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Original article

Comparison of Physiological Outputs of Different Maximum Aerobic Speed Determination Tests

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The aim of the study is to compare blood lactate, VO_2max and HRmax values after the participants' maximum aerobic speeds (MAS) are determined with 30 seconds running 15 seconds rest interval running test (30-15_{IFT}), 45 seconds running 15 seconds resting area incremental interval running test (45-15_{FIT}), and incremental treadmill tests.

Materials and Methods: The participants of the study are fifteen athletes whose branches are football with an average age of 22.07 ± 0.69 years. Blood lactate values have been measured with portable lactate measuring device, VO_2max with gas analyser, and heart rate with GPS running watch during the tests. SPSS 19.0 package program has been used for the statistical analysis of the study. Shapiro Wilk test has been used to assess the suitability of quantitative variables to normal distribution, Friedman test for the comparisons of non-normally distributed variables between 3 dependent groups, Wilcoxon test in 2 dependent group comparisons and Spearman correlation coefficient for the relations between quantitative variables.

Results: When the data obtained at the end of 30-15_{IFT}, 45-15_{FIT} and treadmill tests were compared, a significant difference was found between the test- end blood lactate ($p=0.019$), VO_2max ($p=0.006$) and maximum aerobic speed (MAS) values ($p<0.001$). However, when HRmax values obtained from these three tests were compared, no significant difference was found ($p=0.683$).

Keywords: Blood lactate, oxygen uptake, aerobic speed, interval training, heart rate

Introduction

Interval running exercises are often used in training to improve the performance of athletes and are emphasized to be important in improving running performance **(1,2,3,4)**. The high intensity interval training method is of great interest in terms of creating more fat burning than other methods, being more economical in time and being entertained by individuals **(5,6,7)**. In addition to all these, it should not be forgotten that nutrition is very important in increasing performance and shortening the recovery process. Since muscle glycogen stores are exhausted as the duration and intensity of exercise increases, how much carbohydrate or protein should be taken for interval training depends on the severity and duration of the training. It is recommended to take high amounts of carbohydrates about 3-4 hours before training.

Studies have shown that carbohydrate consumption before 60 Minutes improves the athlete's performance **(8)**. Interval runs are grouped under two main headings: long-term or short-term, which include active and passive resting **(9)**. Determining adequate working speed and resting intervals at this level during Interval running training seems especially critical to achieving VO_2 level. In this context, it is important to determine the appropriate maximum aerobic velocity (MAS). Today, continuous and intermittent field tests applied in the field with a gradual increase, and gradually increasing treadmill tests in the laboratory are used to determine VO_2max and the corresponding maximum aerobic speed (MAS) **(10,11,12,13)**. Variations in loading intensity, duration and rest interval also affect physiological outcomes **(14)**. A stamina training should be organized according to purpose, and the relationship between the three stated norms should be carefully evaluated.In studies conducted about the subject, variations in MAS values depending on loading and resting time are used to reveal high VO2 during training **(12,15,16,17)**. Buchheit suggested using a speed corresponding to 95% of the speed reached at the end of the 30sec:15sec interval fitness test (30-15$_{IFT}$) **(18)**. If the aim is to determine a VO_2max-related speed that an athlete can achieve during 30sec:30sec interval running, then the 45 second interval running test recommended by Georges Gacon in 1994 with 15 seconds rest is considered more appropriate **(14)**. In this context, the aim of the study is to determine the maximum aerobic speed (MAS) with gradual increasing treadmill test (KB), 45s:15s incremental interval running test (45-15$_{FIT}$) and 30s:15s interval fitness running test (30-15$_{IFT}$), and to compare the physiological outputs of these 3 tests.

