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ORIGINAL ARTICLE

INVESTIGATION OF THE PERFORMANCE RESPONSES OF YO-YO AND SHUTTLE RUN TESTS WITH THE TREADMILL RUN TEST IN YOUNG SOCCER PLAYERS

Abstract

The purpose of this study was to determine the relationship between performance in the Yo-Yo intermittent recovery test level 1 (YIRT1), 20-m multi-stage shuttle run test (MST) with measured maximal oxygen uptake (VO_{2max}) in Treadmill test (TRT) and examine the differences in heart rate (HR) responses to the YIRT, MST and treadmill tests (TRT) in young soccer players. Thirteen amateur soccer players (mean age: 15.38 ± 0.51 , mean height: 177.38 ± 5.53 cm, body mass 69.36 ± 5.48 kg, VO_{2max} 60.22 ± 1.47 ml/kg/min) volunteered for the study. Comparisons were made using ANOVA and the Pearson product moment correlation coefficient (r) was used to determine the relationship between the players' performance and VO_{2max} . There were no differences found among the HR_{max} values of YIRT, MST and TRT. There was found significant correlation between VO_{2max} and both YIRT and MST performance respectively ($r = .89$ and $r = .78$) ($p < 0.05$). Both MST and YIRT could be used to determine HR_{max} of soccer players and also MST and YIRT have strong relationship with VO_{2max} , thus they may also be used in order to assessment of soccer player's endurance performance as field-based test.

Key Words: : Soccer, Shuttle Run Test, Yo-Yo Test, VO_{2max}

Introduction

Soccer is intermittent sport and, performance of soccer players are related to the ability of players to repeatedly perform intense exercise (Krustrup et. al, 2003), thus soccer players need well developed aerobic endurance in order to show effective performance during repeated high-intensity efforts (jump, change direction, sprint etc.) and recovery bouts of intense exercise (Stone and Kilding, 2009). Aerobic endurance fitness is measured directly on treadmill (TRT) whilst running to exhaustion in the laboratory environment is the gold standard, there are some disadvantages of these methods are the requirement for expensive exercise ergometers, gas analysis and ventilation equipment etc (Leibetseder et. al, 2002; Sutton, 1992). Therefore, they may not be ideal for team sports like soccer (Aziz et. al, 2005). Thus, field tests have been used to determine endurance performance of soccer players (Krustrup et. al, 2009), such as MST (Leger and Lambert, 1982), the Yo-Yo tests (Bangsbo, 1994).

The most popular field test for the prediction of VO_{2max} is the MST, which is widely used by coach and sport sciences in order to determine VO_{2max} (Svensson and Drust, 2005). There is strong association the MST and VO_{2max} (Aziz et. al, 2005; Leger and Gadoury, 1989; Ramsbottom et. al, 1989). On the other hand, while the MST is a continuous test, soccer is intermittent and performance is related to the soccer' ability to repeated bouts of intense exercise (Krustrup et. al, 2003). Therefore, sport sciences needed to develop a test to evaluate the soccer players ability to repeated bouts of intense exercise (Krustrup et. al, 2003). Bangsbo developed Yo-Yo intermittent recovery test (YIRT) which is more soccer-specific assessment (Krustrup et. al, 2003).

Many studies have examined the relationship between Yo-Yo test performance and measured VO_{2max} using an oxygen analyzer, but the results of these studies represented a scattered picture (Bangsbo et al. 2008). While some studies found a weak correlation between VO_{2max} and Yo-Yo test performance (Aziz et al., 2005; Castagna et al., 2006), other studies showed a moderate to strong correlation (Krustrup et al. 2003; Thomas et al. 2006). A few studies have examined relationship between particularly YIRT performance, MST performance and aerobic fitness. Therefore, The objectives of the current study were twofold : a) to determine the relationship between performance in the Yo-Yo intermittent recovery test

level 1 (YIRT1), 20-m multi-stage shuttle run test (MST) with measured maximal oxygen uptake (VO_{2max}) in Treadmill test (TRT), b) to examine the differences in heart rate (HR) responses to the YIRT, MST and treadmill tests (TRT) in young soccer players.

