TAKIM SPORLARINA ÖZGÜ ANAEROBİK PERFORMANSI ÖLÇEN YENİ BİR SAHA TESTİ GELİŞTİRİLMESİ

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ÖZET

Amaç: Bu araştırmanın amacı anaerobik kapasiteyi sahada ölçen yeni bir testin (Modifiye Illinois Çeviklik Testi: Mod IÇT) geliştirilmesi, güvenilirliğinin araştırılması, Wingate Anaerobik Güç (WAnT) ve Koşu temelli Anaerobik Sprint (RAST) testleriyle ilişkisinin incelenmesidir.
Yöntem: Araştırmaya 43 erkek sporcu (10 hentbolcu, 9 basketbolcu ve 10 futbolcu; takım sporu yapan grup: TSG) ve (orta ve uzun mesafe atlet; bireysel spor yapan grup: BSG). İlk test günü laboratuvarda tüm sporcuların boy uzunluğu, vücut ağırlığı ve vücut yağ yüzdesi ölçülmüş, sporculara WAnT testi ve Mod IÇT; ikinci test günü RAST ve Mod IÇT tekrarı uygulanmıştır. Mod IÇT testleri uygulanırken arada en az bir gün dinlenme verilmiş ve bir katılımcının tüm testleri en fazla yedi gün içerisinde tamamlanmıştır. Testlerin bitiminde ve toparlanmanın beşinci dakikasında kalp atım hızı ölçülmüş ve parmak ucundan kapiller kan örneği alınıp kaydedilmiştir. Testlerin sonunda algılanan zorluk derecesi (AZD) sorulup not edilmiştir.
Bulgular: Testlerde elde edilen nabız, kan laktat konsantrasyonu ve Algılanan Zorluk Derecesi (AZD) gibi fizyolojik yanıtlar TSG ve BSG arasında farklı değilken grup içinde farklı bulunmuştur. Anaerobik testler gruplar arasında karşılaştırıldığında WAnT sonuçları benzerdir. RAST sonuçlarında ise minimum güç (MG) ve yorgunluk indeksi (Yİ) için anlamlı fark yokken pik güç (PG) ve ortalama güç (OG) için TSG'de BSG'ye göre anlamlı olarak daha yüksektir. Yeni geliştirilen testteki toplam süre (TS), minimum süre (MS), pik süre (PS) ve Yİ skorlarının hepsi hem testlerin ilk uygulamasında hem de ikinci uygulamasında gruplar arasında anlamlı olarak farklılıklar göstermiştir. Testler arasındaki korelasyon incelendiğinde BSG için dikkate değer anlamlı bir ilişki yokken, TSG için RAST ve Mod IÇT arasında anlamlı negatif korelasyonlar bulunmuştur. Yeni geliştirilen saha testinin tekrar uygulamasında sadece BSG'de TS test retest sonucu anlamlı olarak farklıyken diğer tüm sonuçlar her iki grup için de benzerdir.
Sonuç: Mod IÇT'nin fizyolojik olarak anaerobik metabolizmayı baskın olarak kullanan güvenilir bir test olduğu belirlenmiştir. Mod IÇT, takım sporlarındaki çeviklik becerisini (yön değiştirme dışında hızlanma ve yavaşlama) barındırdığı ve kolay uygulanabilen bir saha testi olduğu için anaerobik kapasiteyi belirlemekte kullanılabilir.
Anahtar Kelimeler: Anaerobik kapasite, Wingate Anaerobik Güç Testi, Running-based Anaerobic Sprint Test, Illinois Çeviklik Testi, Çeviklik

DEVELOPMENT OF A NEW FİELD TEST TO ASSESSMENT OF ANAEROBİC PERFORMANCE FOR TEAM SPORTS

ABSTRACT

Objective: The aim of this study is develop a new anaerobic field test (Modified Illinois Agility Test: Mod IAT) for team sports and investigate to reliability and reliationship with running-based anaerobic sprint test (RAST) and Wingate anaerobic power test (WAnT).
Method: Fourtythree male athletes were participated (10 handball, 10 football and 9 basketball players; team sports group: TSG and middle-long distance runners; individual sports group:ISG). At first day, height and body composition was assessed and all participants went to WAnT and Mod IAT measurements. Second testing day, RAST and repeat of Mod IAT was performed. There was at least 24-hour between Mod IAT tests. Also all tests were executed in a week for one subject. Heart rate and blood lactate was measured after the test and 5th min of recovery. Rate of percieved exerciton (RPE) is also asked and saved after all the performance tests.
Results: Physiological responses of all anaerobic tests were similar between BSG and TSG. When compared in-group there was significant difference in physiological parameters. The main finding of the study was the differences of completing times of new repeated agility test between ISG and TSG. The Mod IAT has good reliability cause of there is no significant difference between test-retest results of peak time (PT), total time (TT) and fatigue index (FI) values for all groups except PT value for ISG.
Conclusion: The present study indicate that required energy for Mod IAT was primerly provided by anaerobic pathways. Mod IAT is reliable and simple anaerobic field test which replicate team sports activties. Further researchs required to compare a gold standart test and understand to validity of this method.
Key Words: Anaerobic capacity, Wingate Anaerobic Power Test, Running-based Anaerobic Sprint Test, Illinois Agility Test, Agility

