International Research Journal of Applied and Basic Sciences
© 2015 Available online at www.irjabs.com
ISSN 2251-838X / Vol, 9 (3): 300-307
Science Explorer Publications

Comparison of running time in anaerobic threshold to exhaustion stage in active and inactive boys

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ABSTRACT: Current study aimed at Comparison of running time in anaerobic threshold to exhaustion stage in active and inactive boys. For this, two examining groups, including one active group from athlete student boys (N=10) with age range (21.1±1.37 years), body mass index (24.09±3.53 kilogram per square meter),percent fat:16.5±2.97%, resting heart rate(60.3±3.3 beats per min), and non-athlete group (n=10)from healthy non-athletic students with age range of (22.47±3.67 years),body mass index (22.69±2.08 kilogram per square meter),percent fat:22.47±3.67%,and resting heart rate (62.7±2.49 beats per minute)were selected among students of Mohaghegh Ardabili university students and participated in the test. In this study, three protocols of Bruce, individual dependent and running time measuring protocol were used. In each protocol, respiratory gases were recorded, and in order to analyze data, independent statistical t method was used. Running time in anaerobic threshold to exhaustion stage in boys was respectively (5.03±1.51 and 3.36±0.96 minute), and significant results obtained between two groups (p<%5). According to obtained results, it can conclude that time of activity in active people is longer than inactive people, which is due to high level of physical fitness in active people and protocol used in the study.
Key words: anaerobic threshold, exhaustion, running time, active and inactive boys.

INTRODUCTION

In most sport texts, three factors of exercise intensity, duration, and continuation in sport activities have always attracted sport physiologists, and if we appropriately use these two factors (intensity and duration), we will see good compatibilities such as improvement in maximum consumed oxygen (VO_2max), anaerobic threshold, and lactate threshold. Considering that duration of sport activity has a high correlation with intensity of that activity, therefore sport scientists combine the two factors to obtain described compatibilities (Gaeini et al 2002). Determination of anaerobic threshold for careful planning of sport exercise intensity has always been one of the topics of interest for researchers and specialists of sport science, which considering the important issue in increased lactate threshold resulted from exercise, marathon should become better. Also endurance exercise such as marathon has strong correlation with rate of OBLA, and the rate of blood lactates in the range of 2 and 4 milligram per deciliter of Vo_2max and consumed oxygen volume, is a good criterion for performance time. In order to sustained increase in blood lactate response to sport activity, exercise in above lactate threshold is more effective than exercise in lactate threshold. Until now, no information about exercise compatibilities in response of blood lactate to sport activities with what rate or suitable intensity exists, and in the investigations aimed at evaluation of correlation between blood lactate concentration and performance or effects of exercise on blood lactate concentration an incremental protocol should be used to determine the threshold of lactate and blood lactate concentration. However, it doesn’t seem that concentrations more than 4 mM, obtained during incremental sport activity is representative of amount of work performed during prolonged sport activities.

Since there are limited investigations about rate of activity in anaerobic threshold in active and inactive boys, by comparison of running time in anaerobic threshold among active and inactive boys in the study, our purpose is determination of intensity and speed in which anaerobic threshold is observed, and the following questions will be answered:

How long does it take the running time in anaerobic threshold to exhaustion stage in active boys?
How long does it take the running time in anaerobic threshold to exhaustion stage in inactive boys?

Where, according to the above questions, following assumptions will be presented

There is a significant difference between running time in anaerobic threshold to exhaustion in active and inactive boys.
There is significant difference in vVO_2max between active and inactive boys.
There is significant difference in the running time, at the moment of reaching exhaustion between active and inactive boys.
There is a significant difference between workload of anaerobic threshold equivalent to VO_2max in active and inactive boys.
There is significant correlation between anaerobic threshold and VO_2max.

