiopia namely Ethiopian Youth sport Academy and Tirunesh Dibaba Athletics training centere. Running times were obtained after consulting the officials and coaches of the training centers approved by the Ethiopian Athletics Federation (EAF).

All runners had been training for around 5 years and had taken part in national competitions. The criteria applied to determine the best performance of those athletes involved in 5000m was established by means of the corresponding performance equivalent according to the score awarded by the International Amateur Athletic Federation (IAAF) (Spiriev, 2014). The IAAF, using a database of performances obtained at world events, assigns a score to each performance, enabling them to compare the different performances in different events for the same athlete [3].

2.1Selection of Variables

The anthropometric, physiologic and physical fitness variables that could influence performance in long distance events particularly in 5000m were recorded by reviewing and studying related literature in detail. The fololowing variables were selected so as to achieve the objective of the present study.

2.2 Anthropometric variables: standing height, body weight, body mass index, sum of 6 skinfold measure (for upper body), sum of 8 skinfold measure (for upper and lower body), percent body fat, upper arm girth, upper thigh girth, waist girth, gluteal girth, mid-thigh girth calf girth total arm length and total leg length. **Physiologic variables:** V02max, resting heart rate, systolic blood pressure and diastolic blood pressure and the **physical fitness variables** were 40m speed test, 300m time trial for special endurance and 12 minutes run general endurance. Athletes running performance was rated by the scoring procedures of the IAAF (International Amateur Athletics Federation).

2.3 Administration of the Test

To get reliable information from the research participants, the types of instruments used have paramount importance. Thus tests and measurements of the variables under study and documents were the main data collecting mechanisms of this study. Below, the detailed description and procedures are presented.

2.4Procedure of recording anthropometric variables

For the purpose of obtaining current reliable anthropometric data from subjects the following measurement equipments and procedures were used.

For body stature (height) - a standardized stadiometer, for body weight - a standard weighing machine (Omron HBF-375 Karada Scan Body Fat Analyzer), for leg and arm length - anthropometric rod and for Skinfold measurement - Gadget Hero's GHAC Body Fat Analyzer were used. All the equipments used for the measurement of anthropometric variables are tested for their accuracy.

2.5 Procedure of recording physiological variables

Vo2max, blood pressure and resting heart rate were the focus of physiological variables. For the measurement of vo2max of athletes the cooper VO2max test was employed. As a result, the necessary equipments and supplies were provided. These includes: 400 meter track – marked every 50m, Stop watch, and assistants were provided. This test comprises of seeing how far an athlete can run in 12 minutes. The assistant have recorded the total distance covered and based on the distance covered an estimate of the athlete's VO2max has been calculated.

For the purpose of determining athletes' blood pressure and resting heart rate the instrument Omron HEM-7200 -AP3 (JPN1) Bp Monitor, has been used. The blood pressure and resting heart rate of athletes were measured right after athletes naturally wake up in the morning, without an alarm and the measurement were taken for 3 consecutive days in order to enhance the reliability of the result.

To undertake the Vo2Max test the following facility and equipments were used. These were: 400 metre track – marked every 50m, Stop watch and assistants. The test comprised of seeing how far an athlete can run in 12 minutes. All the athletes were started at the same time for the copper vo2max test after proper warm up. The assistants were record the total distance covered. Based on the distance covered an estimate of the athlete's VO2max was calculated as follows: VO2max = (Distance covered in metres – 504.9) / 44.73

2.6 Procedure of recording Physical fitness parameters

To undertake 40 Metre Sprint Test the following were used. These are: 400m track, Cones, Stop watch and assistant. The test was conducted on a marked 40m section on the track, letting the athletes in a standing start with leading foot behind the starting line. On the command "Go", the athletes were sprint as fast as possible through to the finish line. Assistants were recorded the time and the athletes were given two attempts with approximately 2-5 minutes recovery period. The test was made after proper instruction and warm up.

The 300m speed endurance test was used to measure athletes' time to cover the 300m distance. To undertake this test 400m track, stop watch, cones and assistants were used. The test was conducted as follows: Marked with cones a 300m section on the track, athletes were used a standing start with leading foot behind the starting line, on the command "Go", the athletes were sprint as fast as possible through to the finish line. Assistants were recorded the time and the athletes were given two attempts with approximately 2-5 minutes recovery period. The test was made after proper instruction and warm up.

For testing the general endurance of athletes the copper 12 minutes run was employed and it comprises seeing of how far an athlete can run in 12 minutes. To undertake this test 400 metre track – marked every 50m, Stop watch and assistants were used. All the athletes were started at the same time for the copper 12 minutes run test after proper warm up. The assistants were recorded the total distance covered with in 12 minutes.