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INTRODUCTION

There are various performance tests in the sports science to measure short-term high-intensity power production and thereby the anaerobic capacity. The methods like Maximal Accumulated Oxygen Deficit (MAOD), Wingate Anaerobic Power Test (WAnT), Maximal Anaerobic Running Test (MART), Exercise Excessive Post-exercise Oxygen Consumption (EPOC) are among the sensitive methods used in laboratory (Haff GG, 2012; Kaminagakura EI, 2012). The most commonly known and used method among these method is the WAnT Method, which measures anaerobic capacity with a cycle ergometer in the laboratory (Vandewalle H, 1987; Al-Masri L, 2010). It has been demonstrated that 60-85% of the energy used for this test comes from Adenosine Triphosphate - Creatine Phosphate (ATP-CP) and glycolytic energy system (the first 3-15s ATP-CP, the rest glycolytic system) (Haff GG, 2012). However, the laboratory tests like MAOD, MART and EPOC require specific equipment and specially trained staff. In addition, there are other difficulties in these tests like the standardization of the laboratory conditions and the calibration of the equipment, and there are some problems like the tests taking too much time and the costs being high. Due to such performing difficulties, Practically Repetitive Sprint Tests have been developed instead of these tests that make sensitive measurements to meet the need for tests that can be applied in the field (Zagatto AM, 2009; Whyte, 2006; Mendez-Villanueva A, 2011).

Another test that measures the anaerobic capacity is the Running-based Anaerobic Sprint Test (RAST). In this test 35 m sprint is applied for six times with 10-second recovery time. RAST is an attractive method due to its being easily applied and is a reliable one among the others (test-retest ICC=0.88) and its correlation with WAnT is high (Kaminagakura EI, 2012; Zagatto AM, 2009).

However, both the WAnT and RAST and other repetitive sprint tests are based on continuous cycling or sprint running. On the other hand, there are complex activity patterns that require changing direction, accelerating-decelerating up, and decision making according to the opponent, which require agility skills in the nature of team sports. According to the time-motion analyses results in previous studies, it was determined that the players ran forward, backward and sideward in hockey, football, basketball and handball which include multiple sprints (Haj-Sassi R, 2011). It is known that if the movements and exercise types required by the sports branch are selected during the measurement of anaerobic performance, more accurate results are obtained (like obtaining lower results in endurance tests of the swimmer if the test is performed in treadmills) (William D McArdle, 2011).

Developing performance tests that are specific to the sports attracts the attention of the sports scientists because of the low costs, time saving property and the ease in applying. Recently researchers examined the validity and reliability of the Soccer Specific Intermittent Exercise Test (SSIET) (Oliver JL, 2007). It was demonstrated that the test, in which the splints during a half-time of a football game are stimulated, is reliable (CV=2.5%). also another research group conducted a study and developed an anaerobic endurance test that was specific to the rugby league players (Holloway KM, 2008). The new test (3x120 m sit-up) consisted of 10 m sprint and fighting activities that are specific to rugby. It is required that 40 m (in total 120 m) distance is covered in each repetition. The newly-developed anaerobic

endurance test was compared with the 60-second WAnT Method, and it was demonstrated that this test was valid. Bampouras et al. conducted a study that was specific for the water polo and compared two different anaerobic capacity tests that were called 14 x 25 m Maximal Sprint and Crossbar Jump with the WAnT. No statistically significant correlation between the two tests and the WAnT (Bampouras, TM, 2009). When the anaerobic performance is measured the necessity for the measurement methods that are specific for sports led to the increase in the studies in this field. However, the agility skill is an important factor in short-term high-intensity actions that are repeated in team sports because of the opponent and the status of the ball. Haj-Sassi et al. (Haj-Sassi R, 2011) applied the Repeated Modified Agility Test (RMAT) in a repetitive manner and recommended that agility must also be included in the tests that measured the anaerobic performance. In this test, the 20 m distance is run 10 times by changing the direction to the front, to the side and backwards with 25 seconds recovery intervals, and it is compared with WAnT and jumping tests. Significant correlation was found with the other tests only between the total time and peak time. However, RMAT has been evaluated as a field test that has reliability.

As our knowledge there is only one study on the field of integrating the agility skill in the tests for measuring the anaerobic capacity for team sports in the literature. There is a need for new studies because there are many agility tests with different properties. The purpose of this study is developing a new test that measures the anaerobic capacity in the field (Modified Illinois Agility Test), investigating its reliability and determining its relation with the Wingate and RAST tests.

