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SÜPER LİG VE BÖLGESEL AMATÖR LİG FUTBOLCULARININ KALP ATIM HIZLARINI YÜZDESEL OLARAK KULLANMA DÜZEYLERİNİN KARŞILAŞTIRILMASI

A COMPARISON OF THE PERCENTAGE UTILIZATION LEVELS OF HEART RATE IN SUPER LEAGUE AND REGIONAL AMATEUR LEAGUE FOOTBALL PLAYERS

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Süper Lig ve Bölgesel Amatör Lig Futbolcularının Kalp Atım Hızlarını Yüzdesel Olarak Kullanma Düzeylerinin Karşılaştırılması

ÖZ

Bu çalışmanın amacı, Bölgesel Amatör Lig ve Türkiye Süper Lig'indeki futbolcular arasında kalp atış hızı kullanım yüzdelerini karşılaştırmaktır. Araştırmaya toplam 49 futbolcu katılmıştır. Futbolcuların 29'u Türkiye Süper Liginde, 20'si ise Bölgesel Amatör Liginde oynamaktadır. Gerçek zamanlı kalp atış hızı izleme için Polar Team2 giyilebilir sporcu takip sistemi kullanıldı. Araştırma grubuna kalp atış hızı seviyelerini ve kullanım yüzdelerini belirlemek için Yo-Yo IR1 aralıklı iyileşme testi uygulandı. Gruplar arasında ortalamaları karşılaştırmak için bağımsız örneklem T-Testi kullanıldı. Tüm analizler SPSS 26.0 paket programı kullanılarak gerçekleştirildi. Çalışmanın etki büyüklüğü 0.80, araştırma gücü 0.80 ve hata payı 0.05 olarak belirlendi. Maksimum kalp atış hızları ve harcanan kaloriler, aynı zamanda 2. bölge kalp atış hızları ve 4. bölge kalp atış hızları, Bölgesel Amatör Lig ve Süper Lig'deki oyuncular arasında benzerlik gösterdi ($p>0.05$). Ancak en düşük kalp atış hızı, ortalama kalp atış hızı, maksimum kalp atış hızı, 1. bölge kalp atış hızı, 3. bölge kalp atış hızı ve 5. bölge kalp atış hızı değerleri arasında oyuncular arasında farklılıklar gözlendi ($p<0.05$). Sonuç olarak, kalp atış hızı kullanımı ve ortalamaları açısından, yüksek seviyeli oyuncular daha dengeli bir kalp atış hızı kullanımı sergiler. Yoğunluk arttıkça, düşük seviyeli oyuncuların maç sırasında maksimum kalp atış hızı kullanım seviyelerine ulaşması ve dolayısıyla enerjilerini daha hızlı tüketmeleri beklenmektedir.

Anahtar Kelimeler: Futbol, kalp atım hızı, yo-yo IR1.

A Comparison of the Percentage Utilization Levels of Heart Rate in Super League and Regional Amateur League Football Players

ABSTRACT

The aim of this study was to compare the percentage levels of heart rate utilization between players in the Regional Amateur League and the Turkish Super League. A total of 49 players participated in the research, including 29 from the Turkish Super League and 20 from the Regional Amateur League. The Polar Team2 wearable athlete tracking system was used for real-time heart rate monitoring. The Yo-Yo IR1 intermittent recovery test was applied to the research group to determine heart rate levels and utilization percentages. T-Test for independent samples was used to compare means between groups. All analyses were performed using the SPSS 26.0 package program. The effect size of the study was determined as 0.80, research power as 0.80, and margin of error as 0.05. While the maximum heart rates and calories expended, as well as the 2nd zone heart rates and 4th zone heart rates, showed similarity between players in the Regional Amateur League and the Super League ($p>0.05$), there were differences observed in the lowest heart rate, average heart rate, maximum heart rate, 1st zone heart rate, 3rd zone heart rate, and 5th zone heart rate values between players in the Regional Amateur League and the Super League ($p<0.05$). In conclusion, in terms of heart rate utilization and averages, high-level players exhibit a more balanced use of heart rate. As the intensity increases, lower-level players are predicted to reach maximum levels of heart rate utilization and consequently deplete their energy faster during matches.

Keywords: Football, hearth rate, yo-yo IR1.

