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VARIABLES AFFECTING EGYPTIAN ATHLETE'S ENDURANCE — A STATISTICAL STUDY

By

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INTRODUCTION :

Sport performace is greatly benefical particularly when starting in early childhood. Sports raise the degree of health and decrease the susceptibility to disease. It develops some mental and social abilities such as courage, endurance, fellowship fairness, respect of the opponent, and readiness for assistance and sacrifice.

Sport's value in physiotheropy and in correction of some developmental abnormalities in childhood is well known. It's an essential element in paychological theropy both in young and old ages.

Sport's through raising the level of physical fitness are one of the important factors that affect the rate of human production.

This beside being a factor in the establishment of peace between nations, through encouraging friendship during international meetings.

The degree of civilisation of a country is measured by its progress in sports, as the later reflects its socials, economic, nutritional, psychlogial and spiritual conditions of its people.

During the $_{20}$th contury, sports exhibited great progress as shown by the remarkable increase in scores obtained in the olympic games.

It was noticed that the Egyptian athlete's scores lag behind international standards. However, the real cause of such lag is not fully understood. IN an attept to explain the cause, several factors were bleamed including racial, genetic, hereditory and dietetic factors. But the real value of the factors as limiting agents for Egyptians's abhlities is doubtful, and the subject remains obscure needing further investigations. It is more reasonsble to believe that the real cause include the lack of hard and serious training, lack of applicction of moder techniques of training and, may be, faylts in directing the athletes to certain sporting disciplines.

AIM OF THE WORK :

The aim of the present study is twofold :

1. To test whether there are significant differences between the endurasce requirementes for the various sporting disciplies.

2. Determination of the most significant variables that affect the athlete's endurance.

HYPOTHESIS :

A) An efficient sport performance requires a high level of physical fitness, which is achieved through regular and sustained muscle training. The later increases the various modelities of muscular performance, namely, strength, speed, skill and endurance.

Each sport disciplinne requires specifically one or more of these modalities, for its proper performance.

So, male athletes were divided into groups according to the different requirements of each discipline :

1. Ball games (football, volley ball, basket ball, and hocky) : these games require mainly endurance and skill.
2. Boxing and wrestling : which requires strength and skill.
3. Gymnastics and athleties : which requires skill and speed
4. Bicycling : which requires endurance and speed.
5. Swimming : which requires endurance and temperature tolerance.

Female athletes were divided into 3 grops only :

1. Ball games (volley ball and basket ball).
2. Gymnastics.
3. Swimming.

The following composite hypothesis was formulated to investigate the first aim in the present study :

1. There are no significant differences between various sporting games of the same group.
2. There are significant differences between various sporting groups.

B) To achieve the second aim, it was assumed that the athlete's endurance depends upon the following variables :

1. Maximal aerobic capacity (O_2 consumption) which is agreed by most physiologists to be of utmost importance in assessing physical fitness, as it determines the efficiency of O_2 supply to active muscles.

2. Maximal O_2 pulse : which is obtained by calculating the O_2 consumed pulse beat. It is directly proprtional to the degree of physical fitness.

3. The ratio of recovery B.P. / resting B.P.
4. The ratio of recovery pulse rate/resting pulse rate.

Both 3 and 4 are inversely propertional to the degree of physical fitness, as they indicate that the recovery values are still higher than the resting values.

N.B. : the better the state of physical fitness, the quicker will be the return of B.P. and pulse rate to their resting values after muscular exercise.

5. Maximum breathing capacity (M.B.C.) : This is the maximal amount of air that can be inhaled/minuted. It is one of the accurte tests in asuring the sepiratory caspecity which is an importanat factor in the determinatin of the level of physical fithness, as it controle the O_2 supply to the body during muscular activity.
6. Maximal B.P.
7. Maximal pulse rate/min.

Both factors 6 and 7 are inversily proportional to the level of physical fitsose, as the various physiological equilibria are less disturbed, the better the physical condition of the individual.