METHODS

This study was approved by the Ethics Committee of Dokuz Eylül University (DEU), Turkey. The measurements was performed at DEU Exercise Physiology Laboratory and İnciraltı Campus Sports Hall. Participants were informed about the tests and protocols and gave their written consent. Fourtythree well-trained (2hours/day, 5days/week and at least 5 training years) male athletes were voluuntered in this study. Participants were seperated two groups as team sports group from (TSG, 10 handball, 9 basketball, 10 soccer players n=29) and individual sports group (ISG, middle distance runners n=14). Subjects were excluded which had undergone anterior curigiate ligament (ACL) surgery or any other injury to negatively affect their performance. Also it has been asked to avoid exhauseted training before the testing days. The measurements were performed maximum in a week, two seperated days between at least 24 hours rest. First testing day, body composition, WAnT and Mod IAT were meausured between 30 min rest. Second testing day, RAST and repeat of ModIAT were performed as considered previous resting time. During the all anaerobic tests, immediately after and 5th min of recovery heart rate (Polar RS 800, Finland), blood lactate consentration (Biosen C_Line, Magdeburg, Germany) and rate of percieved exertion (RPE) were monitored and recorded (Gunnar AV, 1982).

Body composition was determined by bioelectrical impedance analyser (Biospace, Inbody 720, Seul, Kore). Firstly body length was assessed via electonic stadiometer (G-Tech International) than assessment of weight, lean mass, fat mass and fat percentage were performed as fasting conditions (3-hour) according to manufacturer guide (Gibson AL, 2008).

Wingate Anaerobic Test: The cycle ergometer (Monark, 894E, Stockholm, Sweden) seat height was adjusted for every participants. WAnT was performed with standart load (75g/kg). A standart warming up session which include 3-5 repititons of 4-6 seconds sprint without load performed before the test. During the warming up sprints the revolution per minute (RPM) was recorded and inserted to the automaticly start protocol of the test. During the test participants were encouraged for the give their maximum efort. After the test PP, MP and FI were calculated from 5 s periods and reported relatively according to body weight (Bar-Or O, 1987). At the end of testing and the 5th minute of recovery, heart rate and blood sample collected from capillary taken from the fingertip were recorded. RPE was asked and recorded at the end of test.

Running-based anaerobic sprint test: Running-based anaerobic sprint test is consisted of running 35 meters six times in a row at the maximum speed with 10 seconds rest. Standard warm-ups were performed by all participants including 10 minutes of running exercises and stretching for pre-sprint (ballistic stretching of calves, hamstring and quadriceps muscles). Additionally they performed 3 x 35 m sprints at %90-95 intensity. The starting point of testing and the following beginning of running were performed with the signal of the photocell system (Zagatto AM, 2009). Every 35 meters sprint time was measured with the photocell system and recorded (Newtest Powertimer 300, Finland). Power output was calculated in Watt (W) from the formula, Power= (body weight×distance2)/time3. According to this, the fastest of 35 meters sprints were found as PT, the slowest was found as MP. Average of Power calculated from the the all 6 sprint times was evaluated Anaerobic capacity. Fatigue index was calculated from the formula, FI=(PT-MP)*100/PT. At the end of testing and the 5th minute of recovery, heart rate and blood sample collected from capillary taken from the fingertip were recorded. RPE was asked and recorded at the end of test.

Modified Illinois Agility Test: Illinois Agility Test, consisting of a sudden stop, acceleration and slalom run is a standard method used to evaluate agility (Winter EM, 2007). New test was modified without changing the running directions of IAR trail, shortening the distance and performing repeatedly so that the distance of it would be similar to the distance of repetitive sprint tests. In this modified test method, testing distance was run six times in a row with 10 seconds of rest in the shortest time. At the end of test, the fastest lap was evaluated as peak time (PT), the slowest lap was evaluated as minimum time (MT) and total time of the all laps was evaluated as total time (TT) as seconds. Fatigue index was calculated with the formula of FI=(PT - MT) x 100) / PT). At the end of testing and the 5th minute of recovery, heart rate and capillary blood sample taken from the fingertip were recorded. RPE was asked and recorded at the end of test.