INTRODUCTION

Football is one of the most played sports in the world.[1,2] Being a complex sport by nature, players need a high level of aerobic and anaerobic fitness to play football competitively.[3] Owing to the duration of the game, football is primarily dependent on aerobic metabolism[4] and aerobic fitness level (i.e. maximum oxygen uptake– $\dot{V}O_2max$) is associated with the distance covered during a match at high intensity.[5] Previous studies have reported that even though most of the movement is at low or submaximal intensity, the total distance covered at 75% of $\dot{V}O_2max$ is about 10-12 km[2,4,6-9] and close to the anaerobic threshold.[2,8] On the other hand, although aerobic metabolism predominates in energy distribution during a football match, the most decisive actions are met through anaerobic metabolism. The release of anaerobic energy is the decisive factor in actions such as short sprints, rapid acceleration or deceleration, turns, jumps and steals[5,10] and is often crucial to the outcome of the match.[4]

Many laboratory tests (e.g. treadmill tests) and field tests (e.g. shuttle running) have been developed to evaluate the physical performance of team sport athletes and to measure their maximum oxygen uptake capacity.[11] Even though laboratory tests give accurate information about maximal oxygen consumption, running economy, respiration, and lactic acid threshold, they are not preferred by trainers as they are not specific to the training of athletes, require knowledgeable and experienced staff and the use of expensive materials, are not portable, and take up a long time.[12] In addition, most standard laboratory tests involve continuous runs. However, in many sports branches such as ball games, runs are intermittent, and the determinant of performance is related to the repetitive intense running skills of the athletes. For instance, previous studies have shown that football quality is related to the amount of high-intensity running performed throughout the game.[8,9,13] Hence, it seems reasonable to evaluate in this type of sport the ability of athletes to repeatedly perform intense exercise and their potential to recover from intensive exercise.[14]
Based on this logic, the Yo-Yo Intermittent Recovery Test Level 1 (Yo-Yo IR1) was designed to evaluate intermittent endurance performance in football players.[15] During Yo-Yo IR1, participants perform repeated runs (2×20 m) at gradually increasing speeds, with 10-second periods of active recovery (2×5 m). Yo-Yo IR1 has become very popular in recent years because it is less costly, less time-consuming, easier to access, more practical and fit for purpose compared to laboratory tests[15] Previous studies have reported that Yo-Yo IR1 is a reliable and valid field test to evaluate match-related fitness in football players.[14,16] Furthermore, several studies have shown that Yo-Yo IR1 can precisely distinguish between performance differences that players achieve at various levels, in different playing positions, and after various training approaches.[15,17,18]

It has been reported in previous studies that the performance and condition levels of the players during a football match are affected by the league level they play in and that elite players run at a higher intensity during the match than sub-elite players.[8,19,20] While there are many studies that focus on measuring the physiological characteristics of players at different levels, no study has been found that examines the use of heart rates by percentage in football players according to league levels. In light of this, the objective of the present study was to compare the use of heart rates by percentage in football players playing in two different leagues (Super League-Regional League).

MATERIAL AND METHODS

Participants

The study group consisted of a total of 49 athletes, namely 20 professional footballers of a team competing in the Turkish Super League (TSL) and 29 footballers of a team competing in the Turkish Regional Amateur League (RAL). GPower[21] was used to calculate the necessary sample size. Participants did not report any chronic illness or recent injury that could compromise testing. All participants were informed about the testing procedures and signed a written informed consent form before starting the study. The study was approved by the Non-Interventional Clinical Research Ethics Board (Protocol No: 2023/7) and was conducted in line with the guidelines of the Declaration of Helsinki. The demographic characteristics of the participants are given in Table 1.

Table 1. Demographic Characteristics of RAL and TSL Players

League	N	Variable	Xmean	SD
RAL	20	Age (years)	25,45	4,27
		Body height (cm)	180,15	5,63
		Body weight (kg)	75,65	6,49
		Body fat percentage	8,64	2,02
TSL	29	Age (years)	20,31	1,79
		Body height (cm)	181,96	5,74
		Body weight (kg)	75,24	7,19
		Body fat percentage	7,93	2,69

Cm: Centimeters **Kg:** Kilograms **SD**: Standard Deviation; **RAL**: Regional Amateur League; **TSL**: Turkish Super League

Research Design

All participants were instructed to avoid moderate to vigorous activity and alcohol consumption for 24h before the tests. Although nutrition and hydration data were not measured directly, participants were asked to prepare as if they were preparing for a football match. The test environment conditions and the players' heart rates (HR) were monitored. Testing was done at the end of a training camp that both teams did in the same city. The fact that both teams did their training camp under identical ambient conditions such as temperature and moisture prevented differences in camp data related to parameters depending on external factors.

