COMPARISON OF RECOVERING TIMES AND AEROBIC CAPACITY ACCORDING TO PLAYING POSITIONS OF ELITE FOOTBALL PLAYERS

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ABSTRACT

The purpose of this study was to compare aerobic capasities and recovery times according to playing positions of elite male football players. For this reason, twenty-four professional football players who played in Trabzonspor participated in voluntarily to this study. According to playing positions, players were divided to four different groups as three goalkeepers (age: $26,0 \pm 2,64$ years; height: $188,8 \pm 2,88$ cm; weight: $79,6 \pm 5,13$ kg), eight defencive players (age: $27,1 \pm 2,69$ years; height: $183,5 \pm 5,12$ cm; weight: $76,3 \pm 3,06$ kg), eight midfield players (age: $25,8 \pm 1,64$ years; height: $178,5 \pm 8,79$ cm; weight: $75 \pm 7,63$ kg) and five forward players (age: $28,0 \pm 1,87$ years; height: $181,8 \pm 4,81$ cm; weight: $73,4 \pm 3,78$ kg). The football players applied Yo-Yo Intermittent Recovery Level-1 (Yo-Yo IR1) which was a field test and recovery times, maximal oxygen consumption, maximal heart rates, and covered distances of players values were examined according to positions of players. Kruskal Wallis-H test was used to determine significant difference between groups. According to test results, there is a significant difference ($p < 0.05$) between recovery times, maximal oxygen exhaustion values, maximal heart beating numbers, and covered distances according to playing positions of male football players is statistically obtained. The differences between groups was determined with Mann Whitney-U analyze technique. According to test results, it was found that the covered distances ($1987,5 \pm 260,3$m) and maximal oxygen consumption values ($53,0 \pm 2,17$ ml/kg/dk) of midfield players was greater than players who played in other positions. The forward players had better recovery time values ($3,38 \pm 0,6$ dk) than players who played in other positions while goalkeepers had lower maximal heart rate ($179,3 \pm 8,50$ atım/dk) than players who played in other positions. As conclusion, it was statistically determined that aerobic power performance and recovery times of elite male football player was differentiated according to position of football players.
Keywords: Elite Football, Playing Position, Aerobic Power, Recovery

EL T FUTBOLCULARIN OYUN POZ SYONLARINA GÖRE AEROB K KAPAS TE VE TOPARLANMA SÜRELER N N KAR ILA TIRILMASI[3]