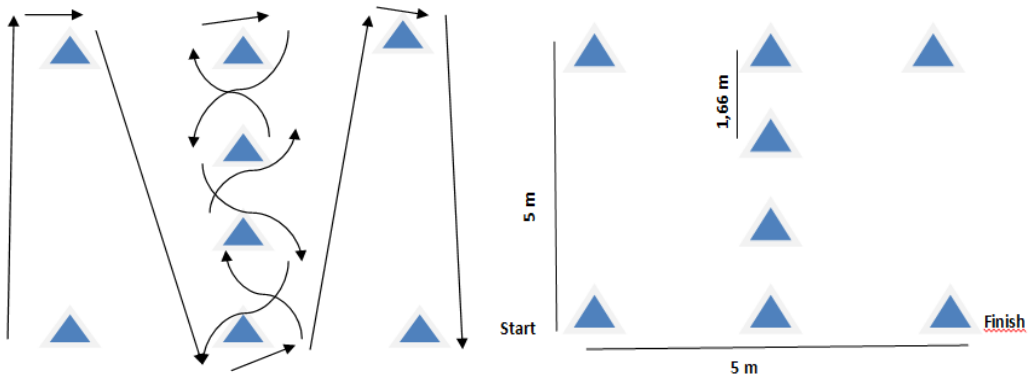

Figure1. Schematically demonstration of the Mod IAT track and running directions

Statistical Analyses:
All measurements were analyzed by using computer based software (SPSS 21.0, Chicago, IL). Age and body composition datas were presented as descriptive analyses as mean and standard deviation. Differences between the groups of anaerobic test scores and physiological responses were analyzed with Mann Whitney U test. They were analyzed with two way Friedman Variance analyses when compared in the group and Wilcoxon signed rank test was used for to find origin of significant difference. Relationship between anaerobic test was tested with Spearman correlation analyses. Significance of correlation was considered according to Hopkins scale (r<0.1; 0.1-0.3; 0.3-0.5; 0.5-0.7; 0.7-0.9; >0.9; 1) (Hopkins WG, 2013). Reliability of new test examined with Wilcoxon Signed Ranked Test. Statistically significance was considered as p<0.05.

RESULTS
All the data of age, body weight, fat mass, percentage of fat, skeletal muscle mass given as average and standard deviation for individual and team sports group and presented in Table 1. While the average age of groups are similar, values related to body composition are found statically and significantly higher in team sports group than individual sports group.

Table 1. Descriptive data of age and body composition for both ISG and TSG

	ISG (n=14)	TSG (n=29)	Total (n=43)	
	Mean ± Standard Deviation	Mean ± Standard Deviation	Mean ± Standard Deviation	p value
Age (year)	18,88 ± 4,08	18,89 ± 2,27	18,88 ± 2,93	.500
Body length (cm)	174,10 ± 9,09	182,18 ± 8,22	179,20 ± 9,30	.12
Body weight (kg)	58,78 ± 11,18	79,19 ± 11,35	72,54 ± 14,77	.000
Body fat percentage (%)	8,63 ± 3,62	14,00 ± 4,22	12,30 ± 4,72	.000
Fat mass (kg)	5,44 ± 2,54	13,49 ± 7,97	11,69 ± 8,50	.000
Skeletal muscle mass (kg)	31,83 ± 3,98	36,96 ± 9,52	34,58 ± 9,76	.000

Comparison of physiological responses related to anaerobic tests between groups are presented in Table 2. When the physiological responses in all tests of two groups are examined, RPE in RAST and recovery heart rate values in Mod IAT 1 are statically found significant in team sports group and individual sports group (respectively p=0.018 and p=0.044). Physiological responses of tests are compared within groups and are presented in Table 3.While there no difference among final heart rate, recovery heart rate and final lactate values in individual sports groups, significantly statically difference between RPE and final lactate values is recorded.

Table 2. Comparison of physiological responses of all anaerobic tests between groups

	WAnT			RAST			Mod IAT 1			Mod IAT 2		
	ISG	TSG	p value	ISG	TSG	p value	ISG	TSG	p value	ISG	TSG	p value
HR_{end} (bpm/min)	180,61 ± 11,44	174,06 ± 8,42	.156	178,07 ± 11,03	179,96 ± 7,10	.659	181,35 ± 8,91	181,41 ± 6,86	.846	180,14 ± 12,99	179,44 ± 7,21	.378
LA_{end} (mmol/l)	8,52 ± 1,81	7,83 ± 1,99	.311	9,15 ± 3,76	9,65 ± 2,43	.557	11,51 ± 2,86	11,95 ± 3,13	.779	11,99 ± 3,56	11,55 ± 3,56	.678
RPE	6,15 ± 2,34	7,31 ± 1,34	.129	4,79 ± 2,39	6,59 ± 1,72	.018	6,36 ± 1,74	7,45 ± 1,82	.071	6,79 ± 2,08	7,62 ± 1,47	.173
HR_{rec} (bpm/min)	108,58 ± 12,08	107,06 ± 7,75	.419	105,57 ± 17,10	107,65 ± 8,94	.697	105,07 ± 12,07	112,51 ± 8,24	.044	103,35 ± 15,20	107,06 ± 8,30	.259
LA_{rec} (mmol/l)	11,38 ± 2,08	12,34 ± 2,02	.270	12,04 ± 4,08	12,01± 2,58	.641	12,73 ± 2,17	13,24 ± 3,06	.364	12,68 ± 3,57	12,72 ± 3,29	.837