MATERIAL :

Well trained international (159) EGYPTIAN top athletes were included in the present work : (130) males and (29) females. They performed different sporting disciplines : male athletes : (16) football, (15) hocky (16) volley ball (16) basket ball, (17) boxing, (20) wrestling (16) gymnastics, (7) athletics, (8) swimming and (9) bicycling. Their ages ranged (21.3—26) years with an average of (23 ± 1.20) years, their heights ranged (163—187 cm.) with an average of (175 ± 1.92 cm.). Their weights ranged (94—63 kg.) with an average of (73 ± 2.67 kg.). Their body surface areas ranged (1.58—8.15 sq. m); with an averge of (1.86 ± 0.11 sq. meter).

Female athletes : (12) volley ball, (8) basket ball (3) swimming and (6) gymnsatics. Their ages ranged (17.8—20.8) years with an average of (19 ± 2.14) years. Their heights ranged (157—172 cm.) with an average of (165 ± 2.78 cm.). Their weights ranged (54—68 kg.) with an average of (61 ± 3.58 kg.). Their body surface areas ranged (1.54 — 1.76 eq. meters) with an average of (1.66 ± 0.12 Square m.).

EXPERIMENTAL METHODS AND COLLECTING DATA :

After a routine medical examination, every athlete was subjected to an ergospirometric examination and his maximal breathing capacity was measured. The later was determined by a respirometer, then it was calculatted per square meter body surface area to eliminate the influence of both the height and weight on this parameter.

Ergospirometry :

A bicycle ergometer was used for work performance and the spirolyt was used for the determination of the O_2 consumption.

The Bicycle ergometer (Ziamermann, GDR) acts by an eddy current brake having a maximum brake power of (450) watts. The wanted performance is supplied on a scale balance on the eddy current brake by means of a movable jocky.

The spirolyt (GDR) is an autimatic gas analysis apparatus which operates without liquids or chemicals. It contain an (O_2) analyser operating on the therme — magnetic principle and a (CO_2) analyser based on the method of thermal conductivity. Both analysers were arranged in the form of a wheatstone bridge.

PROCEDURE :

The test started by breathing quietly through the spirolyt while riding the bicycle ergometer, for (5) minutes the pulse ıate and blood pressur were recorded at the end of the first, third and fifis minutes of rest. The subject was then asked to start pedalling the bicycle ergometer against a load resistance of (100) watts, on a rate of (75) turns/minute. By the end of every (2) minutes of exercise, the pulse rate was recorded, the blood preseure was measure and the load was increased by (50) watts. This procedure was continued till exhaustion.

During recovery, the subject remained on the bicycle, continued to breath through the spirolyt without pedalling while the pulse rate and blood pressure were recorded at the end of every minute for a period of (5) minutes of recovery.

The (O_2) consumption and (CO_2) production were continuously recoded alternatively every (4) seconds by the spirolyt, through the whole period of the test ; comprising the rest ; exercise and recovery periods.

From the ergospirometric examination the following parameters were determined :

1. An endurance index : This was calculated as (load X interval of exercise ; where : i = I,2,.... ; and represents the sequence order of intervals). This variable represents the net result of physical fitness of the athlete.
2. The max. O_2 consumption/min./Sq.M.B.S.A.
3. Max O_2 pulse (Ml/beat) : This was obtaind by dividing the max. O_2 consumption by the max. pulse rate.
4. The ratio of B./P. after (5) minutes of recovery to the resting B.P.

5. The ratio of pulse rate after (5) minutes of recovery to the resting pulse rate.
6. Maximal breathing capacity/Sq. M.B.S.A.
7 Maximal B.P. at the moment of exhaustion.
8. Maximal pulse rate at the moment of exhaustion.

STATISTICAL METHODOLOGY AND RESULTS :

A) To test the first composite hypothesis the regular (F) test was used (6) times ; (4) of these tests were for male athletes, and (2) were for female athletes.

Out of the (4) (F) tests for male athletes (3) were used to test the significance of the differences between the endurance requirements for the different plays within each one of the (3) play groups which contain more than one sporting discipline (ball mame group, boxing, and wrestling group, and gyimmastic and athletic group). The remaining (F) test was used to test for the significance of the differances between endurance requirments of all the (5) groups of male's sporting disciplines.

The results of these (4) male (F) tests are shown in table (I) ; which follows :

TABLE (1)

F tests between and within male groups.