ÖZET

Bu çalı manın amacı, elit erkek futbolcuların oyun pozisyonlarına göre aerobik kapasite ve toparlanma sürelerinin kar ıla tırılmasıdır. Bu amaçla, Trabzonspor'da oynayan 24 profesyonel futbolcu çalı maya gönüllü olarak katılmı tır. Oyun pozisyonlarına göre oyuncular; 3 kaleci (ya : $26,0 \pm 2,64$ yıl; boy: $188,8 \pm 2,88$ cm; vücut a ırlı ı: $79,6 \pm 5,13$ kg), 8 defans oyuncusu (ya : $27,1 \pm 2,69$ yıl; boy: $183,5 \pm 5,12$ cm; vücut a ırlı ı: $76,3 \pm 3,06$ kg), 8 orta saha oyuncusu (ya : $25,8 \pm 1,64$ yıl; boy: $178,5 \pm 8,79$ cm; vücut a ırlı ı: $75 \pm 7,63$ kg) ve 5 hücum oyuncusu (ya : $28,0 \pm 1,87$ yıl; boy: $181,8 \pm 4,81$ cm; vücut a ırlı ı: $73,4 \pm 3,78$ kg) olmak üzere dört farklı gruba ayrılmı tır. Futbolculara bir saha testi olan Yo-Yo aralıklı toparlanma seviye 1 (Yo-Yo IR1) testi uygulanmı ve futbolcuların ko u mesafeleri, maksimal oksijen tüketimleri, maksimal kalp atım sayıları ve toparlanma süreleri oyun pozisyonlarına göre incelenmi tir. Gruplar arasındaki anlamlı farklılı ı belirlemek için Kruskal Wallis-H testi kullanılmı tır. Test sonuçlarına göre; erkek futbolcuların oyun pozisyonlarına göre ko u mesafeleri, maksimal oksijen tüketim de erleri, maksimal kalp atım sayıları ve toparlanma süreleri arasında anlamlı bir farklılık ($p<0,05$) oldu u istatistiksel olarak elde edilmi tir. Gruplar arasındaki farklılıklar Mann Whitney-U analiz tekni i ile belirlenmi tir. Test sonuçlarına göre; orta saha oyuncuların ko u mesafesi ($1987,5 \pm 260,3$m) ve maksimal oksijen alımı de erlerinin ($53,0 \pm 2,17$ ml/kg/dk) di er oyun pozisyonlarındaki oyunculardan daha yüksek olarak bulunmu tur. Kaleciler, di er oyun pozisyonlarında oynayan oyunculardan daha dü ük maksimal kalp atım de erlerine ($179,3 \pm 8,50$ atım/dk) sahipken, hücum oyuncuları ise di er pozisyonlarda oynayan oyunculardan daha iyi toparlanma süresi de erlerine ($3,38 \pm 0,6$ dk) sahiptir. Sonuç olarak, elit seviyedeki erkek futbolcuların aerobik güç performansları ve toparlanma sürelerinin futboldaki oyun pozisyonlarına göre farklıla tı ı istatistiksel olarak elde edilmi tir.
Anahtar Kelimeler: Elit Futbol, Oyun Pozisyonu, Aerobik Güç, Toparlanma

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Introduction

Soccer is an intermittent activity that requires high aerobic and anaerobic capacity(13). Soccer players are required to perform multi-directional sprints intercept the ball, and maintain a fairly high intensity throughout the game which can vary according to the intensity of the game. During an increase in the intensity due to aforementioned activities anaerobic metabolism becomes dominant. However, when the intensity is at submaximal levels, majority of the energy production is provided by aerobic metabolism. Due to the long duration of a soccer match (90mins) it is excepted that aerobic metabolism dominants energy production(32). Thus aerobic capacity is of great importance in the game of soccer in order to tolerate the high physiological intensity of the game (16).

In aerobic dominant sports VO_2max capacity in an important indicater that can effect performance. VO_2max is the maximum capacity of an individuals body to transport and use oxygen during incremental exercise (33), which reflects the physical fitness of an indivudual and cardiovascular capacity(9). Hence it is accepted that individuals with high VO_2max values have greater endurance capacity and cardivascular suitability(28). The literature reports that elite soccer players display VO_2max values between 55-67 ml•kg^{-1}•min^{-1} (1, 15, 16, 22, 26, 31).

An increase in aerobic capacity correlates to a greater running distances during a soccer match. A study has reported that an increase of %11 in VO_2max can result in an average increase of an additional 1800m travelled during a soccer match(14). Most of the investigations were put forward in a soccer match, running distance can vary dependent on playing positions. In addition cardiovascular intensity is around 80-90% of HR^{max} and furthermore the intensity is reported to be close to lactate threshold.

Moreover average individual speed during a soccer match is between 10-13.5km.hr. (5, 10, 20, 21, 22, 31). Researchers using artificial time motion analysis techniques, playing Champions League matches for the players suggested that a higher average distance of 13.7 m (16).

High aerobic capacity also aids in recovering quicker between performing high intensity intermittent activity(23). Due to the busy match schedules and high intesity training sessions, soccer players display psychological and physical symptoms of fatigue(19). It is of great importance the ability of soccer players to recover from intense soccer activity and return the fitness which can have great consequences on performance. The development of fatigue is believed to be caused by lactic acid accumulation which should be addressed in order to recover fully and partcipate in training sessions. Attending training sessions fully recovered from previous performances will have great benefits on performance, especialy for soccer due to busy match schedules(2).