Table 3. Comparison of physiological responses of all anaerobic tests in-group

	Individual sports group (n=14)					**Team Sports Group grup (n=29)**				
	Wingate	**RAST**	**Mod IAT 1**	**Mod IAT 2**	**p valu**	**Wingate**	**RAST**	**Mod IAT 1**	**Mod IAT 2**	**p value**
HR_{end} (bpm/min)	180,61 ± 11,44	178,07 ± 11,03	181,35 ± 8,91	180,14 ± 12,99	.887	174,06 ± 8,42	179,96 ± 7,10	181,41 ± 6,86	179,44 ± 7,21	**.001**
LA_{end} (mmol/l)	8,52 ± 1,81	9,15 ± 3,76	11,51 ± 2,86	11,99 ± 3,56	**.000**	7,83 ± 1,99	9,65 ± 2,43	11,95 ± 3,13	11,55 ± 3,56	**.000**
RPE	6,15 ± 2,34	4,79 ± 2,39	6,00 ± 2,12	7,09 ± 1,85	**.008**	7,31 ± 1,34	6,59 ± 1,72	7,45 ± 1,82	7,62 ± 1,47	**.003**
HR_{rec} (bpm/min)	108,58 ± 12,08	105,57 ± 17,10	105,07 ± 12,07	103,35 ± 15,20	.736	107,06 ± 7,75	107,65 ± 8,94	112,51 ± 8,24	107,06 ± 8,30	**.007**
LA_{rec} (mmol/l)	11,38 ± 2,08	12,04 ± 4,08	12,73 ± 2,17	12,68 ± 3,57	.742	12,34 ± 2,02	12,01 ± 2,58	13,24 ± 3,06	12,72 ± 3,29	**.023**

All the values of parameters calculated in team sports groups among tests are statically found significantly different. In individual sports group, both in first and second practice, final lactate values are significantly higher in Mod IAT than

WAnT and RAST. Recovery lactate values are found similar in all tests. In individual sports group, perceived difficulty scale is significantly higher in Mod IAT 1 and 2 than RAST. In individual sports group, there is no statically significant difference between the values of final heart rate and recovery heart rate for all tests. In team sports group, final lactate values are found significantly lower in WAnT than other tests. Moreover, final lactate values are recorded as significantly lower in RAST than Mod IAT 1 and 2. In the same group, recovery lactate values are found significantly higher only in Mod IAT 1 than WAnT and RAST.

In team sports group, RPE is found significantly lower in RAST than other three test. In team sports group, final heart rate values are found lower in WAnT than other three tests. Recovery heart rate values are recorded significantly higher in Mod IAT 1 than RAST and Mod IAT 2. There are no significant difference in WanT results between two groups. Although there no statically difference in MP and FI when RAST results are compared in two groups, PT and AP are significantly higher in TSG than PSG (Table 4).

Table 4. Comparison of RAST and WAnT scores between groups

	WAnT			RAST		
	BSG	TSG	p value	BSG	TSG	p value
Peak Power (watt/kg)	12,54 ± 2,58	11,97 ± 1,66	.613	6,59 ± 1,64	7,97 ± 1,75	.023
Minimum Power (watt/kg)	4,86 ± 2,35	4,72 ± 1,15	.204	4,69 ± 1,37	5,11 ± 1,20	.238
Anaerobic Capacity (watt/kg)	9,07 ± 1,70	8,35 ± 0,78	.199	5,44 ± 1,35	6,49 ± 1,33	.015
Fatigue Index (%)	57,97 ± 21,39	59,86 ± 10,75	.422	28,68 ± 11,70	35,3 ± 8,98	.062

ISG: Individual Sports Group (n=14), TSG: Team Sports Group (n=29), WAnT: Wingate Anaerobic Power Test, RAST: Running-based Anaerobic Sprint Test.

All the data of total time, minimum time, maximum time and fatigue indicator in the newly developed test shows significant differences between groups both in first trial and the second.

Table 5. Comparison of Mod IAT scores between groups

	Mod IAT 1			Mod IAT 2		
	ISG	TSG	p value	ISG	TSG	p value
Total Time (s)	84,74 ± 2,21	76,70 ± 3,57	.000	84,24 ± 2,13	76,25 ± 3,12	.000
Peak Time (s)	13,69 ± 0,34	12,14 ± 0,60	.000	13,60 ± 0,36	12,10 ± 0,50	.000
Minimum Time (s)	14,57 ± 0,49	13,31 ± 0,69	.000	14,54 ± 0,41	13,23 ± 0,59	.000
Fatigue Index (%)	6,45 ± 3,37	9,67 ± 3,93	.007	5,78 ± 4,69	9,35 ± 3,02	.006

ISG: Individual Sports Group (n=14), TSG: Team Sports Group (n=29), Mod IAT 1: Modified Illinois Agility Test 1st assessment, Mod IAT 2: Modified Illinois Agility Test 2nd assessment

Table 6. Relationship Between Anaerobic Test Scores of Individual Sports Group

Individual Sports Group (n=14)								
	PP		MP		AC		FI	
	r	p	r	p	r	p	r	p
WAnT - RAST	0,365	0,199	0,268	0,353	0,442	0,114	,832**	.000
WAnT - Mod IAT 1	0,138	0,637	0,086	0,77	0,319	0,267	0,09	0,759
WAnT - Mod IAT 2	0,015	0,958	-0,073	0,805	0,251	0,387	,532*	0,05
RAST - Mod IAT 1	0,11	0,708	-0,009	0,976	0,095	0,748	0,231	0,427
RAST - Mod IAT 2	-0,081	0,782	-0,02	0,946	0,051	0,864	0,503	0,067

* Correlation is significant at the p< 0.05 (2-tailed). ** Correlation is significant at the p< 0.01 (2-tailed). PP:Peak Power, MP:Minimum Power, AC:Anaerobic Capacity, FI:FAtigue Index. WAnT: Wingate Anaerobic Power Test, RAST: Running-based Anaerobic Sprint Test, Mod IAT 1: Modified Illinois Agility Test 1st assessment, Mod IAT 2: Modified Illinois Agility Test 2nd assessment.