The overall object of current study is comparison of running time in anaerobic threshold to exhaustion stage in active and inactive boys; which is divided into more detailed objectives, which are

Determination of running time in anaerobic threshold to exhaustion in active and inactive boys.
Determination of vVO_2max in active and inactive boys.
Determining the running speed at the moment of exhaustion in active and inactive boys.
Determining workload of anaerobic threshold equivalent to VO_2max in active and inactive boys.
Determining the correlation between anaerobic threshold and VO_2max

In general, according to the outline provided, results of the study will be useful for followings

National Olympic Committee of different athletes
All sport federations
All academic and laboratory centers
It will be useful to determine anaerobic threshold (AT) in different athletes.

Following individuals have investigated about the topic

Oyono Angelo et al (1990), have investigated the responses of oxygen consumption volume, blood lactate and heart beats to prolonged sport activities (45 minutes or exhaustion, whichever occurs first) in three intensities: anaerobic threshold (with blood lactate concentration equivalent to 4 gram per deciliter) and amount of work located between lactate concentration equivalent to 2 and 4 mg per deciliter, according to incremental protocol about bicycle ergometer with stages of 4 minute and 50 watt,blood lactate concentration increase was determined equivalent to 2 and 4 mg per deciliter. When testing have worked in the power output dependent to concentration of 4 milligram per deciliter, blood lactate concentration at exhaustion stage in all testing was more than 4 milligram per deciliter. (Mean blood lactate concentration was around 7 milligram per deciliter),and none of the subjects were not able to continue for more than 30 minutes.Until reaching the exhaustion, mean time was about 25 minutes. Beaver et al (1986) have used the method of analysis of VCo_2 to Vo_2 regression slope to determine the anaerobic threshold and results of the study reveal that anaerobic threshold was estimated. Average of VCo_2 is a good evaluator of lactate threshold and threshold of HCo_3. Further, respiratory compensation point calculated using ratio of VE to VCo_2, was significantly more than AT amounts, and it was concluded that respiratory compensation point is more reliable and superior than other methods of determining anaerobic threshold. Magnoly et al (1990) reported that their subjects were able to pedal for 60 minute in incremental activity associated with 4 milligram per deciliter concentration of blood lactate. After that, subjects were divided into 3 groups: the group failed to complete the 60 minute exercise (worked with maximum blood lactate concentration of 5.3 milligram per deciliter around 45 to 55 minutes),the group have exercised for 60 minute and maximum concentration of blood lactate, equivalent to 4.3 milligram per deciliter, and the group exercised for more than 60 minute and maximum blood lactate, equivalent to 3 milligram per deciliter .Also Wasserman et al (1994)study aimed at explains the determination anaerobic threshold through changes in respiratory gases. It should be noted that two protocols of submaximal and ramp protocol were used on cycle ergometer and calculated the AT using 4 methods of: VE/Vo_2 increase, 2) PETo2 increase 3) V-slope, 4) variations of respiratory gases, and concluded that best method of AT determination for cardio-vascular patients and healthy people is V-slope method. In order to validate the primary compensatory threshold and secondary compensatory, determination of critical exercise intensity and determination of correlation between duration of buffering stage, and aerobic and anaerobic capacity, Nikooie et al conducted a study. 15 active individuals, in three different sessions and minimum time span of 48 hours, performed 3 incremental tests. Primary respiratory threshold and compensatory respiratory threshold were calculated by analysis of respiratory gases and lactate threshold based on the accumulation of blood lactate through evaluation at each 3 minutes bloodletting during performing sport test. Results of the study indicated that, according to the number of breaths observed per minute in its equivalent workload and exercise at the level of compensatory respiratory threshold, can be used to improve respiratory muscles function (because it can be the exhaustion agent in maximal exercises). Further, results of the study indicated that threshold of compensatory respiration significantly occurs at function intensities beyond lactate threshold, and therefore the parameter cannot directly represent the maximal intensity of exercise which maintains in unlimited period without continued increasing in blood lactate concentration.