It is also accepted that a players aerobic capacity can vary accross a soccer team. Thus, the aim of this study is to determine if any the differences of VO_2max values according to players field positions and observe recovery rates of players.

Method

24 male professional soccer players who actively participate for Trabzonspor which competes in Spor Toto Turkish Premier League were chosen in this study voluntarily. According to player positions participation characteristics were; 3 goalkeepers (Age: 26,0 ± 2,64 years; Height: 188,8 ± 2,88 cm; weight: 79,6 ± 5,13 kg), 8 defensive players (age: 27,1 ± 2,69 years; height: 183,5 ± 5,12 cm; weight: 76,3 ± 3,06 kg), 8 midfield players (age: 25,8 ± 1,64 years; height: 178,5 ± 8,79 cm;

Weight: 75 ± 7,63 kg) and 5 forward players (age: 28,0 ± 1,87 years; height: 181,8 ± 4,81 cm; weight: 73,4 ± 3,78 kg) and 4 groups were created according to their player positions (GK, DF, MF,ST). Prior to testing, participants were fully informed of the experimental conditions. All participants underwent a warm up protocol prior to data collection. Data was collected on the first training sesssion of the week.

Measurement of running distance

Bangsbo's (3) Yo-Yo intermittent recovery test (Yo-Yo IR1) was used to calculate aerobic capacity of the participants. Participants are directed with an automated audio track. Participants with each bleep perform 2x20m intermittent running which the speed incrementally increases. 2X20m running area was clearly marked by cones which also included a 5m recovery area adjacent to the 2x20m area. On completion of the 40m run, participants walk or jog slowly in the 5m active recovery area. Participants then remain in this area just beside the start line and wait for the signal to complete another 40m run. These signals are given with the use of a audio track. If the participants fail to complete a 40m run before the next signal the test is terminated and their level would be recorded. This test can last between 2-15 minutes dependent on the aerobic capacity of the participants.

Measurement of Maximal Heart Rate

Participants heart rate (HR) values were determined by using a Global Positioning System (GPS). These systems determine the positioning of the participants with the help of satalites and which can also observe HR. These systems determine and observe running distances of the players during a soccer match(8). The participants wore a vest which is used to safely secure a GPS tracking device and wore a heart rate transmitter. All tracking devices are number coded and participants tracking device number was recorded on a sheet. Electrode

areas of the transmitters were moistened, electric strap tightened and was straped just beneath the sternum. Subsequently, GPS vest were worn and the tracking device was implanted in a pocket on the 2nd thoracic vertabrae. Immediately after completing all experimental condition the data from the tracking devices were uploaded on to computer for further analysis.

Measuring Oxygen Consumption

The standart procedure for measuring oxygen consumption is conducted on labaratory settings using very expensive equipment. Futhermore these test require well trained personnel and for a long time. There are alternative some field test that are developed which can test multiple athletes at once, easy to implement and cheaper cost. In this study VO_2max values of the participants were calculated by using the Yo-Yo IR1 field test developed by Bangsbo (3). The below formula is used to calculate the estimated VO_2max values.

$$VO_2max \ ml\bullet kg^{-1}\bullet min^{-1} = IR1 \ running \ distance \ (meters) \ X \ 0.0084 + 36.4 \ (6).$$

Recovery Times

Recovery times were determined using GPS technology after completion of the Yo-Yo- IR1 (level 1) test.

Statistical Analysis

On completion of the testing conditions participants performance time on the Yo-Yo IR1, maximal heart rate values, VO_2max values and recovery rates were obtained. These variables were further analysed using Statistical Package For Social Sciences (SPSS, 16.0) and test for significance. In order to compare individual differences according to field positions, maximal heart rate, VO_2max values and IR1 field test scores of the participants were analysed using a Kruskal Wallis-H test. Futhermore to test differences according playing field positions a Mann Whitney U test was used.