Sporting Group	F Value	D. F.	Significance
A) Between various ball games.	3.9774	3 : 59	Nonsignificant
B) Between boxing and wrestling.	0.4771	1 : 35	Nonsignificant
C) Between gymnastics and athletics.	9.5742	1 : 11	Nonsignificant
D) Between all sporting groups.	23.5652	4 : 125	Significant

From table (1) ; it can be clearly seen that the results of the (4) (F) tests agree completely with the composite hypothesis stated previously. In other words ; one can conclude that there is no significant differences for the endurance indices within each group of sporting discipline ; while there are significant differences for the endurance indices between the various athletic groups.

As regards ; the (2) (F) tests for female athletes one was used to test for the significance of the differences between the endurance indices for the ball games group ; where it was possible to assertian data on only (2) plays (basket—ball, and volly—ball) out of all different plays of this group. For the other (2) groups of sporting discipline ; which contain more than one discipline (boxing and wrestling group ; and gymnastic and athletic group) there were no available data. The remaining (F) test for female athletes was used to test for the endurance indices for all groups of female athletes where data were available. The results of these (2) (F) tests are shown in table (2) ; which follows :

TABLE (2)

F tests between and within female groups.

	Sporting Group	F Value	D. F.	Significance
A)	Between the (2) ball games.	12.7004	1 : 18	Nonsignificant
B)	Between all sporting groups.	2.3852	2 : 26	Nonsignificant

The results shown in table (2) indicate that the first part of the previous composite hypothesis may be accepted as a true stament in the female case as it was in the case of males. On the other hand ; the results of the fial (F) test ; cannot be used to supplement the second part of the hypothesis in the female case ; which is in contrast to the male case.

In spite of the last remark the writers don't think that the result of the last (F) test weakens the accuracy of the second part of their composite hypotesis.

From the statistical point of view ; one can think that the result of the last (F) test may be due ; on one hand to the small sample size of female athletes in comparison with that of male athletes, and on the other hand ; the results may also be due to the limited number of play groups in the female case.

B) to test the second hypothesis an ordinary least—squares analysis was used to estimate the parameters of the following linear regression function ; once using all male athletes observations ; and once using all female athletes observations.

The function to be estimated :

$$\text{E.I.} = \alpha + \beta_1 \frac{\text{B.S.A.}}{\text{M.O.}_2\text{.C}} + \beta_3 \text{ M.O.}_2\text{.P.} + \beta_2 \frac{\text{Rc.B.P.}}{\text{R.B.P.}}$$

$$+ \beta_4 \frac{\text{Rc.P.}}{\text{R.P.}} + \beta_5 \frac{\text{M.B.C.}}{\text{B.S.A.}} ++ \beta_6 \text{ M.B.P.} + \beta_7 \text{ M.P.} + U$$

Where :

B.I.	=	Endurance index
$\frac{M.O_2C.}{B.S.A.}$	=	Max. O_2 consumption/sq.m. body surface area.
$M.O_2P.$	=	Max. O_2 pulse.
$\frac{Rc.\ B.P.}{R.\ B.P.}$	=	Recovery B.P. / resting B.P.
$\frac{Rc.P.}{R.P.}$	=	Recovery pulse/resting pulse.
$\frac{M.B.C.}{B.S.A.}$	=	Max. Breathing Capacity/sq.m. body surface area.
M.B.P.	=	Maximum blood preasure.
M.P.	=	Maximum pulse.
U	=	error term.
α , βi	=	paraceters to be estimated (i = 1,2, ...7).

The results of these (2) estimated (as shown by equations «1a and 1b» in tables «3 and 4» in the appendix) indicaeteted that only (2) regression ceefficionts out of the (7) used are significantly different from zero. These (2) regression coefficients are of the max. oxygen pulse and max. pulse variables.

These results are not strange because of the high multicolinearity and interdependence between the remaining (5) variables from the medical point of view.

In an attempt to remove the effect of this high multicolinearity between the explanetory variables, a crude method of removing one or more of these varibles from the model to be estimated was used several times. Some of the results of these attempts are presente in table (3) for male athletes and in table (4) for female athletes in the appendix.