RESEARCH METHODOLOGY

Regarding the objectives, current study is quasi-experimental. Statistical population study is all male students of Mohaghegh Ardabili University, which are health, considering the public health and have no disease, and were studying at Mohaghegh Ardabili University in 2013. Ten active students of physical education and ten inactive students which where homogenous considering related indices, were selected as statistical sample among male students of Mohaghegh Ardabili University who were volunteered to participate in the study.

Study tools included

(Gansharn Medizin Electronic GmbH97618Niedelaur – Germany)
Advanced electronic treadmill device
(Model:Valiant, LodeBv, Groningen)
Bar graph and stadiometer to measure the subjects
Polar stethoscope to observe heart beats during exercise
(Polar Elector, Made in china, 31 CoDeD , N2965)
Pooyacaliper to measure fat percentage
Dmax software to calculate heart rate deflection point (HRDP)

Analysis

Physical variables

Average and standard deviation of active subjects' age for current study are 21.1±1.37 with minimum age of 19 and maximum age of 23 years, and for inactive subjects, 22.3 ±1.25 years with minimum age 21 and maximum age 25 years. Average and standard deviation of values of standing height for active subjects was 180±6.2 cm with minimum of 174 cm and maximum 194 cm. Average and standard deviation for inactive subjects is 173.9 ± 4.5 cm with minimum height 166 cm and maximum 182 cm. Active subjects weight with average and standard deviation of 76±11.7 kilogram, minimum 58 and maximum 96 kilogram, and for inactive subjects with average and standard deviation of 68.5±7.9 kilogram, minimum 58 and maximum 78 kilogram.

Body composition variables

Average and standard deviation of fat percentage values for active subjects are 16.5 ±2.9 percent with minimum of 9.8 percent and maximum of 20.1 percent, and for inactive subjects 22.47±3.6 with minimum of 15.7 percent and maximum of 27.5 percent. Values of average and standard deviation of Lean body mass for active subjects was 63.23 ±8.35 kilogram with minimum of 49.7 and maximum 77.4 kilogram, and for inactive subjects values of average and standard deviation were calculated 52.96±5.34 kilogram with minimum of 44.2 and maximum of 61 kilogram. Average and standard deviation of body mass index (BMI) for active individuals 24.09 ±3.5 kilogram per square meter with minimum value of 19.2 and maximum 32.4 kilogram per square meter, and for inactive individuals average and standard deviation 22.69±2.8 kilogram per square meter with minimum value of 17.5 and maximum 27 kilogram per square meter.

Physiological variables

Average and standard deviation (Vo_2max) for active individuals was obtained46.38±4.6 (milliliter per kilogram per minute) with minimum amount of 39.7 and maximum amount 55.4, and for inactive individuals, average and standard deviation 42.26±6.28 milliliter per minute with minimum amount of 31 and maximum amount 51 milliliter per kilogram per minute. Average and standard deviation of resting heart rate (RHR) for active individuals was 60.3±3.3 (beat per minute) with minimum values of 55 and maximum 65 beats per minute, and for inactive individuals 62.7±2.4 (beat per minute) with minimum values of 60 and maximum 68 beats per minute. In the study, at the end of first protocol where subjects' heart rate was maximum MHR was obtained. Average and standard deviation of maximum heart beats for active individuals was obtained 196.6 ± 7.4(beat per minute) with minimum 187 and maximum 208 beat per minute, for inactive individuals 195.2±10.4 beat per minute with minimum of 176 and maximum of 208 beats per minute. At the beginning of first protocol, after warming up the subjects, Narita equation which is nominated according to Target heart rate(THR)was used. Average and standard deviation of Target heart rate for active individuals was calculated 114.3±2.26 (beat per minute) with minimum of 111 and maximum of 118 beat per minute, and for inactive individuals 115.9±2.28 beat per minute with minimum of 113 and maximum of 121 beats per minute.

First question

How long does it take the running time in anaerobic threshold to exhaustion stage in active boys?
Minimum values, and maximum running time to exhaustion is respectively 1.9 and 6.8 minute, and mean and standard deviation is 5.03±1.51 minute.