Results

Table I below displays the physical characteristics of the participants divided into playing field position groupings.

	GK (n = 3)	DF (n = 8)	MF (n = 8)	ST (n = 5)
Age (years)	26,0 ± 2,64	27,1 ± 2,69	25,8 ± 1,64	28,0 ± 1,87
Height(cm)	188,8 ± 2,88	183,5 ± 5,12	178,5 ± 8,79	181,8 ± 4,81
Weight(kg)	79,6 ± 5,13	79,6 ± 5,13	75 ± 7,63	73,4 ± 3,78

Table I: Physical characteristics of the participants (Average and standard deviations)

Table II below displays average values of distance travelled during the Yo-Yo IR1 field test, VO_2max values, HR^{max} and recovery rates of the paticipants.

	GK (n = 3)	DF (n = 8)	MF (n = 8)	ST (n = 5)
Distance travelled (m)	1266 ± 83,2	1925 ±168,9	1987 ± 260,3	1744 ± 360,6
VO_2max ml•kg^{-1}•min^{-1}	47,0 ± 0,72	52,5 ± 1,42	53,0 ± 2,17	50,9 ± 2,93
HR^{max} (b.min)	179,3 ± 8.5	186,0 ± 6,5	185,0 ± 11,0	188,4 ± 7,53
Recovery time (sec)	3,89 ± 0,5	3,49 ± 0,5	3,44 ± 0,6	3,38 ± 0,6

Tablo II: Distance travelled during the Yo-Yo IR1 field test, VO_2max values , HR^{max} and Recovery rates (Average and Standard deviations)

Table III below displays Kruskal Wallis-H comparison results for running distance during the Yo-Yo IR1 filed test according to field positions.

	n	Mean rank	X^2	P	Meaningful diff.
GK	3	2,33	8,914	0,030	MF>DF
DF	8	14,00			MF>FW
MF	8	16,00			MF>GK
FW	5	10,60			

(p<0.05)

Tablo II: Kruskal Wallis-H results for running distance according to playing position.

Total running distance of elite soccer players according to field position display a meaningful difference (X^2 = 8,914 p<0.05). When a Mann Whitney U test was conducted to observe where this difference is, it was evident that MF players travelled a greater distance compared to DF and FW.

Table IV below displays Kruskal Wallis-H comparison results for HR^{max} values of participants according to their playing positions.

	n	Mean rank	X^2	p	Meaningful dif.
GK	3	7,83	1,701	0,637	FW>MF
DF	8	12,50			FW>DF
MF	8	13,12			FW>GK
FW	5	14,30			

(p<0.05)

TableIV:Kruskal Wallis-H results for HR^{max} values of the participants according to playing positions.

Hr^{max} values of elite soccer players according to field positions display a meaningful difference (X^2 = 1.701 p<0.05). When a Mann Whitney U test was conducted

to observe where the difference lies, it was evident that FW players HR^{max} was higher compared to MF and DF.

Table IV below displays Kruskal Wallis-H comparison results for VO_2max values of participants according to their playing positions.

	n	Mean Rank	X^2	p	Meaningful dif.
GK	3	2,33	8,914	0,030	MF>DF
DF	8	14,00			MF>ST
MF	8	16.00			MF>GK
FW	5	10.60			

(p<0.05)

Table V: Kruskal Wallis-H results for VO_2max values of the participants according to playing positions.

VO_2max values of elite soccer players according to field positions display a meaningful difference (X^2 = 8,914 p<0.05). When a Mann Whitney U test was conducted to observe where this difference in VO_2max lies, it was evident that MF players compared to FW and DF displayed a greater VO_2max values.

Table VI below displays Kruskal Wallis-H comparison results for recovery times of participants according to their playing positions.

	N	Mean rank	X^2	p	Meaningful dif.
GK	3	17,67	2,057	0,561	GK>MF
DF	8	11,94			GK>DF
MF	8	12,38			GK>H
FW	5	10,50			

(p<0.05)

Table VI: Kruskal Wallis-H results for recovery times of participants according to playing positions.