Data Collection

Body Height, Body Weight & Body Composition Measurements

The participants body height was measured in the anatomical standing position with 0.5 cm accuracy using a Tanita Leicester Portable Height Measure (*Tanita, Tokyo, Japan*). Body weight and body composition were measured using a Tanita MC780MA multi-frequency bioelectrical impedance segmental body composition analyser (*Tanita Tokyo, Japan*). The participants wore light clothing (shorts and t-shirts) during measurement and all measurements were made barefoot without shoes.

Yo-Yo IR1

Yo-Yo IR1 is an endurance test consisting of repetitive runs between the start, turn, and finish lines in a 2 x 20 m area, where the participants start with a running speed of 10 km/h and gradually increase their running speed according to audible signals emitted from a signal device (Figure 1). The test is conducted on turf, and cones are used to mark 2 x 20 m running lanes. After every 40 m sprint, there is a 10-second

active recovery area consisting of 2 x 5m. The test consists of 1 lap at 10 km/h, 1 lap at 11 km/h, 1 lap at 12-13 km/h, 3 laps at 13.5 km/h, 4 laps at 14 km/h, 8 laps at 14.5 km/h and 8 laps with 0.5 km/h increments up to 19.5 km/h. The test is terminated if a participant misses three signals in a row or reaches the point of exhaustion [22]. Prior to the test, all footballers did a warm-up that consisted of the first four phases of the test. All footballers did a trial run at least once before they started the test. The footballers were tested in groups of 10-12 according to the protocol described above.

Heart Rate Values

Polar Team2 (*Polar, Kempele, Finland*) wearable athlete tracking system was used for real-time heart rate (HR) tracking. Designed to be mounted on straps worn at heart level, the Polar Team2 GPS-based field tracking device is provided with computer-supported online software in the form of a mobile application that transmits physiological and mechanical data at 10 Hz in real time.[23] During the Yo-Yo1 IR test, Polar Team2 devices were attached to all athletes with chest straps, and instantaneous HR measurements were taken in an online computer environment. Post-test data were used to calculate minimum HR, mean HR, and maximum HR values as well as test load, caloric expenditure, use of HR by percentage, use of HR zones by percentage, and above-threshold HR use by percentage.

Data Analysis

The data collected in this research was recorded in an electronic environment. Homogenous distribution of the collected data was measured by skewness and kurtosis and the Kolmogorov-Smirnov values were analysed. T-Test for independent samples was used to compare means between groups. All analyses were performed using the SPSS 26.0[24] package program. The effect size of the study was determined as 0.80, research power as 0.80 and margin of error as 0.05.

RESULT

Table 2. T-Test Analysis of the Difference in Mean Heart Rate Values and Some Variables in RAL and TSL Players

Variable	League	N	Xmean	SD	t	p
HR_{min}	RAL	20	100,30	19,37	3,93	,000*
	TSL	29	77,24	20,65		
HR_{mean}	RAL	20	167,75	10,51	3,83	,000*
	TSL	29	153,13	14,59		
HR_{max}	RAL	20	192,40	10,56	1,07	,288
	TSL	29	188,75	12,32		
Test Load	RAL	20	75,20	16,65	2,37	,021*
	TSL	29	60,65	23,54		
Caloric Expenditure	RAL	20	342,95	63,88	1,50	,139
	TSL	29	307,41	91,24		
Above-Threshold %	RAL	20	59,97	14,41	5,01	,000*
	TSL	29	32,10	21,76		

*p<0.05, **HR:** Heart Rate; **RAL**: Regional Amateur League; **TSL**: Turkish Super League

When Table 2 is examined, it is seen that there is no statistically significant difference between RAL and TSL players' HR_{max} and caloric expenditure values (p>0.05). When we look at the other parameters, it is seen that HR_{min}, HR_{mean}, test load and above-

threshold (%) values differ significantly between RAL and TSL players (p<0.05). In other words, it can be said that TSL players have better values than RAL players.