The relation among the results WAnT, RAST, Mod ICT 1 and 2 of individual sports group is presented in Table 6. When there is no significant relationship all parameters of WAnT and RAST except a positive significant relationship in FI parameter (r=,832; p=,000). There is correspondingly reasonable positive relation between WAnT and Mod ICT 2 FI (r=,532; p=0,05). There is no statically significant relation in all parameters for Mod ICT 1 and WAnT, Mod ICT 1 and RAST, Mod ICT 2 and RAST.

Table 7. Relationship Between Anaerobic Test Scores of Team Sports Group

Team Sports Group (n=29)								
	PP		MP		AC		FI	
	r	p	r	p	r	p	r	p
WAnT - RAST	0,065	0,737	-,553**	0,002	-0,208	0,278	0,178	0,356
WAnT - Mod IAT 1	0,319	0,091	0,201	0,297	0,179	0,354	-0,033	0,863
WAnT - Mod IAT 2	0,133	0,492	0,233	0,224	0,169	0,381	0,087	0,655
RAST - Mod IAT 1	-0,253	0,185	-,451*	0,014	-,379*	0,043	0,367	0,051
RAST - Mod IAT 2	-,425*	0,022	-,564**	0,001	-,542**	0,002	0,141	0,464

* Correlation is significant at the p< 0.05 (2-tailed). ** Correlation is significant at the p< 0.01 (2-tailed). PP:Peak Power, MP:Minimum Power, AC:Anaerobic Capacity, FI:FAtigue Index. WAnT: Wingate Anaerobic Power Test, RAST: Running-based Anaerobic Sprint Test, Mod IAT 1: Modified Illinois Agility Test 1st assessment, Mod IAT 2: Modified Illinois Agility Test 2nd assessment.

The relation among the results of WAnT, RAST, Mod IAT 1 and 2 of team sports group is presented in Table 7. Negative correlation is found between WAnT and RAST MG (r=-,553; p=,002). No statically significant relation is seen between Want and both Mod IAT 1 and Mod IAT 2 parameters. Reasonable negative correlation is found between RAST and Mod IAT 1, MP and AP (respectively r=-,451; p=,014 and r=-,379; p=,043). There is correspondingly negative correlation between RAST and Mod IAT 2, MP and AP (respectively, r= -,425; p=,022, r= -,564; p=,001 and r= -,542; p=,002.)

In the repeated practice of newly developed field test, while the total time is significantly different in individual sports group, it is similar in team sports group. Peak time and fatigue index rates are found similar for both groups when the test is repeated.

Table 8. Reliability analyses of Mod IAT

	TT ± 1.test	TT ± 2.test	p value	PT± 1. test	PT ± 2.test	p value	FI ± 1.test	FI ± 2.test	p value
ISG (n=14)	84,74 ± 2,21	84,24 ± 2,13	.041	13,69 ± 0,34	13,60 ± 0,36	.328	6,45 ± 3,37	5,78 ± 4,69	.638
TSG (n=29)	76,70 ± 3,57	76,25 ± 3,12	.150	12,14 ± 0,60	12,10 ± 0,50	.496	9,67 ± 3,93	9,35 ± 3,02	.689

TT: Total time (s); PT: Peak Time (s); FI: Fatigue Index (%); ISG: Individual Sports Group (n=14);

TSG: Team Sports Group (n=29)

DISCUSSION

In this study, new test, which measures the anaerobic capacity in the field for team sports, has been developed, and its repeatability has been examined. The results demonstrated that the physiological responses of the newly-developed test uses the anaerobic mechanism; it is a reliable test; and produces different results when applied in individual/team sports.

Physiological Responses

The first finding of this study is that the ATP that is required for the developed Mod IAT mostly comes from anaerobic energy pathways. The maximal heart rate value was reached because high-intensity exercises were applied after all anaerobic performance tests that were applied both for ISG and TSG; and the lactate concentration accumulated with the influence of anaerobic metabolism exceeded 8 mmol/l. Because it is known that 70% of the ATP production in supramaximal exercises that last for 30 seconds is covered from the anaerobic mechanisms (Noordhof DA, 2010). In addition, according to a study that examined the aerobic-anaerobic energy contribution for 1500 m run, which is one of the medium-distance competitions, for the duration of the race, the energy production via anaerobic way in the first 10 seconds is dominant (65/35%) (Kraemer WJ, 2012).