Prior to testing, the investigator was well acquainted with the subjects with due help from their coaches to explain the procedure in collecting the data. They were requested to co-operate and participate actively for the same.

The precise assessment of anthropometric measurements can be difficult and therefore extreme care is required. For the anthropometric measurements, throughout the protocol the subject has been asked to assume different positions. Assistants were used to record values and help standardize measurement techniques. First of all, the researcher had the consent of Ethiopian youth sport Academy office for its permission for cooperation and the collection of data and relevant information. Prior to measuring and data collection, the testers and assistants were given training about appropriate measuring technique. This is to reduce the level of error in repeated measurements and among investigators, to establish accuracy, and to expose any weaknesses in technique.

The investigator were gathered every subject in their own training centres and they were explained the purpose of the study. Necessary instructions were passed to the subjects. Each subject was informed as to what measurements are to be taken, what positions to assume during the measurement and local or institutional rules followed regarding consent. In addition to the above general aspects specific instructions and procedures has been followed strictly during anthropometric tests and measurements. All the measurements for anthropometry were taken according to the International Standards for Anthropometric Assessment.

2.7 Tester's Competency

All the measurements were taken by the research scholar himself with the assistances who are well trained in the area. Before going for the original data collection the scholar had a number of practice sessions under the supervision and guidance of professionals in the area. The chosen variables were collected by the research scholar along with the assistance of trained personnel who were serving as a coach and researcher in the training centres during the time of August 2015 to May 2016. The data was collected from the athletes with their consent and convenience on the track and field arena, at their place of accommodation and in the gymnasium by the investigator who was assisted by team coaches, managers and members of each training centres.

2.8 Statistical Analysis

The anthropometric, physiologic and physical fitness data obtained from athletes were computed as follows. For the sake of securing athletes' best race performances time for each event and data about athletes background information, documents like training plan and athletes' competition profile from the training centres and the coaches were obtained. Data are expressed as means and standard deviation. For the purpose of achieving the objectives of this study, the data thus collected was manipulated through SPSS (statistical package for social science) version 20. Particularly for the purpose of investigating the relationship between the selected anthropometric, physiologic and physical fitness measurements (independent variables) with athletes' running performance in 5000m (dependent variable) a Pearson's Product moment Coefficient Correlation with a significant level of .05 was employed. Multiple Regression Analysis was computed to find out the contribution of each anthropometric, physiologic and physical fitness variable in predicting running performance for women 5000m athletes.

3. Results and Discussion

The means and standard deviations for performance, anthropometric, physiologic and physical fitness values are presented in Table I, the association between these variables in table 2 and the performance predicting variable are given in table 3 as well.

Table 1: Mean and standard deviation values for anthropometric, physiologic and physical fitness variables in junior female 5000m athletes.

	M	SD
Sta H in cm	156.28	3.56
BW in kg	48.56	3.08
BMI kg.m-2	19.88	.95
S6SFM (upper body)	63.56	13.70
S8SFM (Up & Lo Body)	86.11	17.33
PBF	16.40	2.50
UAG in cm	23.28	2.19
WG in cm	65.50	3.07
GG in cm	87.33	2.85
UTG in cm	49.67	2.59
M-Th G in cm	44.67	1.91
Calf G in cm	31.94	1.30
TAL in cm	58.78	2.34
TLL in cm	82.17	4.73

Table 2: Mean and standard deviation values for anthropometric, physiologic and physical fitness variables in junior female 5000m athletes.

Variable	M	SD
Vo2 Max in Li/min	53.84	6.32
RHR in beat/minute	61.89	7.90
DBP in mmHg	67.61	12.81
SBP in mmHg	109.17	6.21
40 m ST in sec	7.14	.15
300 m SET in sec	46.42	.31
12 min RGET in mt	3395.50	42.61
40 m ST in sec	7.14	.15

The association between athletes' anthropometric, physiologic and physical fitness measures and running performances**.**

Result of Multiple Linear Regression analysis in terms of anthropometric, physiologic and physical fitness measures predictive of running performance in 5000m female athletes.

Table 3: Results of the bi-variate association between athletes' anthropometric characteristics and their running performance.