Method

Subjects

Thirteen soccer players participated in the study. The players' physical characteristics were mean age: 15.38 ± 0.51 , mean height: 177.38 ± 5.53 cm, body mass 69.36 ± 5.48 kg, VO_{2max} 60.22 ± 1.47 ml/kg/min, covered distance in MST 1981.54 ± 349.0 m, covered distance in YIRT 2649.23 ± 288.9 m. Players were informed of the tests' protocols and procedures, but to ensure that players devoted equal effort to each trial, the aim of the study was not disclosed. They were familiarized with the tests' protocols and had undergone the MST, YIRT and TRT at least once prior to the study. The players provided written informed consent for the study, which was approved by the Ankara University ethics committee.

Procedures

The test performed as separate sessions with 2 day intervals between tests for each player. On day 1, body composition values and VO_{2max} on a treadmill (Cosmed, Gambettola, Italy) were determined; on day 2, YIRT and MST were performed randomly and the other test day wise versa within 1 hour and took place between the times of 10:30 and 12:30. The MST and YIRT were performed at the same outdoor location on a synthetic pitch. The standardized warm-up for the YIRT and MST trials consisted of 3 minutes of running the 20m distance back and forth at a set pace (i.e. 8.0 km/h) with the help of "beep" sounds; for the TRT trials, it consisted of 3 minutes of running on a treadmill at 8 km/h. This was followed by 5 minutes of stretching, focusing on the lower limb muscles (Aziz et al., 2005). During the TRT, expired gases were analyzed using a breath-by-breath automated gas-analysis system (Fitmate Pro; Cosmed, Italy). The flow, volume, and gas analyzer were calibrated before each player's test according to the manufacturer's instructions. Achievement of VO_{2max} was considered as the attainment of at least two of the following criteria: 1) a plateau in VO_{2max} despite increasing

speed, 2) a respiratory exchange ratio above 1.10, and 3) $HR \pm 10 \text{ beats}\cdot\text{min}^{-1}$ of age-predicted maximal HR ($220 - \text{age}$) (Bravo et. al, 2008). Heart rate was recorded at 5-second intervals during YIRT and MST via short-range radio telemetry (Polar Team Sport System, Polar Electro Oy, Finland). The HR measurements were stored by using polar 610i (Finland) throughout the tests and transferred to the computer and filtered by polar software (Finland). The highest HR measurement was recorded as HRmax. The temperature and relative humidity at the test site were consistent throughout the study, ranging between 25.4-27.6 °C and 51.3-53.7%, respectively. Each player completed all of the tests within the one-week period.

20-m multi-stage shuttle run test (MST)

The 20m MST required subjects to run back and forth between 2 cones set 20 m apart. Subjects started running at an initial speed of 8.5 km/h, which increased by 0.5 km/h every minute. The player was warned once if he did not reach the end line in time. When the subjects twice have failed to reach the finishing line in time, the distance covered is recorded and represents the test result (Leger and Gadoury, 1989)

The Yo-Yo intermittent recovery test (YIRT)

The YIRT consists of repeated 2 x 20-m runs back and forth between the starting, turning, and finishing line at a progressively increased speed controlled by audio beeps from a tape recorder. Between each running bout, the subjects have a 10-s active rest period, consisting of 2 x 5 m of jogging. When the subjects twice have failed to reach the finishing line in time, the distance covered is recorded and represents the test result (Bangsbo, 1994; Krstrup et.al, 2003).

Test of running on a treadmill (TRT)

The TRT trials were conducted in a standardized laboratory environment. Player warmed-up on the treadmill (Cosmed, Italy) for 3 min at $8.0 \text{ km}\cdot\text{h}^{-1}$ followed by 5 min of self-stretching the lower limbs. The test commenced at $10.0 \text{ km}\cdot\text{h}^{-1}$ and zero gradient for 2 min, followed by an increase to $12.0 \text{ km}\cdot\text{h}^{-1}$ for another 2 min. Thereafter, the speed was increased by $1.0 \text{ km}\cdot\text{h}^{-1}$ every minute thereafter until the player attained volitional exhaustion.