Table 3. T-Test Analysis Of The Difference Between Mean Use Of Heart Rates By Percentage And Use Of Heart Rate Zones By Percentage In RAL And TSL Players

Variable	League	N	Xmean	SD	t	p
HR_{min} %	RAL	29	51,40	10,23	4,41	,000*
	TSL	20	38,17	10,34		
HR_{mean} %	RAL	29	86,15	5,90	5,17	,000*
	TSL	20	76,10	7,14		
HR_{max} %	RAL	29	98,90	5,73	2,95	,005*
	TSL	20	93,96	5,74		
HR Zone 1 - 50-59%	RAL	29	6,37	8,62	-4,08	,000*
	TSL	20	20,85	14,09		
HR Zone 2 - 60-69%	RAL	29	9,61	5,23	-1,06	,291
	TSL	20	11,28	5,50		
HR Zone 3 - 70-79%	RAL	29	8,96	2,54	-2,30	,025*
	TSL	20	14,04	9,59		
HR Zone 4 - 80-89%	RAL	29	20,23	9,55	-1,82	,074
	TSL	20	26,23	12,34		
HR Zone 5 - 90-100%	RAL	29	54,81	16,63	4,93	,000*
	TSL	20	27,57	20,45		

*p<0.05, **HR :** Hearth Rate; **RAL**: Regional Amateur League; **TSL**: Turkish Super League

According to the values given in Table 3, there is no statistically significant difference in HR Zone 2 % and HR Zone 4 % values of RAL and TSL players (p>0.05). In other words, RAL and TSL players' HR Zone 2 % and HR Zone 4 % values did not differ statistically significantly. When the values in Table 3 are examined, it is seen that HR_{min} %, HR_{mean} %, HR_{max} %, HR Zone 1 %, HR Zone 3 %, and HR Zone 5 % differ significantly between RAL and TSL players (p<0.05). In other words, it can be said that TSL players have statistically significantly better values than RAL players.

DISCUSSION

In this section, the findings of this study are interpreted together with a comparison of similar studies and data in the literature. In our study, no statistically significant difference was found between RAL and TSL players' HR_{max} and caloric expenditure values (p>0.05). In other words, RAL and TSL players' HR_{max} and caloric expenditure values were found to not differ statistically significantly. When the data in Table 2 are examined, it is seen that HR_{min}, HR_{mean}, test load and above-threshold (%) values differ significantly between RAL and TSL players (p<0.05). These values suggest that TSL players have statistically significantly better values than RAL league players. HR Zone 2 % and HR Zone % of RAL and TSL players does not differ statistically significantly (p>0.05). In other words, no statistically significant difference was found between RAL and TSL players' HR Zone 2 % and HR Zone 4 % results. When the values in Table 3 are examined, it is seen that HR_{min} %, HR_{mean} %, HR_{max} %, HR Zone 1 %, HR % Zone 3 and HR Zone 5 % values differ between RAL and TSL players (p<0.05), which suggests that TSL players have statistically better values than RAL league players. A review of similar studies in the literature showed similar results.

In a study conducted to examine the effect of 4*4 small-sided games like controlled pass games and free play on heart rate and number of contacts with the ball in young football players, Yo-Yo 1 Intermittent Recovery Test was applied to measure the players HR_{maks} values and it was found that the players had a mean HR_{max} value of 198.5±4.58 bpm[25]. In a study, it was found that the mean for 70% of HR_{max} was (142.3±6.0 bpm), (161.0±5.4 bpm) for 80%, (177.0 ± 6.6 bpm) for 90% and (189.4±7.9 bpm) for HR_{max}[26]. In another study, when the heart rate of elite players throughout a match was examined, it was observed that their heart rate went down to 150 bpm in short sections of the game, while maximum heart rate ranged between 150-190 bpm[27]. HR_{max} at the highest level of the Yo-Yo test in English elite football players was found as 191±3 beats per minute (bpm)[28]. In the present study, RAL players were found to have a mean HR_{max} value of (192,4±10.5), whereas TSL players were found to have a mean HR_{max} value of (188.7±12.3). Based on these results, it is seen that the HR_{max} value of the players in our study delivered better results than those in the study of Diker et al. (2011)[25] but delivered similar results to those of Verges et al. (2006)[26], Bangsbo (2014)[27] and Bradley et al. (2011)[28].

In a study titled “Analysis of maximum heart rate values with different test protocols in elite soccer players,” the players’ mean heart rate in the Yo-Yo 1 test was found as 196.7±8.5 bpm.[29] After a test applied to elite players, the mean heart rate after anaerobic endurance was determined as 183.75±5.89 bpm.[30] The players’ mean HR was found to be 162 bpm.[31] When we look at the data obtained in our study, mean HR in RAL players was (167.7±10.5 bpm), whereas mean HR in TSL players was (153.1±14.5 bpm). Based on these data, it is seen that the players who participated in our study had better mean HR values than those reported in the literature.