Question two

How long does it take the running time in anaerobic threshold to exhaustion stage in inactive boys?
Maximum running time to exhaustion is respectively 1.63 and 4.6 minute, and mean and standard deviation is 3.36±0.96 minute.

Testing hypothesis

First hypothesis

There is significant difference between running time at anaerobic threshold to exhaustion in active and inactive boys.
First testing hypothesis: according to the results obtained from implementing active and inactive subjects, mean and standard deviation, running time at anaerobic threshold to exhaustion in active and inactive boys were obtained 5.03± 1.51 and 3.36±0.96, respectively. Further, using independent t test for two groups and comparison of two groups, it was found that there is significant difference between two groups.
Therefore, the hypothesis of existing significant difference between two active and inactive groups is proved.

Table 1. Results of levene's test for similarity of two groups and independent t test to compare the difference of exhaustion time between two active and inactive groups.

Sig	Degree of freedom	T	Means difference	leven statistic Sig	F	Factor investigated between active and inactive groups
0.009	18	2.92	1.667	0.301	1.135	Exhaustion time

Second hypothesis

There is significant difference in v Vo_2max between active and inactive boys.
Second hypothesis test: measuring results of current study are obtained about speed at maximum consuming oxygen in active and inactive boys with average and standard deviation of 17.2±1.22 and 15.6±1.9 kilometer per hours, which values are presented in table 2. Further, according to the results of independent t test for two independent groups reported in table 2, it was found that significant difference exists between two groups. Therefore, the assumption of existence of significant difference between two active and inactive groups is proved.

Table 2. results of first test for equality of two groups and independent t test to compare v Vo_2max between two active and inactive groups

Sig	Degree of freedom	T	Means difference	Leven's test Sig	F	Factor evaluated between two inactive and active groups
0.042	18	2.191	1.6	0.196	1.8	v Vo_2max

Third hypothesis

There is significant difference in the running time, at the moment of reaching exhaustion between active and inactive boys.

Third hypothesis test: results of calculated v Exhaustion for active and inactive male students in the current study were obtained with mean and standard deviation 17.4±0.96 and 15.6±1.9 kilometer per hour. Also, according to table 3, results of independent t test to calculate running speed at the moment of exhaustion, it was cleared that there exists a significant difference between active and inactive boys. Therefore, null hypothesis about existence of significant difference between two groups of active and inactive boys is confirmed.

Table 3. results of leven test for equality of two groups and independent t test about comparison of difference in the running speed at the moment of reaching exhaustion between two active and inactive groups

Sig	Degree of freedom	T	Means difference	Leven statistic		Evaluated factor between two active and inactive groups
				Sig	F	
0.018	18	2.6	1.8	0.062	3.9	v Exhaustion

Fourth hypothesis

There is a significant difference between workload of anaerobic threshold equivalent to Vo_2max in active and inactive boys.

Fourth hypothesis test: results of current study measurements were obtained about threshold of anaerobic workload difference equivalent Vo_2max in active and inactive boys with mean and standard deviation of 68.21±9.7 and 67.65±11.4 percent.Also regarding to the results of independent t test for two groups presented in table 4, it was found that there is no significant difference among two groups. Therefore the null hypothesis of existing significant difference between two groups is rejected.

Table 4. Results of leven test for equality of two groups and independent t test about comparison of difference in anaerobic workload threshold equivalent to Vo_2max between two active and inactive groups

Sig	Degree of freedom	T	Mean differences	Leven statistics		Evaluated factor between two active and inactive groups
				Sig	F	
0.9	18	0.11	0.56	0.9	0.56	Anaerobic threshold workload equivalent to vo_2max

