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Reliability and Validity of a Novel Soccer Specific Field Test

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Abstract

Introduction: Soccer Specific Modified 1.5 Mile Run Test is a new field test which improved by modifying "1.5 mile Run Test" with soccer specific movement pattern. The aim of this study was to evaluate the criterion and construct validity and reliability of Soccer Specific Modified 1.5 Mile Run Test.

Methods: Totally 48 athletes were participated in the study. To evaluate the construct validity, 16 non-soccer player athletes (handball, basketball and volleyball) were recruited in the study in addition to 32 soccer players. Participants visit the laboratory once. Height, weight, body fat percentage and maximal oxygen uptake were measured during laboratory session. In subsequent 2-7 days, Soccer Specific Modified 1,5 Mile Run Test is performed two times in the soccer pitch with 2-7 days apart.

Results: Soccer players completed the field test in a shorter time, significantly ($p<0,001$). There is a significant, strong and positive correlation between maximal oxygen uptake and time to complete Soccer Specific Modified 1,5 Mile Run test in soccer players ($r=0,83$). However, there is no significant correlation between maximal oxygen uptake and time to complete Soccer Specific Modified 1,5 Mile Run test for non-soccer player athletes. There is a significant, strong and positive correlation between two-field test both groups ($r=0,91$; $r=0,87$ respectively).

Discussion: Soccer Specific Modified One and Half Mile Run Test is a reliable and valid test.

Keywords: Maximal Oxygen Uptake, Soccer, Field test, Validity, Reliability

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Introduction

Soccer requires not only complicated techniques and tactics but also high physical performance so the scientific studies mostly focus on evaluating and increasing the physical performance capacity. Multiple sprint activities, jumping, tackling, movement patterns such as shooting and shuttle run reveal the necessity of improving reliable and valid soccer specific methods for the researchers.

Gold standard method to detect the maximal oxygen consumption capacity (VO_{2max}) is the direct evaluation method in a laboratory by using a metabolic analyzer. Laboratory tests are expensive, time-consuming tests that require qualified personnel. However, there are kinematic differences between a run on an actual soccer pitch and on a treadmill (Schache et al., 2001). On the other hand, major specific field tests are more popular among the trainers and the athletes as they are easy to apply, reliable and cheaper to maintain (Mirkov et al., 2008; Sağıroğlu et al., 2016)

A lot of soccer specific field tests have been introduced (Nassis et al., 2010; Kemi et al., 2003; Chamari et al., 2004; Svensson et al., 2005). Even though there are tests that have so much in common with Soccer Specific Modified One and Half Mile (MOHM) Test (figure 1) in litterateur, there is requirement to develop highly valid, new soccer specific field tests. Some tests that takes place in litterateur, imitating the soccer specific movement patterns and evaluating the aerobic power are Loughborough Intermittent Shuttle Test (LITS), Hoff Test, Bangsbo Intermittent Shuttle Test, Ekblom Soccer Specific Endurance Test, Copenhagen Test and the most popular one of the recent years, Yo-Yo Intermittent Recovery Test.

Loughborough Intermittent Shuttle Test is a test designed for a scientific study (Thompson et al., 1999). The test lasts about 90 minutes, with 6 intermittent series which last for 15 minutes each. The test is developed to simulate a soccer game simulation for scientific researches while reflecting the distance and the speed covered in a game, appropriate with the aim of the test. It doesn't involve the movements without the ball in a game.

The Hoff Test was introduced by Hoff et al (2002) as a training method. It later on as introduced as valid (Kemi et al., 2003). Hoff Test also involves soccer specific movements such as running backwards, slalom, rapid direction change. In ten minutes' time, the distance covered by the player is correlated with the VO_{2max}. However; Hoff Test is performed with dribbling. Considering the technical skill level of the player may affect the distance he

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covered, it is reasonable to say that the logical validation of the test is questionable. Besides, dribbling a ball non-stop for ten minutes is inappropriate for the nature of soccer. Soccer players dribble 1.7-1.9% of total distance of a competition which means nearly 200-250 meters (Carling, 2010; Di Salvo et al., 2007; Rampinini et al., 2009).