From the results presented in table (3) ; it can be seen that the most appropriate function for predicting the (E.I.) of a male athlete ; which in turn can be used as a guide towards the determination of the most appropriate kind of sport suitable for him is :

$$E.I. = -4853.70 + 0.39 \frac{M.O_2C.}{B.S.A.} + 120.95\ M.O_2C + 21.23\ M.P.$$

The same is also true for female athletes : where the most appropriate function is :

$$E.I. = -4336.03 + 0.08 \frac{M.O_2C.}{B.S.A.} + 115.70\ M.O_2C. + 21.49\ M.P.$$

With the exception that the regression coefficient of the first explanatory variable turned to be nonsignificant in this case.

In all estimates the multiple correlation cofficients did not excedd (82%) which is some what low. But this can be explained by the strong dehetrogeneaty present between the (E.I.) response of the athletes in comparison with the values of the other variables ; which strongly supports our first presumption, that lack of training amongg Egyptian athletes is one of the major factors behind their weak endurance and performance if compered with international standards. The relatively low (R) values are attributed to the high value of the residuals as shown by the S.E. of estimates ; which is probably due to the omission of an important variable ; namely ; training — for which data are lackeing.

LIMITATIONS :

I— A linear function was used to calculate the (E.I.) ; which might not be true to some extent ; since endurance may decrease as the time of exercise on the ergometer passes.

2— It was assumed that the relationships between the explained variable (E.I.) and the different explanatory variables are linear ; which may not be true.

The combining effect of the previous two factors ; in addition to the high multicolinearity present between some of the explanatory variables may be the cause behind the relatively smale obtained (R's) and the nonsignificance of some of the parameters.

3— In choosing the sample subjects ; random selection methods from all Egyptian athletes was not used. Rather the asmple subjects were those Egyptian athletes who were willing to participate in this expermint after some convincng by the authors.

This method of selection may in turn sause some bais in the results. On the other hand ; the authors think that this bais is not serious enough to forego the benefits which can be gained from using the estimated model in the process of determining the (E.I.) of a new athlete and aiming him towards the discipline most suitable for him.

This thought is mainly due to the fact that the sample contained quite different athletes from the point of view concerning : age ; weight, kind of sport, experience time in the sport field, and the level of performance as known commonly about each one of the sample members in the actual contests.

SUMMARY

The results of this study ; first strongly favours the assumption that the differences between endurance requirements are present betwéén different sport groups ; rather than within each sport group.

Second ; the most important variables which determine athlete endurance are : $\frac{M.O_2.C.}{B.S.A.}$, $M.O_2$., pluse, and M.P. ; which agree completely with medical thoughts and the experiments done abroad.

Third ; this study points out again that the lack of training is one of the major factors behind the weak performance of Egyptian athletes.

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TABLE 3 Some of the Result of the Regression

Specification	Equ. No.	The Const. Term (α)	The Regression Coefficients			
			$\frac{M.O._2C.}{B.S.A.}$	$M.O._2P.$	$\frac{Rc.B.P.}{R.B.P.}$	$\frac{Rc.P.}{R.P.}$
The Equation	1a	—4911.82	0.37	119.60	46.09	165.53
r			0.69	0.44	0.17	0.32
T Value			1.89	7.15	0.11	0.93
The Equation	2a	—4899.43	0.36	119.57		170.99
r			0.69	0.44		0.32
T Value			1.90	7.21		1.01
The Equation	3a	—4943.15	0.39	120.56	132.16	
r			0.69	0.44	0.17	
T Value			2.02	7.26	0.33	
The Equation	4a	—2330.76	1.38	46.29	609.53	
r			0.69	0.44	0.17	
T Value			8.46	2.91	1.30	
The Equation	5a	—2000.80	1.32	35.69		367.60
r			0.69	0.44		0.32
T Value			7.87	2.90		1.84
The Equation	6a	—4853.70	0.39	120.95		
r			0.69	0.44		
T Value			2.03	7.36		
The Equation	7a	—1994.91	1.32	45.63		368.28
r			0.69	0.44		0.32
T Value			7.91	2.92		1.86
The Equation	8a	—1675.62	1.42	44.44		
r			0.69	0.44		
T Value			8.74	2.81		
The Equation	9a	—1715.31	1.42	44.92		
r			0.69	0.44	612.81	
T Value			8.75	2.82	0.17	
The Equation	10a	—2290.27	1.39	45.92	1.32	
r			0.69	0.44		
T Value			8.54	2.92		