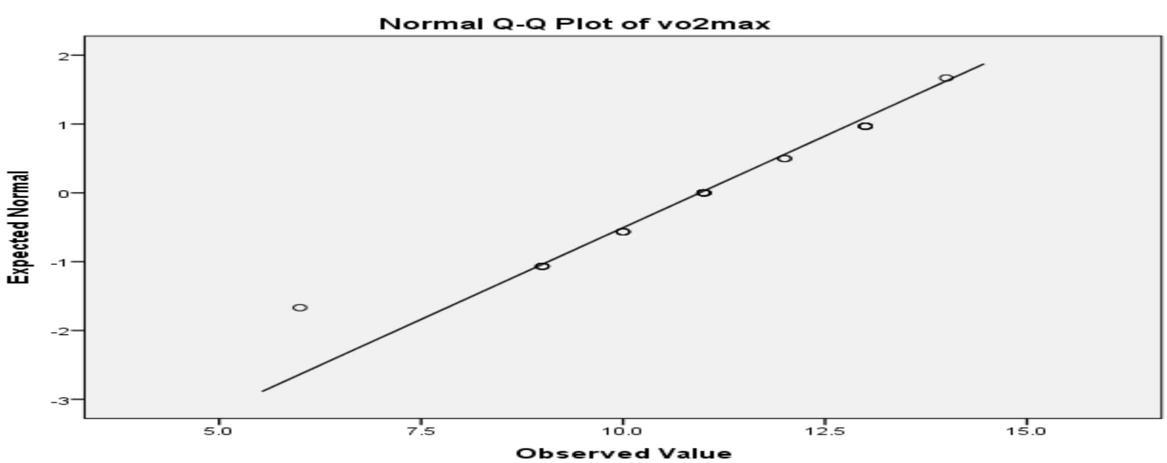
Fifth hypothesis

There is significant correlation between anaerobic threshold and Vo_2max.

Table 5.Normality test of data for active individuals

variables	Kolmogorov–Smirnov			Shapiro-Wilk		
	statistic	Df	Sig.	Statistic	Df	Sig.
vo_2max	0.161	20	0.188	0.934	20	0.181
AT	0.123	20	0.200	0.984	20	0.971

According to table 5, it is concluded that data are normal, and since normality is one of the conditions to use parametric tests, therefore, here we use parametric tests to analyze data.