The Bangsbo Intermittent Shuttle Test, introduced by Jens Bangsbo (Bangsbo et al., 1992). The test is applied around the penalty area. There are soccer specific movement patterns such as side running, running backward, slalom. During the test, the participant makes a run of 15 seconds for 40 times as fast as he can. In every time, there are 10 second active breaks. Evaluating the distance, he covered after 40 running periods, the VO_{2max} level of the participant is detected. Bangsbo Intermittent Shuttle Test is not a valid test. It can have explained as the test is not non-stop, always requires high speed and other than $VO_{2max,}$ it is anaerobic (Chamari et al., 2004). Besides, the testing area needs details preparation and a sound system is also required to perform the test. As a result, the applicability of the test is questionable.

Ekblom Soccer Specific Endurance Test was introduced by Ekblom et al (1989). The test takes place around a soccer pitch. The test is about completing a section of 1905 meters as soon as possible. Involving soccer specific movement patterns such as running, side running, running backwards, slalom, rapid change of direction, the test is considered as reliable on the litterateur (Williams et al., 2009) but there is no study to investigate the validity of Ekblom Soccer Specific Endurance Test

Copenhagen Test was designed by Bendiksen et al (2012). Designed by the activity profiles on elite leagues soccer games. This test consists of two parts of 45 minutes, divided into two by a break of 15 minutes. Just like Loughborough Intermittent Shuttle Test, this test was created scientifically to evaluate the physical demands of a soccer game. It is not a convenient test to monitor the VO_{2max} changes of a soccer team throughout the season, however; it is valid (Bendiksen et al., 2012).

Yo-Yo Intermittent Recovery Test was designed by Bangsbo (Bangsbo, 1994). Available for soccer movement patterns, it is a test of shuttle running of 40 meters gradually getting difficult, and divided by 10 seconds active breaks (5 meters of walking). The test is quite valid and reliable (Krustrup et al., 2003). However; it only consists of running forward and doesn't involve the other movements of soccer.

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Considering the disadvantages of soccer specific field tests, new field tests are much needed lately.

The purpose of this research is to measure and evaluate the construct and criterion-related validity and also reliability of a recently improved (MOHM) Soccer Specific Modified 1.5-mile Running test which is developed to add the literature a new field test.

Methods

Forty-eight male well-trained athletes (2 hours/5 days/week, at least five years training experience) were participated to study voluntarily, who are between the age of 17-24 and playing in a team sport on an amateur level. Participants were separated two groups as Non-Soccer Players (NSP; n=16, 5 basketball players, 4 volleyball players and 7 handball players) and Soccer Players (n=32). The participants were chosen among those who haven't been away from the trainings and the events due to injuries for the last 3 months.

This research is approved by the local ethics committee. The participants and the parents of the participants under 18, provided written and oral information about the study, which included briefing about the risks and benefits of the participations. They all gave their informed written and oral consent prior to participation.

The laboratory measurements have been completed in a human performance laboratory. The field measurements have been completed on a synthetic soccer pitch. The measurements were performed in the same daytime.

The participants were invited to three sessions, one to the laboratory and two to the field measurements. Laboratory measurements were done on the first day. The height, the weight, the body fat percentage (BFP) and the VO_{2max} of the participants were measured. The participants attended to the first field test in 2-7 days following the laboratory session. In 2-7 days after the first field session, the MOHM Test was repeated.

The heights were measured by electronic stadiometer (G-Tech International, South Korea). The weight and the BFP were measured by bioelectrical impedance device (Biospace, Inbody 720, South Korea). All body composition measurements were done with shorts and t-shirts on but shoes off. The participants were asked; not to take part in any strenuous exercise 2 days before testing, not to take caffeine or alcohol at least 24 hours before testing, not to consume any food at least 3 hours before testing and not to drink any beverage at least 1 hour before testing for both lab and field test days.

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The measurement of VO_{2max} was completed on the treadmill (Cosmed T 34, Italy) and the Bruce protocol was used during the procedure. During the test, the air the participant inhaled was analyzed with gas analyzer (Cosmed Fitmate Pro, Italy) and the maximum oxygen consumption level was detected.

Soccer Specific modified 1.5 Miles Running Test is the soccer modified version of the 1.5 miles running test which is applied on a soccer pitch. The test is done in and around the penalty area. The test involves soccer specific movements such as backward running, side running, rapid change direction (figure 1). These movements are used in many sports but what makes those running special for the test is that the distances of backward running, side running and running forward that reveals on movement analysis of professional soccer games is calculated and reflected to the distance of the test. On a soccer game, the distances covered by players are approximately 10 km. The 9 out of 10 km is running forward which consists of a variety of movements from sprint to walking. The 1 km left is side- running or running backwards (Stolen et al., 2005; Bangsbo, 1994). The distance covered on MOHM Test is approximately ¼ of the distance covered in a soccer game. The different type of running on a soccer game has been simulated on the test according to this rate (1/10 of 2410 m).