Variables	Association
Sta.H in cm	-.53*
BW in kg	-.55*
BMI kg.m-2	-.24
PBF	.54*
S6SFM (upper body)	.51*
S8SFM (Up & Lo Body)	.50*
UAG in cm	.34
UTG in cm	-.21
WG in cm	.43
GG in cm	-.27
M-Th G in cm	-.20
Calf G in cm	-.72**
TAL in cm	-.23
TLL in cm	-.60**

Table 4: Results of the bi-variate association between athletes' anthropometric characteristics and their running performance.

Variables	Association
Vo2 Max in ml/kg/min	.806**
RHR in beat/minute	-.684**
SBP in mmHg	-.090
DBP in mmHg	-.184
40 m ST in sec	.094
300 m SET in sec	-.563*
12 min RGET in mt	.779**

Table 5

Model		SS	df	MS	F	*p*
1	Regression	16006.675	5	3201.335	53.185	.000[b]
	Residual	722.314	12	60.193		
	Total	16728.989	17			
a. Dependent Variable: PBRT in secs						
b. Predictors: (Constant), 12 min RGET in meter, PBF, Sta H in cm, 300 m SET in seconds, BW in kg						

Table 6

Model		Unstandardized Coefficients		Standardized Coefficients	t	p
		B	Std. Error	Beta		
1	(Constant)	1701.798	438.913		3.877	.002
	Sta H in cm	4.410	.794	.501	5.555	.000
	BW in kg	-6.110	1.221	-.599	-5.002	.000
	PBF	-3.926	.808	-.313	-4.860	.000
	300 m SET in seconds	26.853	7.466	.265	3.597	.004
	12 min RGET in meter	-.661	.070	-.898	-9.449	.000
a. Dependent Variable: PBRT in secs						

A multiple linear regression was calculated to predict 5000m running time for female athletes based on their selected anthropometric, physiologic and physical characteristics. As a result standing height, body weight, percent body fat, 300m special endurance and 12 minutes run general endurance test were found to predict their running performance. A significant regression equation was found ($F(3,12) = 53.185$, $p < .000$) with an R^2 of .957.

Participants' predicted personal best running time is equal to 1701.798 + (4.410 x 156.2778) - (6.110 x 48.5622) - (3.926 x 16.3967) + (26.853 x 46.4194) – (0.661 x 3395.50), where standing height is measured in cm, body weight is measured in kg, percent body fat is measured in percentage, 300m special endurance in measured in seconds and 12 minutes general endurance is measured in meter. Athletes running time increased 4.410 seconds for each cm of standing height, decreased 6.110 for each kg in body weight, decreased 3.926 seconds for each percent in body fat, increased 26.853 seconds for each seconds in 300m special endurance test and decreased 0.661 seconds for each meter of 12 minutes general endurance. Standing height, body weight, percent body fat, 300m special endurance test and 12 minutes run general endurance test were found significant predictors of running time for female 5000m athletes.

3. Conclusion

From the above findings, discussion and within the limitations of the present study, the following conclusions may be drawn.

1. Most of the anthropometric variables selected for the study namely standing height, body-weight, percent body fat, sum of 6 skin fold measures, sum of 8 skinfold measures, calf circumference, total leg length, had shown significant relationship, though of varying magnitude, with running performance in female 5000m.

2. From the physiological variables selected for the study vo2max and resting heart rate had shown strong and significant relationship with running performance in female 5000m.
3. 300m time trial for special endurance and 12 minutes run for general endurance were the physical fitness variables selected for the study which had shown strong and significant relationship with running performance in female 5000m.
4. Multiple Regression analysis revealed that predictions regarding performance in different categories can be made, by developing multiple regression equations, on the basis of selected anthropometric, physiologic and physical fitness variables for female 5000m athletes.

4. Recommendations

On the basis of analysis and conclusions made the following recommendations are forwarded within the limitations and scope of the study.

1. The coaches and teachers of physical education and sport scientists may recognize the fact that anthropometric variables are important factors and may be considered as essential factors for selecting potential talent for female 5000m running. Particularly, standing height, body-weight, percent body fat, sum of 6 skin fold measures, sum of 8 skinfold measures, calf circumference, total leg length, should be given special attention for tat they were significantly associated to performance in majority of the different category of the study group.
2. The coaches and teachers of physical education and sport scientists may recognize the fact that physiologic variables particularly that of Vo2max and resting heart rate are important factors and may be considered as essential factors for selecting potential talent for female 5000m running athletes.
3. For female 5000m athletes the physical fitness variables namely 300m special endurance and 12 minutes run general endurance may be considered as important factors for selecting potential athletes and as important training factors for the overall enhancement of performance.
4. A similar study may be conducted using high performance and employing more extensive anthropometric, physiologic and physical variables including some psychological factors with wider running events.

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