Materials and Methods

Participants: 15 male students (22.07 ± 0.69 years of age, 72.20 ± 2.09 kg, 177.20 ± 1.66 cm) from Marmara University Faculty of Sport Sciences who continue to be active athletes aged 18 years and over, volunteered to participate in the study. After the approval of the Ethics Committee of Marmara University Faculty of Medicine for the protection of athletes, a presentation was made in which the objectives, research planning, measurement processes and responsibilities of the study were explained. It was not included in the study in cases where the participants had any chronic disease or were on medication continuously. In addition, it was requested not to exercise at least 48 hours prior to measurements.

Test Protocol: The study consists of 3 different maximum aerobic speed determination tests: 35-15$_{IFT}$, 45-15$_{FIT}$ and incremental treadmill test. At the end of the tests performed at 1 week intervals and in random order, the maximum aerobic speeds were determined and then blood Lactate, VO_2max and HRmax values were compared.

Blood Lactate, Heart Rate Number and VO_2max Measurements: The blood lactate values of the participants were measured with fingertip blood samples before and 2 minutes after the tests were finished using the 'Lactate Scout' brand portable lactate measuring device. During the tests, VO2max was measured with the calibrated 'Cortex MetaMax 3D' gas analyzer. The heart rate of the athletes was determined and recorded with the data obtained from the GPS running watch brand "Polar M400 (Kempele, Finland)".

Treadmill Test: The incremental treadmill test was performed in the laboratory on an electronic Ergo-Fit Track 3000 Alpin 'model electronic treadmill. Training was increased by 1%, starting speed was set to 8 km/h, and 0.5 km/h was increased every minute until the athlete was unable to maintain his or her speed. The final working speed reached during the Test was considered MAS$_{TR}$ **(14,19)**.

Intermittent Fitness Test (30-15$_{IFT}$): The athlete who starts running from point A has a rest time of 15 seconds after continuing for 30 seconds at the set time and speed.The initial speed of the Test is 8 km/h and this speed increases by 0.5 km/h for each subsequent 30-second stage. Athletes are required to run between two lines placed at intervals of 40 metres at a speed managed by the" beep " sound. As the levels progress, the time between beeps decreases and the speed-intensity of the test increases. There are two 3-meter zones in the middle of the test area where athletes can adjust their speed. Similarly, in the return zones

at points A and B, there are also 3-metre areas for athletes to adjust and maintain their speed. During the 15-second rest, athletes are required to walk in the forward direction towards the nearest 3-meter zone, which is where they will start the next running phase. Athletes must reach the next 3-metre area. The test is terminated when it fails to reach it three times in a row **(20)**. The final speed reached was accepted as $MAS_{30\text{-}15}$.

The Field Incremental Test ($45\text{-}15_{FIT}$): It is a test consisting of 15-second resting 45-second loading periods. During the first 45 seconds, the athlete runs a distance of 100 meters from the "start 1" cone to the "finish 1" cone at a speed of 8 km/h, then during the 15-second rest process, the athlete walks from the "finish 1" cone to the "start 2" cone at 6.25 meters. In the second 45-second run, the athlete runs 106.25 metres at a speed of 8.5 km/h from the "start 2" cone to the "start 1=Finish 2" cone. After 15 seconds of rest, he must run back 112.50 metres at a speed of 9 km/h from the "start 1=Start 3" cone to the "finish 3" cone in 45 seconds. Starting and stopping is announced by an audio signal emitted by the audio system connected to the computer. The test is stopped when the athlete fails to reach the desired cone at the relevant time. The final speed reached during the test is considered $MAS_{45\text{-}15}$ **(14)**.

Statistical Analysis: Statistical analysis of the study was conducted in SPSS 19.0 package program. Descriptive statistics of the quantitative variables in the study were given with their mean, standard error, median, minimum and maximum values. The suitability of quantitative variables to normal distribution was examined with the Shapiro Wilk test. The Friedman test was used for 3-dependent group comparisons of variables with no normal distribution, and the Wilcoxon test was used for 2-dependent group comparisons. In all statistical analyzes in the study, results below "p" value of 0.05 were considered statistically significant.