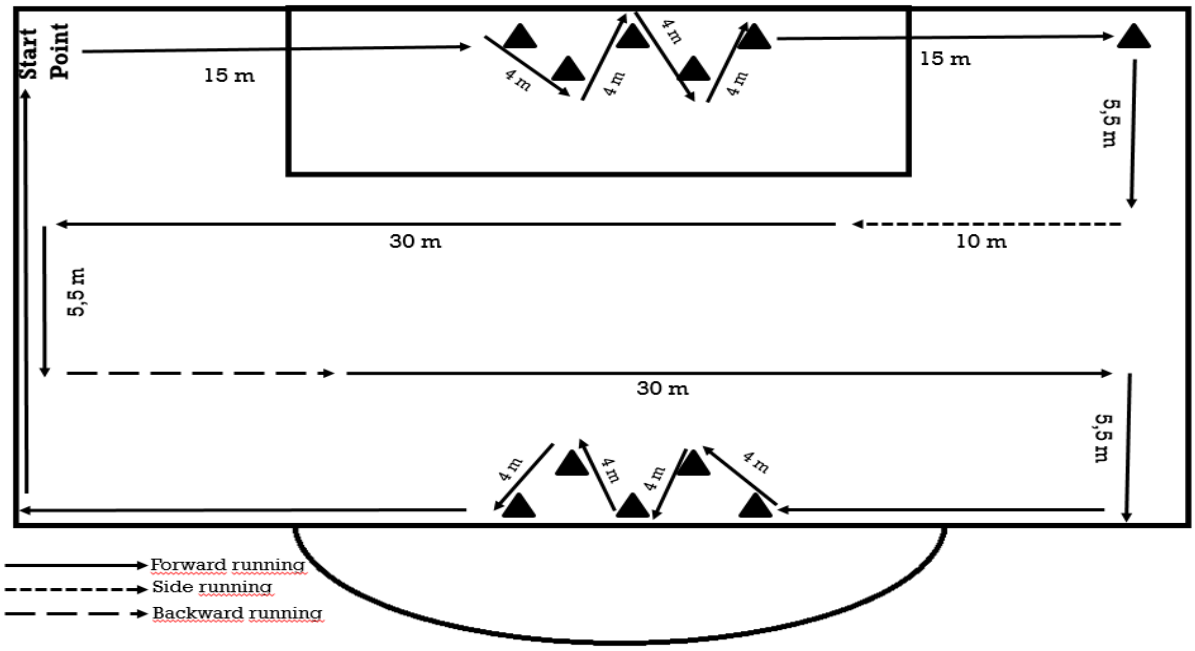

Figure 1. Modified One and Half Mile Test Diagram

On this test, the participant tries to run the distance of 1.5 miles, which is 2410 meters as soon as possible. The participant completes a lap every time he passes by the starting point.

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A lap is 205 meters. So, the participant makes 11 laps and completes the test on the finish line which is on the 155th meters of the 12th lap. The test was explained to the participants in details and the instructor ran for a lap to be a model. Before the test, the participants took standard 10 min warm up running and stretching activities.

The participants were free to wear any shoes they want during field test. As it might have affected the efficiency of running, the performance of the participant in a negative way if they ran in shoes they weren't used to wearing. The soccer players mostly ran in soccer cleats but some of the soccer players and NSP ran in jogging shoes. However, the participants used the same shoes in both of the sessions. The timing of the running was measured by chronometer. During soccer Specific Modified 1.5 Miles Test, more than one person at a time can be tested. Three to four participants on the starting line start to run after being issued a command at 10 seconds interval. The number of participants running can be more according to the number of the instructor. The maximum heart rate (HR_{max}) and the average heart rate (HR_{mean}) were recorded by a wearable heart rate monitor (Polar RS 800, Finland)