When the physiological responses of all the anaerobic tests in this study were compared among the groups it was observed that all the values were similar except for the RAST RPE and Mod IAT 1 recovery heart rate at fifth minute. In this context it was observed that the players coming from individual or team sports gave similar results that were independent from the test results. However, when the physiological results of the tests were compared within the group, it was observed that there were differences. In both groups, the highest lactate values were found in Mod IAT 1 and 2. The RPE being higher in RAST and ISG than in TSG gave rise to its being evaluated as a more difficult test. In this context, when it is evaluated subjectively, it is possible to claim that the newly-developed test is difficult.

The WAnT and RAST lactate values measured in this study are high when compared with some studies (Zupan MF, 2009; Beneke R, 2002) while they are low when compared with some other studies (Zagatto AM, 2009; Jaafar H, 2014; Keir DA, 2013). The reason for these high values may be that in the studies the blood samples were taken immediately after the tests and the peak lactate values were measured (Zagatto AM, 2009; Keir DA, 2013) or maybe due to the fact that more resistance was applied than the standard load in the WAnT protocols of these studies (8.7%, 11.5%). Again, the results of this study are similar to the lactate values obtained in the study that was conducted by Beneke et al. to measure the energy contribution of WAnT (Beneke R, 2002). The RPE was not included in many studies, but was only used in the study conducted by Jafaar et al. (Jaafar H, 2014) to examine the effect of the WAnT loads on the performance and repeatability. However, since Borg used 20-scale RPE, the results are not compared with the results of this study. The heart rate results of the Hawaii Anaerobic Run Test - HART, which measures the anaerobic performance in the field, are similar to those obtained in the new test; however, the lactate value is lower. The subjective evaluation of the test was conducted with Borg 20-scale RPE (Kimura IF, 2014). Haj Sassi et al. conducted a study to measure the anaerobic performance with the Repetitive Modified T-Test (RMAT) and reported that the end-test blood lactate concentration (9.66 ± 6 2.61) lower than the value in the Mod IAT (Haj-Sassi R, 2011). The reasons for this is that the RMAT consists of 10 repetitions each of which ends in nearly 4-6 seconds, while the Mod IAT consists of 6 repetitions each of which end in 12-16 s. This application has longer recovery intervals between the RMAT repetitions. In the recovery, the ATP-CP renewal may be influenced, and therefore the lactate values decreased. In addition, the power production capacities of the muscles are strained due to sudden accelerations and decelerations in the tracks that require agility skills. In this context, 9 direction changes are made in Mod IAT, 4 are made in RMAT, and this may be another factor influencing the high lactate value. In our study, it is considered that the lactate accumulation increased with the production of anaerobic energy being triggered.

Anaerobic performance Test Results and the Correlations

The second finding in this study is that a significant difference between the ISG and the TSG of the Mod IAT results. When the results of the other tests among the groups are examined it was observed that the RAST PG and AC values were different as the Mod IAT, the WAnT results were found to be similar for the two groups.

The most important finding of this study is that, when the correlation between the tests are examined, there is no significant relation for ISG; however, there is a significant negative correlation between the RAST and Mod IAT for TSG. In the repetitive plain sprint performance and the repetitive application of a track where directions are changed with sudden accelerations and decelerations, the athletes who are in the team sports give better results, because they have to change directions and speeds according to the position of their opponents or the position of the ball or attack-defense situation in their sports. For this reason, the Mod IAT may be evaluated as the field test specific for sports. According to a previous study, a significant negative correlation was found between the repetitive agility test, RMAT PT, TT and WAnT PG and AC (Haj-Sassi R, 2011). However, WAnT is a supraximal laboratory test which is in the non-repetitive continuous structure and applies

additional resistance. On the other hand, in this study, the repetitive agility test has been compared with RAST, which is a field test similar to Mod IAT. In addition, the participants were selected from among the university physical education department students and from only team players. However, while developing a test for team sports, it would be more appropriate to compare them with a group that does not do the specific actions of that sport. The different results being obtained for individual and team players in this study while measuring the anaerobic performance with Mod IAT makes us consider that this newly-developed test may be used for team sports.

When the WAnT results in this study are compared with the WanT results reported in the literature in terms of Peak Power and Average Power, these results were found to be similar to the results of some studies (Zagatto AM, 2009; Hale T, 2003); however, these values were found to be higher than those reported in some other studies (Haj-Sassi R, 2011; Noordhof DA, 2010). In addition, according to the normative data reported by Zupan et al. the PP and AC values of the ISG (12,54 ± 2,58 W and 9,07 ± 1,70 W, respectively) are classified in the Very Good category; and the PP and AC values of TSG (11,97 ± 1,66 W and 8,35 ± 0,78 W, respectively) are classified in the Good Category (Ching-Feng C, 2012). According to another norm database, the PP and AC for both groups are evaluated in 90% level (Noordhof DA, 2010). It has been determined that the RAST results of this study are lower than the results of the previous studies that were conducted for both groups. The reason for this may be the distance in RAST is constant, and it is applied without additional resistance, because it may be considered that the participants whose body weights are more will produce more power. Moreover, the FI value of the RAST in this study (ISG: 2,90% ± 1,35 and TSG: 6,58% ± 2,64) is the lowest value when compared with those in the previous studies (Kaminagakura EI,2012; Zagatto AM, 2009; Keir DA, 2013; Lockie RG, 2013).