Recovery times of elite soccer players according to field positions display a meaningful difference (X^2 = 2,057 p<0.05). When a Mann Whitney U test was conducted to observe where this difference in recovery times is, it was evident that GK had greater recovery times compared to FW, DF and MF players.

Discussion and Conclusion

Soccer is a complex game which during the 90 mins forces players to conduct multi-directional movements, jumping, tackling and high velocity running frequently. Soccer which stimulates aerobic and anaerobic energy sytems is a high-intensity physical activity (25). Blood, muscle and HR variables collected during soccer matches have indicated that aerobic load during soccer activity is intensive. Hence, a soccer player in order to house the requirements of soccer and display positive performance during the 90-mins soccer match will need to improve their aerobic capacity.

An increase in aerobic capacity positively increases distance travelled, work intensity, frequency of sprints and contact times with the ball (16, 20, 22, 26). Improvements in aerobic capacity also effects recovery times during intermittent high-intensity activities performed during training and matches (23). Coaches in order to measure and assess players physical performance, plan short and long-term training programs and monitor the efficacy of these session will need measure

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and collect data which via the use of physiological tests.

There are various different measurement techniques that observe the physical properties of training sessions and matches in combination with physiological properties. In order to determine and measure these properties according to age and playing positions of elite soccer players, field tests such as the bleep test that measure aerobic capacity of players and laboratory test that measure VO$_2$max are frequently used (24). Recently Bangsbo (3), in order to measure performances in team sports have developed the Yo-Yo intermittent recovery test.

The findings of this study are in line with the findings of other studies which also observed the running distances of soccer players during the Yo-Yo intermittent recovery test level 1. Mohr & Ark, (27) have reported that midfield players, wing backs and forward players running 2230m, 2210m and 1990m respectively, during the Yo-Yo intermittent recovery test level 1. Moreover, Reilly & Ark, (31) have reported on Danish soccer players that, goalkeepers, defencive players, wing backs, midfield players and forward players running distance of 1790m, 1990m, 1950m, 1950m and 1820m respectively, during the Yo-Yo intermittent recovery test level 1.

In contract to the findings of this study, Krustrup & Ark (24) have reported on elite soccer players that wing backs travel the greatest distance (2241) while defencive players running the least distance (1919m) during the Yo-Yo intermittent recovery test level 1. Also in the same study it has been reported that midfield players running 2173m, while forward players running a distance of 1966m.

Similar findings has been reported by using different experimental methods. Bradley & Ark (11) reported that during a 90-min soccer match in the Premier League midfielder players running the most with an average of 11450m, while defencive players running the least with an average of 9885m. Videographic analysis techniques were used in this study. In a similar study Di Salvo & Ark (17) also used the videographic method in elite soccer players and reported that midfield players travel the greatest distances (12,027m) while defencive players the lowest distance (10,627m).

Barros & Ark (7) by using the videographic method on elite soccer players playing for Sao Paulo FC, a respected professional club competing at the highest level in Brazil, reported according to playing positions that midfield players, defencive players, wing backs and forward players running a distance of 8514m, 7170m, 7018m and 6620m, respectively. Burgessa & Ark (12) also conducted a similar study on Australian elite soccer players and reported that midfield players running the greatest distance (10100m) during the course of a 90-min soccer match while defencive players running a total of 8800m.

It is evident from these findings that midfield players whose role is to move between the forward players and the defencive players running the greatest distances during the course of a 90-min soccer match. The Yo-Yo IR1 results are in line with these findings and this difference could be the result of physical capacity of the defencive players or could be down to the tactical roles the defencive players adopt due to their playing positions. It also evident the performance of forward players are also lower than midfield players.