The collected data was analyzed on a computer by a statistical software program (SPSS 15.0, SPSS Inc. Chicago, USA). The body composition, VO_{2max} and the results of the Soccer Specific Modified 1.5 Miles Running Test were presented as average and standard deviation. The correlation between VO_{2max} and Soccer Specific Modified 1.5 Miles running Test and the correlation between the body composition and VO_{2max} was evaluated by Spearman's correlation coefficient Analysis. The group of participants who were detected to have significant correlation among each other taken to regression analysis session for VO_{2max} and soccer Specific Modified MOHM Test running period. Using the regression analysis, out of Soccer Specific MOHM Test running period, the formula to guess the VO_{2max} was achieved. The Regression Line was also acquired. In this study, the construct validity of the Soccer Specific MOHM Test was achieved by comparing the soccer players and the NSP. Among the soccer players and the NSP, the VO_{2max}, average and maximal heart rate speed were tested by Mann-Whitney U test to see if there was a difference between the first and the second field test periods. Whether there was a difference between the finishing time of the first and the second field test among the groups was tested by Wilcoxon signed rank test. Statistical significance level was stated as $p<0,05$.

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Results

The average age of the 48 male is 20.2±2.4. The average age of the soccer players is 20.7±2.5, the average age of the non-soccer players (NSP) 19.4±2.

The body composition data of the participants are demonstrated on table 1.

Table 1. Body Composition of Participants (means±SD)

	Soccer Players (n=32)	NSP (n=16)	p
Height (cm)	174.±6.3	181.3±5.8*	0.002
Body Weight (kg)	70.6±7.3	73.8±10.8	0.213
BFP (%)	14.9±3.8	14±4.6	0.305

*Significant difference between two groups (p<0.01)

The average height of the participants is 176.9±6.9. The average height of the soccer players is 174.7±6.4 and the average height of the NSP is 181.3±5.8. The height of the NSP is significantly higher than the soccer players (p<0.001).

The average weight of the participants is 71.4±8.8 kg. The weight of the soccer players is 70.6±7.3 kg, but the average weight of the NSP is 73.8±10.8 kg. There isn't any significant difference between body weights of the two groups.

The average BFP of the participants is %15±4.5, the BFP of the soccer players is %14.9±4.4, the BFP of the NSP is %14±4.6. There isn't any significant difference between the two groups.

The data of the participants VO_{2max} is demonstrated on table 2.

Table 2. VO_{2max} of the Participants (means±SD)

	Soccer Players (n=32)	NSP (n=16)
VO_{2max} (ml/kg/min)	52.2±4.6	51.2±2.6

There isn't any significant difference between the two groups according to VO_{2max} (52.2±4.6, 51.2±2.6 ml/kg/min, respectively). The VO_{2max} of the participants is 51.9 ml/kg/min. The completing time of the participants' MOHM test was measured in minutes and it was turned into seconds to analyze (Table 3).

Table 3. Compilation Time of Soccer Specific MOHM Test

	Soccer Players (n=32)	NSP (n=16)
MOHM 1 (sec)	703.6±51.2	889,4±69.2*
MOHM 2 (sec)	695.2±57.6	881,3±59.6*

* Significant difference between two groups, (p<0.001)

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The soccer players, compared to the NSP, completed the first and second MOHM test in a significantly shorter time ($p<0.001$, $p<0.001$). The completing time of the first MOHM test of the soccer players is 703.6±51.2 seconds (11 minutes, 43 seconds), the completing time of the second MOHM Test is 695.2±57.6 seconds (11 minutes, 35 seconds). There isn't any significant difference between the second MOHM test of the soccer players and the NSP. The maximal heart rate speed of the soccer players is (HR_{max}) 186.2±6.3 bpm; the HR_{max} of the NSP is 189.6±5.8 bpm. There isn't any significant difference between the maximal heart rate between two groups. The HR_{mean} of the soccer players during the test is 172.8 bpm; the HR_{mean} of the NSP is 176.4 bpm. There isn't any significant difference between the two groups according to the average heart rate. There is a negative, strong and significant correlation between the VO_{2max} level of the soccer players and the first and the second MOHM Test running periods ($r= -0.76$, $p<0.001$; $r= -0.76$; $p<0.001$, respectively), (table 4).

Table 4. Correlation coefficients between MOHM test duration and VO_{2max} levels of soccer players.

	VO_{2maks}	MOHM 1 r
MOHM 1 r	-0.89*	
MOHM 2 r	-0.76*	0.91*

* Strong and significant correlation ($p<0.001$)

There is a negative, strong and significant correlation between the first and the second Soccer Specific MOHM Test of the soccer players and the first and the second MOHM Test running periods ($r=091$, $p<0.001$).