The Reliability of the New Test and the Other Tests

The Mod IAT test/retest results were compared, and the reliability analyses of the TT, PT and FI parameters have been performed. All the values were found to be similar to each other except for the TT parameter of the individual sports group. Similarly, the new test RMAT, which was applied in the study conducted by Haj Sassi et al, was presented as reliable. The correlation coefficient in the class of RMAT for PT, TT and FI were found high; r=0.972, r=0.94 and r=0.91 (Haj-Sassi R, 2011). The basic point of both measurement methods is similar in terms of the repetitive application of the agility test; however, different in terms of the performing manner. All in all the two tests have been described as repeatable. When the two test are compared in terms of TT; it was observed that although the RMAT is repeated for 10 times, it lasts much less than Mod IAT (61.22 ± 3.02 s). Although the total distance is close to each other in the tests, Mod IAT lasts more, and this is due to the application of more direction changes. A similar difference is also observed in the FI values. After the RMAT, the FI was observed as being lower than the Mod IAT. The players recovered with the help of longer recovery intervals may have experienced decreases less than PS. In the study conducted by Haj-Sassi et al., the T test, which is relatively used less to measure the agility, was selected and modified. On the other hand, the Illinois Agility test is the most commonly used test which is accepted as the standard (Winter EM, 2007). Hachana et al. conducted a study to examine the validity and reliability of IAR for team sports and found a significant correlation between the IAR and T-test (r=0.31,

p=0.002) (Moore A, 2003). Meanwhile, Hachana et al modified the test track and the total distance run and thus modified the IAR test. It was observed that the Mod IAR test retest ICC was r=0.99, and a high correlation was observed between IAR (r=0.76) (Attia A, 2014). This type of modification may have been made due to the spring distance in sports being 10 m and less (Cronin J, 2003; Hachana Y, 2014), and because of the total distance leading to changes in pathways with the increase of the end-time and with the increase in the total distance. Meanwhile, the profile of the participants consist of only team players, and therefore they did not measure whether these players were different from the other players while they were measuring the anaerobic capacity for the field-team sports. It could be beneficial to compare them with a group that consisted of individual sports with cyclic movement pattern. As a matter of fact, it was demonstrated in this study that there are significant differences between the anaerobic test scores among the groups. Meanwhile, the physiological responses of these tests were found similar between the two groups.

Although the anaerobic capacity tests that were proper for the team sports were tried to be developed, there is only one study that deals with anaerobic field test that includes agility skill. With this study, a contribution has been made to the literature by adding a similar new study. In addition, we can observe that the agility tests, which were selected to be applied repetitively, have characteristic difference. The characteristics of these types of agility (changing directions) tests are examined with the total time, the number of the changing directions, and the plain on which the power is applied (Haj Sassi R, 2009). For each direction change, the acceleration and deceleration afterwards show us that the Mod IAT in this study is a more complex test, because as the number of the direction change increases, the eccentric-concentric power capacity of the muscles and the endurance gains importance. Different from the Mod IAT, applying power on the lateral plain is applied with move-aside steps. While the Mod T-test is completed with 4 horizontal and lateral direction changes in 4-6 seconds, the Mod IAT in this study is completed with 9 direction changes in only horizontal plain in 13-15 seconds. By considering the completion time, it is possible to claim that the Mod T-test covers the required energy primarily from ATP-CP system. However, in order to observe the real metabolic responses of the tests, it could be beneficial to make measurements with portable oxygen analyzers. In cases where this is not possible, the validity could be found by comparing with MAOD. Vescovi et al. conducted a study and found a significant relation between WAnT and MAOD parameters in the 300 m shuttle run (Castagna C, 2003; Reilly T, 2000). On the other hand, when RAST is compared with MAOD in terms of anaerobic capacity measurement indicator, it was observed that no parameters had significant relations with MAOD (Kaminagakura EI, 2012). Despite this situation, there are studies that demonstrated significant relations between WAnT and RAST (Zagatto AM, 2009; Keir DA, 2013).

CONCLUSION

In this study, a new test that measured the anaerobic capacity in the field has been developed for team sports. It was demonstrated that the Mod IAT used the anaerobic metabolism in a dominant manner physiologically. Meanwhile, it was also determined that it is a reliable test. The most important finding of this study is the fact that although there is no significant relation for the individual players between the correlations of the tests, there are

significant negative correlations between the RAST and Mod IAT for team players. In this context, Mod IAT, which is used in measuring the anaerobic capacity, may give different results in sports branches that consist of cyclic and acyclic movements. Again, the results of this study are limited with the number of the participants and their profile. Meanwhile, it is recommended that this test is compared with such a gold standard like MAOD or the metabolic responses are measured with portable analyzers, and further studies that compare it with MAOD are conducted. The agility tests like Mod IAT applied with intervals in a repetitive manner are included in new and few studies. However, its being applied without high-cost equipment, its making many measurements in a short time, and its being a practical field test may be used in determining the anaerobic capacity in team sports.

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