In endurance based sport activities aerobic capacity (VO$_2$max) is a factor that contribute greatly to performance. VO$_2$max is the maximum capacity of an individuals body to transport and use oxygen during incremental exercise (33), which reflects the physical fitness of an indivudual and reflect cardiovascular capacity (9). It is accepted that VO$_2$max values of players can vary according to playing positions. Previous studies has shown that distance running during the course of a 90-min

soccer match is positively correlated to aerobic capacity. Furthermore, the ability of midfield players to running the greatest distance during a 90-min soccer match is also an indication that these players have the highest VO_2max values compared to their team mates.

Bangsbo & Michalsik (4) has shown that midfield player display the greatest VO_2max values and defencive players display the lowest VO_2max values. Furthermore Al'Hazzaa ve Ark (1) has reported an average VO_2max values for midfield players of 59.9ml•kg^{-1}•min^{-1}(±0.93, 59.9 ml•kg^{-1}•min^{-1}), for wing backs 57.7 ml•kg^{-1}•min^{-1} (±5.1 ml•kg^{-1}•min^{-1}), for forward players 56.9 ml•kg^{-1}•min^{-1} (±2.5 ml•kg^{-1}•min^{-1}) and defencive players 52.3 ml•kg^{-1}•min^{-1} (±7.3 ml•kg^{-1}•min^{-1}) who actively compete for Saudi National soccer team. Moreover, Bangsbo (3) conducted a VO_2max study on Danish elite soccer players and reported that midfield players display average VO_2max values of 62.6 ml•kg^{-1}•min^{-1}(±4.0 ml•kg^{-1}•min^{-1}) wing backs display 61.5 ml•kg^{-1}•min^{-1}(±10 ml•kg^{-1}•min^{-1}), forward players display 60.0 ml•kg^{-1}•min^{-1}(±3.7 ml•kg^{-1}•min^{-1}) and defencive players display 56.0 ml•kg^{-1}•min^{-1} (±3.5 ml•kg^{-1}•min^{-1}).

In contrast to the findings of this study, Reevess & Ark (30), reported that defencive players display average VO_2max values of 54.4 ml•kg^{-1}•min^{-1}(±5.2 ml•kg^{-1}•min^{-1}), forward players display 50.7 ml•kg^{-1}•min^{-1}(±6.4 ml•kg^{-1}•min^{-1}) and midfield players display values of 42.8 ml•kg^{-1}•min^{-1}(±14.2 ml•kg^{-1}•min^{-1}). Furthermore the findings of Raven & Gettman (29) which was also in contrast with the findings of this study reported that the lowest VO_2max values were detected for midfield players (56.1±1.4 ml•kg^{-1}•min^{-1}) while forward players(59.6±1.2 ml•kg^{-1}•min^{-1}) and defencive

players (59.3±1.3 ml•kg^{-1}•min^{-1}) displayed the higher values.

In relation to HR^{max}, Al'Hazzaa and Ark conducted a study which observed f Saudi Arabian National soccer players and reported for defencive players an average HR^{max} of 185 beats/min (±5 b/min), for midfield players 195 b/min (±9 b/min) and for forward players 189 b/min (±6 b/min).

Recovery after intense exercise and busy match sechedule is of paramount importance in the game of soccer which can negatively effect performance. The built up of lactic acid which accumulates after and during exercise is a factor which causes fatigue and its removal would be of great bnefit to soccer players (2).

It is evident that aerobic capacity and recovery times of elite soccer player can vary according to playing positions. Furthermore the results of this study show that midfield players who operate between defencive players and forward players greater distances during the course of a soccer match compared to defencive players and forward players.. The discrepensies in running distance could be the result of physical fitness levels of the defencive players or could be directly related to the playing positions. It is evident from previous findings that there is a positive correlation between aerobic capacity and running distance during a soccer match. Midfiel players who running the greatest distances during a soccer match display the greatest VO_2max values. Moreover recovery is dependent on the physical conditions of the soccer players. Players who are well conditioned have faster recovery times compared to players who less conditioned. An increase in the physical conditions of the players are observed due to systematic training and frequent schedule of matches which positively effects recovery times of the players.

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