The formula, created out of Soccer Specific MOHM running test of the soccer players, to predict the $VO_{2max,}$ achieved by the linear regression analysis is as follows:

$VO_{2max}=104.77 + [-0.075 \times \text{running time (s)}]$

The equation significantly explains the VO_{2max} ($p<0.001$). The regression model explains the % 69 of the VO_{2max} rate variations ($R^2=0.69$). There isn't any significant correlation between the VO_{2max} levels and the first and the second Soccer Specific MOHM Test running time of the NSP ($r= -0.31$, -0.28; respectively).

Discussion and Conclusion

There is a strong correlation between the Soccer Specific MOHM Test running time and the VO_{2max} evaluated in the lab. So, the Soccer Specific MOHM Test can be considered to be "criterion-related valid". The Soccer Specific MOHM Test is more convenient to evaluate the VO_{2max} levels of the NSP than evaluating the NSP. As a result, Soccer Specific

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MOHM Test is "construct valid". When repeated at a relatively short time period, there isn't any differences on Soccer Specific MOHM Test completion time so soccer Specific MOHM Test is reliable. There is a negative, significant correlation between the VO_{2max} levels of the soccer players and the completing time of the Soccer Specific MOHM Test (r=0.76). There is no such correlation among the NSP. Soccer Specific MOHM Test is reliable not only for soccer players but also NSP (r=0.91, r=0.89, respectively). The soccer players completed the Soccer Specific MOHM Test, compared to NSP, in a significantly shorter time. It is an expected result since this test which was improved for this research involves soccer specific movement patterns.

The heights of the soccer players are considerably shorter than the NSP. The tall participants of other sports such as basketball, volleyball, handball, are due to different physical demands. There is no difference between the two groups according to the weight and BFP. The soccer players are considered to have quite the same features, as in body composition, taken free from the level of the league (Silvestre et al., 2006). Not only in elite but also in amateur levels, the same results have been stated as ours in different studies about the soccer players of the same ages according to the body composition (Calbet et al., 2001; Matkovic et al., 2003; Uğraş et al., 2002). In a study Matkovic et all, (2003) made with the soccer players of Hungary top league stated the BFP as % 14.9 which was evaluated by bioelectric impedance method. Uğras et al, (2002) stated the height of the players, at the age of 18-24, as 1.76 cm, the weight as 76 kg and the BFP % 15.2. These results aren't similar to results of present study. Erkmen et al (2005), stated in a study that they considered the height as 177.1 cm, the weight as 69.7 kg and the BFP as % 12.8. The facts of this study is similar to our study facts.

There isn't any significant difference between the VO_{2max} levels of the soccer players and the NSP. Non-soccer players are basketballers, volleyball players and handball players. All these sports are the ones that need high performance explosive strength. Aerobic power is positively correlated with repeated explosive movements (Tomlin et al, 2001). As a result, VO_{2max} is considered to be an important factor for such sports. That is probably the reason of why the VO_{2max} level of NSP is not significantly different from the soccer players. Silvestre et al (2006), report that the soccer players with similar features have higher VO_{2max} levels (59.4 ml/kg/min) compared to the soccer players in this study. Possible reason of this contradiction is the discrepancy of the measurement method (Yo-Yo Intermittent Recovery Test Level 2).

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Metaxas at al, (2009), reported similar VO_{2max} levels (52.5 ml/kg/min) for the soccer players of Greece third League, by using a similar method to test the VO_{2max} level as in we used in this research. Helgerud at al (2011), presented the VO_{2max} level of the elite soccer players of the Champions League as 65.7 ml/kg/min. As VO_{2max} refers to consumption amount per kilo of the body weight, a negative correlation between the BFP and the VO_{2max} is considerable but in this study, there is no correlation between the BFP and the VO_{2max} level. There are studies which show the reverse and strong correlation between the BFP and the VO_{2max} (Amani et al., 2010; Sporis et al., 2009).

As there isn't any portable gas analyzer in the lab the research was made, the level of VO_{2max} wasn't measured during the Soccer Specific MOHM Test. The other limitation of the test was that the participants weren't elite players. Since the elite players are more experienced in performance tests and are affected less by the motivational factors, a better study can be completed with such a group of players. That the test was successful to determine the players of different leagues also wasn't evaluated. Additionally, a much better and sensitive formula can be improved to evaluate the VO_{2max} out of Soccer Specific MOHM Test, with the participation of more participants on further researches.

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