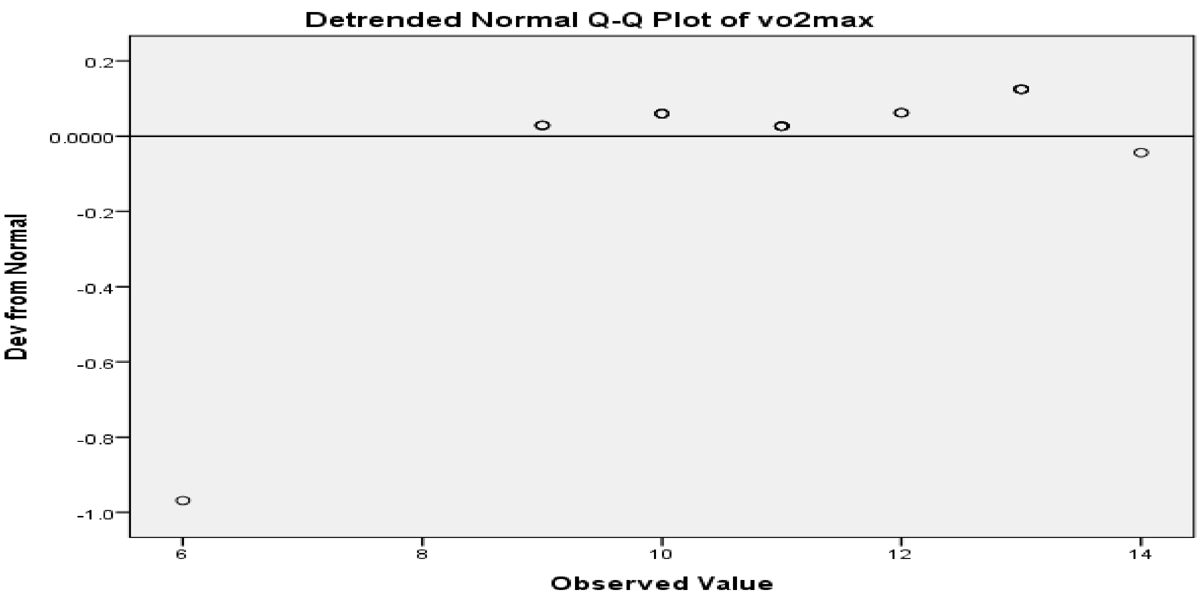


Figure1. Plots related to normality of active subjects data

According to the result of normality test and also considering the data have distance scale, therefore we have used Pearson correlation coefficient.

There is significant correlation between anaerobic threshold and Vo_2max of inactive individuals.

Table 6.Pearson correlation coefficient between threshold of anaerobic and Vo_2max of active individuals

		vo_2max	AT
	Pearson correlation coefficient	1	0.341
vo_2max	Sig		0.335
	N	10	10
	Pearson correlation coefficient	0.341	1
AT	Sig	0.335	
	N	10	10

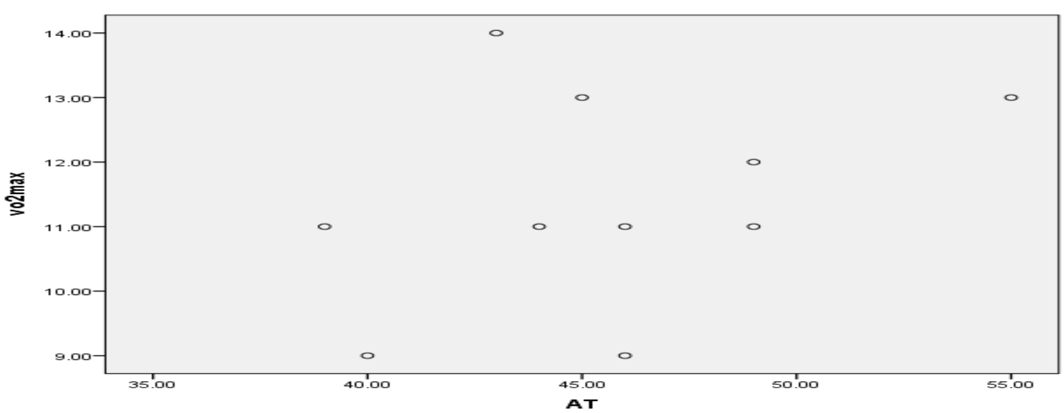


Figure2.Correlation test to measure the correlation between Vo_2max and AT in active boys, reveals no correlation between two variables in active group (R=0.34 and p 0.33)

Correlation coefficient for inactive individuals

There is significant correlation between anaerobic threshold and Vo_2max of inactive individuals.

Table 7.Pearson correlation coefficient between anaerobic threshold and Vo_2max of inactive individuals

		vo_2max	AT
vo_2max	Pearson correlation coefficient	1	0.332
	Sig		0.348
	N	10	1
AT	Pearson correlation coefficient	0.332	1
	Sig	0.348	
	N	10	10