Table 1. Averages of the Participants' Test-End Lactate Values (mmol)

Test	Mean±Sd	Min - Max	P	Difference
$30\text{-}15_{IFT}$ (1)	9.93 ± 0,31	7.40-11.70	0.019	3>2,1
$45\text{-}15_{FIT}$ (2)	10.24 ± 0,37	6.50-12.30		
TR (3)	10.97 ± 0,39	7.80-13.50		

Mean: Mean, Sd:Standard deviation. (1) 30 second running incremental interval running test with 15 seconds rest, (2) 45 second running incremental interval running test with 15 seconds rest, (3) incremental treadmill test.

There is a statistically significant difference between the lactate values of the participants at the end of 3 different tests (p=0.019).

Table 2. Maximum Aerobic Speeds of the Participants (MAS - km/h)

Test	Mean±Sd	Min - Max	p	Difference
		17 – 21		
$30\text{-}15_{IFT}$ (1)	18.73 ± 0.27			
		16 – 19		0.001
$45\text{-}15_{FIT}$ (2)	17.47 ± 0.27			1>2,3
		13.5 – 18.5		
TR (3)	16.33 ± 0.32			

There is a statistically significant difference between the MAS values of the participants at the end of 3 different tests. (p<0.001).

Table 3. Participants' Maximal Oxygen Consumption (VO_2max - ml/kg/min)

Test	Mean±Sd	Min - Max	p	Difference
30-15$_{IFT}$ (1)	60.87 ± 2.25	50 – 88	0.006	3>1,2
45-15$_{FIT}$ (2)	58.00 ± 1.47	50 – 68		
TR (3)	62.27 ± 1.64	54 – 73		

There is a statistically significant difference between the VO_2max values of the participants at the end of 3 different tests (p=0.006).

Table 4. Participants' Heart Rate Averages (HRmax)

Test	Mean±Sd	Min - Max	p	Difference
30-15$_{IFT}$ (1)	197.87 ± 1.40	188 – 207	0.683	1-2-3
45-15$_{FIT}$ (2)	195.80 ± 0.96	189 – 201		
TR (3)	196.67 ± 1.02	188 – 207		

There was no statistically significant difference between the HRmax values of the participants at the end of 3 different tests. (p=0.683).

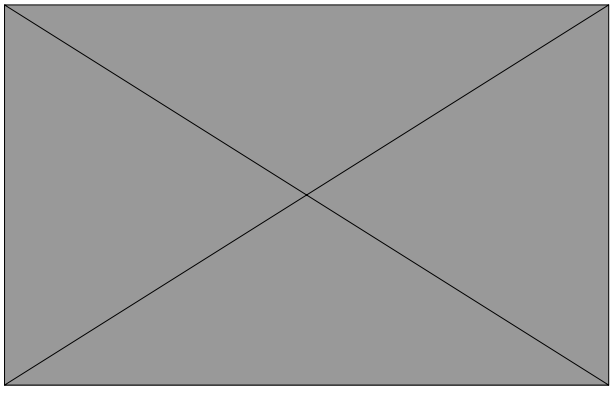

Figure 1. Treadmills, Lactate Values Graph of 45-15$_{FIT}$ and 30-15$_{IFT}$ Tests

There was no statistically significant difference between the lactate values of the participants before 3 different tests (p=0,355). However, there is a statistically significant difference between the lactate values at the end of the test only between "30-15$_{IFT}$" and "Treadmill" tests (p=0.026).