The Regression Coefficients

(B : i = 1, 2, 3, ... , 7) For :			R	S.E. of Estimate	(F) Value	Degrees of Freedom
M.B.C. / B.S.A.	M.B.P.	M.P.				
—0.55	0.15	20.77	0.81	337.23	34.33	7 : 122
0.02	0.15	0.54				
—0.24	0.09	7.25				
—0.54		20.80	0.81	334.51	48.84	5 : 124
0.02		0.54				
—0.24		7.35				
—0.32		21.09	0.81	335.73	48.30	5 : 124
0.02		0.54				
—0.14		7.45				
0.53			0.71	402.33	32.38	4 : 125
0.02						
0.20						
0.08			0.72	339.69	33.22	4 : 125
0.02						
0.03						
			0.81	333.23	81.62	3 : 126
		21.23				
		0.54				
		7.67	0.72	398.10	44.65	3 : 126
	0.09					
	0.09		0.71	403.53	42.34	3 : 126
	0.05					
0.65			0.71	403.44	42.37	3 : 126
0.04						
0.24						
			0.71	400.80	43.49	3 : 126

TABLE 4 Some of the Results

Specification	Equ. No.	The Const. Term ( )	The Regression Coefficients			
			$\frac{M.O._2C}{B.S.A.}$	$M.O._2P.$	$\frac{Rc.B.P.}{R.B.P.}$	$\frac{Rc.P.}{R.P.}$
The Equation	1a	—4561.89	0.01	115.30	71.02	221.65
r			0.69	0.53	0.27	0.35
T Value			0.03	4.16	0.08	0.96
The Equation	2a	—4376.75	0.02	114.29		225.97
r			0.69	0.53		0.35
T Value			0.06	4.28		1.17
The Equation	3a	—4683.01	0.08	114.34	503.05	
r			0.69	0.53	0.27	
T Value			0.19	4.23	0.74	
The Equation	4a	—2261.77	1.39	25.83	1043.06	
r			0.69	0.53	0.27	
T Value			3.71	1.17	1.29	
The Equation	5a	—1480.34	1.37	23.60		295.96
r			0.69	0.53		0.35
T Value			3.62	1.08		1.27
The Equation	6a	—4336.03	0.08	115.70		
r			0.69	0.53		
T Value			0.20	4.37		
The Equation	7a	—1512.35	1.35	23.80		293.75
r			0.69	0.53		0.35
T Value			3.72	1.10		1.28
The Equation	8a	—1224.20	1.49	22.55		
r			0.69	0.53		
T Value			4.18	1.02		
The Equation	9a	—1325.05	1.49	22.92		
r			0.69	0.53		
T Value			4.04	1.04		
The Equation	10a	—2291.66	1.38	26.05	1032.87	
r			0.69	0.53	0.27	
T Value			3.82	1.20	1.30	

of the Regression Analysis

(α) : i = 1, 2, 3, …. , 7) For :			R	S.E. of Estimate	(F) Value	Degrees of Freedom
M.B.C. / B.S.A.	M.B.P.	M.P.				
—1.18 0.16 —0.25	0.70 —0.04 0.31	21.19 0.38 4.38	0.82	279.7[illegible]	11.65	7 : 21
—0.81 0.16 —0.18		21.07 0.38 4.60	0.82	273.33	17.05	5 : 23
—0.68 0.16 —0.15		20.88 0.38 4.46	0.82	276.04	16.56	5 : 23
—0.66 0.16 —0.12			0.71	332.34	10.85	4 : 24
—0.56 0.16 —0.10			0.71	332.63	10.82	4 : 24
		21.49 0.38 4.75	0.82	271.35	28.37	3 : 25
			0.71	328.78	14.76	3 : 25
	—0.53 —0.04 —0.22		0.70	334.76	13.73	3 : 25
0.07 0.16 0.01			0.70	334.95	13.70	3 : 25
			0.71	328.52	14.80	3 : 25