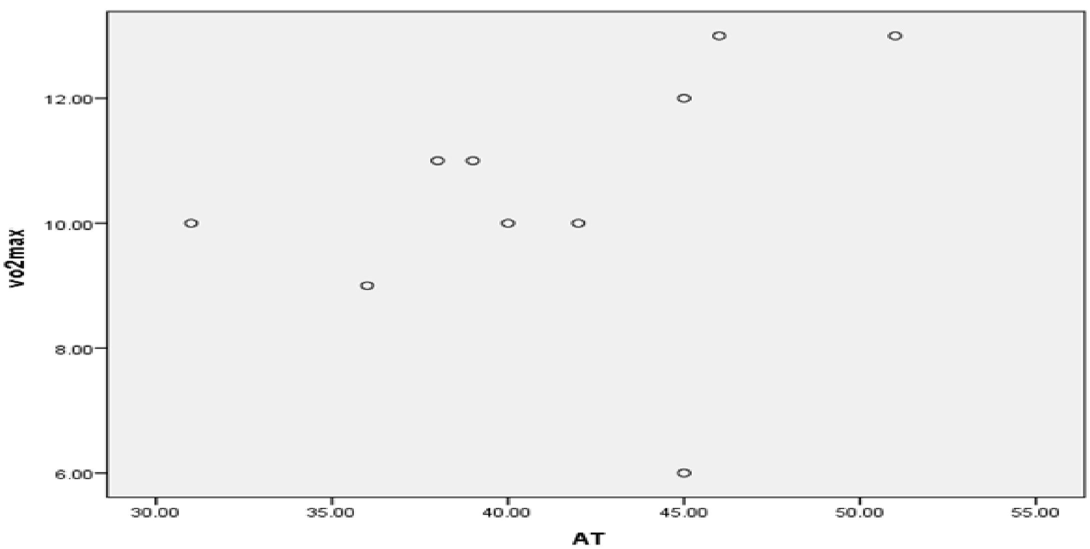


Figure3. Correlation test to evaluate the correlation between Vo_2max and AT in inactive boys, reveals no correlation between two variables in inactive group. (R=0.33 and P=0.34, graph 3).

CONCLUSION

According to the results of current study, running time at anaerobic threshold to exhaustion in active boys, obtained more than inactive boys (5.03±1.51 against 3.36±0.96 min), and significant difference was obtained between two active and inactive groups (p<%5). Critical speed is not determining and effective factor on the exhaustion time (for speeds above the maximum).Although as energy source, anaerobic source is for intensities below Vo_2max, but using anaerobic capacity leads to increased intensities above maximum. Likewise, reduced exhaustion time with extended above maximum intensity is according to Vo_2max and in the range of anaerobic. According the results of the study, differences in implementation of various people, regarding to activity and inactivity and level of subjects fitness, can be due to difference in involved energy system response and other physiological responses through exercise. Therefore, shut biological mechanism in anaerobic threshold is probably influenced by environmental physiological systems during exercise. When exercise intensity is regulated according to differences between energy required for running at above maximum speed difference and maximum aerobic energy consumption, variability of exhaustion time at above maximum speeds significantly decreases. According to the results obtained from this study and compare it with performed studies, it can be told that running time to exhaustion depends on the anaerobic capacity and critical speed. Diversity in different studies can be due to difference in the type and exercise on the treadmill and implementing on the cycle ergometer and also intensity of exercise on cycle ergometer and individuals fitness. As the level of fitness in participants be more, running time in anaerobic threshold to reaching complete exhaustion of subjects will increase. Probably recording shorter time of the study subjects compared to previous study is due to: lower level of subjects' fitness, complexity of subjects, considering sport (taekwondo, weightlifter, wrestler, and runner) and also heredity and subjects exhaustion makes such record.(5.03±1.51 minutes against 9.91±3.73).

The results of testing hypothesis can conclude that running speed at the moment of reaching the exhaustion (v Exhaustion) is equal to running speed at the moment of reaching the maximum consumed oxygen (vVo_2max) and the difference is negligible (mean and standard deviation (vVo_2max) of active and inactive individuals are respectively 17.2±1.22 and 15.6±1.9 kilometer per hour, and mean and standard deviation (vExhaustion) of active and inactive individuals are respectively 17.4±0.96 and 15.6±1.9 kilometer per hour) and according to the obtained results, there could not be seen a significant difference between workload of anaerobic threshold equivalent to Vo_2max in active and inactive boys. Further, referring to the obtained results of correlation test, there could not be seen a significant difference between two variables of maximum consuming oxygen (Vo_2max) and anaerobic threshold (AT). It can conclude that estimation of anaerobic threshold is not practically possible from maximum consumed oxygen.

Finally, it can say that there is limited information related to effects of level of body fitness on running time at anaerobic threshold to exhaustion on treadmill. Therefore, extensive research should be done.

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