Statistical Analyses

SPSS (15.0 for Windows) was used for all statistical analyses. One-way analysis of variance (ANOVA) was used to determine if there were significant differences in the MST, YIRT and BTRT. The Pearson product moment correlation coefficient (r) was used to determine the relationship between the players' performance and selected physiological measures for the three tests. The level of statistical significance was set at $p < 0.05$.

Results

Table 1 shows HRmax obtained during the MST, YIRT and TRT for the 13 players. No significant differences were found between field and laboratory tests in terms of HRmax ($p > 0.05$)

Table 1. Comparison of the physiological responses in the BTRT, MST and YIRT in soccer players.

	HR _{max}		
	Mean	Sd	F
MST	196.92	3.98	0.375
YIRT	196.69	4.69	
TRT	194.84	2.60	

Table 2 shows the correlations between the performances in the YIRT and MST tests with the measured VO₂max in TRT for the 13 players. There were strong correlations between performance in both the YIRT and the MST with measured VO₂max obtained in TRT.

Table 2 . Correlation of the measured VO₂max and distance in the MST and YIRT in soccer players.

	VO ₂ max
YIRT	.89
MST	.78

DISCUSSION

The major finding of this study is that, we found strong relationships between measured VO₂max and both MST performance (distance covered) and YIRT performance (distance covered) and both tests could be used as a field-based tests in order to evaluate VO₂max in soccer players. It is well known that TRT in the laboratory environment is the gold standard in order to evaluate aerobic capacity of players (Costill, 1967; Saltin and Astrand, 1967). The determination of VO₂max by using ergospirometry is very costly way and needs sophisticated equipments and experienced staff (Leibetseder et. al, 2002; Sutton, 1992), additionally it takes more valuable time than field-based tests (Aziz et. al, 2005) that's why it may not be appropriate for some applications (Aziz et. al, 2005; Stickland et. al, 2003). Thus, there are really interest in field-based tests in order to examine aerobic performance of team sport players (Aziz et. al, 2005; Stickland et. al, 2003). Present study results support observations obtained by studies, which examine relationship MST and VO₂max. For example, Ramsbottom et al. (1988) found a correlation of 0.92 between VO₂max and MST performance. Leger and Gadaoury (1989) found a strong relation between the MST performance and measured VO₂max in adults. Aziz et al. (Aziz et. al, 2005) reported that there were strong and moderate relationships between the MST and measured VO₂max values. Additionally, The relationship of YIRT and VO₂max have been examined by studies; Krstrup et al. (2006) found a correlation of 0.56 between YIRT2 and VO₂max. Castagna et

al. (2006) found no correlation between $VO_2\text{max}$ values and YIRT performance. Aziz et al. (2005) found a weak relationship between $VO_2\text{max}$ and Yo-Yo intermittent endurance test performance. In contrast, Thomas et al. (2006) described that strong correlations for YIRT performance and measured $VO_2\text{max}$ ($r = .87$). Krustup et al. (2003), found YIRT performance to also correlate strongly with $VO_2\text{max}$ ($r = .71$). The results of this study and pervious studies show that the MST is valid test, on the other hand it should be remembered that, MST estimated $VO_2\text{max}$ values are different from measured $VO_2\text{max}$ values commonly (Thomas et. al, 2006).

One of the important findings of this study relates to the comparison of HRmax for the MST, YIRT and BTRT. HR monitoring is one of the most popular and useful indirect methods to estimate energy expenditure and intensity of training (1999). We found that there were no significant differences between HRmax values for the three tests. Metaxas et al. (2005) determined HRmax using 2 maximal field tests: the Yo-Yo endurance test (contiuus) and the Yo-Yo endurance test (intermittent) as well as 2 maximal exercise tests on the treadmill they found no significant differences in HRmax values between the four tests. Additionally, Stickland et al. (2003) reported similar results with our study and they determined no differences between HRmax from the YIRT test and that from the MST. According to our results YIRT, MST and TRT tests could be used interchangeably to determine HRmax .

CONCLUSIONS

Both MST and YIRT could be used to determine HRmax of players and have strong relationship with $VO_2\text{max}$. it was concluded that MST and Yo-Yo are the valid tests to determine $VO_2\text{max}$ and HRmax in soccer players.

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