Results: When the test-end lactate values obtained from 30-15$_{IFT}$, 45-15$_{FIT}$ and treadmill tests were compared, there was a statistically significant difference **(p=0.019)**. When the differences among the methods were examined; while there was a statistically significant difference between only "30-15$_{IFT}$" and "Treadmill" **(p=0.026)**, there was no statistically significant difference between "30-15$_{IFT}$" and "45-15$_{FIT}$" **(p=0.572)** and between "45-15$_{FIT}$" and "Treadmill" **(p=0.211)**. The treadmill test lactate value was found to be 1.04 mmol more than the 30-15$_{IFT}$ test lactate value and 0.73 mmol more than the 45-15$_{FIT}$ test lactate value **(Table 1)**. A statistically significant difference was found between 30-15$_{IFT}$, 45-15$_{FIT}$ and treadmill tests in terms of maximum aerobic speed (MAS) **(p<0.001)**. The MAS value obtained from the 30-15$_{IFT}$ test was 2.4 km/h higher than the MAS value obtained from the treadmill, and 1.26 km/h higher than the value obtained from the 45-15$_{FIT}$ test **(Table 2)**. There was a significant difference between VO_2max values obtained during 30-15$_{IFT}$, 45-15$_{FIT}$ and treadmill tests **(p=0.006)**. The treadmill VO_2max value is 1.4 ml/kg/min higher than 30-15$_{IFT}$$VO_2$max and 4.27 ml/kg/min greater than 45-15$_{FIT}$$VO_2$max **(Table 3)**. There was no statistically significant difference in the number of heart beats obtained from 30-15$_{IFT}$, 45-15$_{FIT}$ and treadmill tests **(p=0.683), (Table 4)**.

Discussion

The aim of this study is to compare the physiological responses and maximum aerobic speeds (MAS) that occur during 30-15$_{IFT}$, 45-15$_{FIT}$ and ever-increasing treadmill testing. In our study, it was observed that there was a difference between the Lactate and VO_2max values obtained from 30-15$_{IFT}$, 45-15$_{FIT}$ and treadmill tests. In the study conducted in 2012, VO_2max, HRmax and Lactate values obtained from treadmill tests and 45-15$_{FIT}$ differed with the study revealing that they were similar **(14)**. A significant difference was observed when the treadmill test, 30-15$_{IFT}$ and 45-15$_{FIT}$ tests compared with the maximum aerobic speed (MAS) values. However, the 30-15$_{IFT}$ maximum value was found to be 6.7% or 1.26 km/h compared to the value of 45-15$_{FIT}$ MAS, and 12.8% or 2.4 km/h higher compared to the treadmill mas value. When the 45-15$_{FIT}$ MAS value was compared with the treadmill MAS value, it was found 6.5% or 1.14 km/h higher, so it is similar to the results obtained by Herve's work **(14)**. In our study, the MAS values obtained in 45-15$_{FIT}$ and 30-15$_{IFT}$ tests were found higher than the MAS values obtained in the treadmill test. This supports the conclusion that high intensity interval running exercises have an important role in improving performance, as Laursen noted in his study **(3)**. The previous conducted studies suggest using the 45-15$_{FIT}$ test **(11,12,15,17)**, the 30-15$_{IFT}$ Test **(18)**, and the MAS obtained from the incremental treadmill test **(11,14,15)** in order to achieve high VO_2max in a 30sec:30sec workout. A high VO_2max was obtained at the end of 30sec:30sec interval running training conducted for 15 minutes with the MAS value obtained with 45-15$_{FIT}$ **(14)**. However, in our study, MAS, Lactate and VO_2max values were similar in 45-15$_{FIT}$ and 30-15$_{IFT}$ tests. However, in our study, MAS, Lactate and VO_2max values were found to be similar in 45-15$_{FIT}$ and 30-15$_{IFT}$ tests. Therefore, the 30-15$_{IFT}$ test will also allow us to achieve a high VO_2max. In addition, the highest VO_2max value at the end of these 3 Tests was determined on the treadmill and differed by the study of Herve **(14)**. If our goal is to determine a speed related to VO_2max, the treadmill test, if it is to determine a speed it can maintain, the 30-15$_{IFT}$ test was found more appropriate, therefore it differs from some previous studies **(21,22,23)**. As a result, it has shown that the treadmill is a more accurate test to obtain VO_2max than 30-15$_{IFT}$ or 45-15$_{FIT}$ tests.

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