In a study, mean HR taken during the match was determined as 168±12 bpm. This mean value was found to correspond to 85% of HR_{max}, which was 198±9 bpm. It was found that players’ use of HR_{max} in the zone 80%-90% throughout a match was 40%, 23% for HR in the zone 90%-95%, and 10% for HR in the zone <95%.[32] In a study analysing the percentage of players using heart rate zones, it was found that the use of zone 1 (<114 bpm) corresponded to 0,9% in premier league players and 1,1% in the third league players. The percentage for zone 2 (115-134 bpm) was 5,6% in premier league players and 5,5% in the third league players. The percentage for zone 3 (135-154 bpm) was 20,1% in premier league players and 17,3% in the third league players. The percentage for zone 4 (155-178 bpm) was 68,7% in premier league players and 55,6% in third league players. Lastly, the percentage for zone 5 (>178 bpm) was 4,7% in first-league players and 20,4% in third-league players[31]. According to the data obtained in our study, RAL players’ and TSL players’ HR_{mean} was found as (167,7±10.5 bpm) and (153.1± 14.5 bpm), respectively, while the use of heart rate zones by percentage was found as RAL 6,3% and TSL 20.8% for zone 1, RAL 9.6% and TSL 11.2% for zone 2, RAL 8.9% and TSL 14.0% for zone 3, RAL 20.2% and TSL 26.2% for zone 4, and lastly, RAL 54.8% and TSL 27.5% for zone 5. In this sense, the data of our study differ to some extent from those of previous studies in the literature. More specifically, our study showed that elite players had better usage percentages for zones 1, 2, and 3, whereas according to the literature, their use of zones 4 and 5 was found to be more dominant.

HR_{max} and caloric expenditure values of RAL and TSL players were found to be similar ($p>0.05$). In other words, it can be said that no significant difference is seen between

RAL and TSL players in terms of HR_{max} and caloric expenditure. When Table 2 is examined, it is seen that HR_{min}, HR_{mean}, test load and above-threshold (%) values differ significantly between RAL and TSL players ($p<0.05$). In other words, it can be said that TSL players have better values than RAL players ($p<0.05$). There was no difference between RAL and TSL players in terms of HR Zone 2 % and HR Zone 4 % ($p>0.05$). Accordingly, RAL and TSL players' HR Zone 2 % and HR Zone 4 % values did not differ statistically significantly. When the values in Table 3 are examined, it is seen that HR_{min} %, HR_{mean} %, HR_{max} %, HR Zone 1 %, HR Zone 3 %, and HR Zone 5 % differ significantly between RAL and TSL players ($p<0.05$). Hence, it can be said that TSL players have better values than RAL players.

In a study, Yo-Yo IR1 – Submax HR, 2 min (bpm) was found as 143.8±25.4 in elite players and 165.2±8.8 in sub-elite players; Yo-Yo IR1 – Submax HR, 4 min (bpm) was found as 153.1±20.1 in elite players and 177.1±8.4 in sub-elite players; and Yo-Yo IR1–Peak HR (bpm) was found as 183.7±5.8 in elite players and 192.5±8.1 in sub-elite players[33]. Another study reported the following heart rate values in a field study: 158.40±11.91 bpm for 10 km/h mean running speed, 167.28±9.61 bpm for 11 km/h mean running speed, 174.52±8.72 bpm for 12 km/h mean running speed, 179.97±8.27 bpm for 13 km/h mean running speed, 184.84±7.64 bpm for 14 km/h mean running speed, 190.08±8.05 bpm for 15 km/h mean running speed, 192.17 ± 6.39 bpm for 16 km/h mean running speed, and 193.01±3.56 bpm for 17 km/h mean running speed.[34]

Bağış and Kumartaşlı, (2017)[35] measured the heart rates during playing time. HR of Ankara club players by minute 10 of the match was 133,2±23,3 bpm, 138,9±23,6 bpm by minute 20, 144,7±21,5 bpm by minute 30, and 137,7±16,9 bpm by minute 40, whereas HR of Isparta club players by minute 10 of the match was 120,2±15,2 bpm, 117,7±45,9 bpm by minute 20, 135,5±31,3 bpm by minute 30, and 145,2±27,6 bpm by minute 40. There was no statistically significant difference in the between-group comparison of the heart rate of the football players playing in Ankara and Isparta U13 category ($p>0,05$). Alemdaroğlu et al. (2010)[36] made a comparison between super league (3.98±0.24 m/sec), 2nd league (3.96±0.25 m/sec), 3rd league (3.85±0.15 m/sec), and amateur league footballers (3.74±0.25 m/sec) in terms of their anaerobic thresholds and concluded that there was a statistically significant difference between amateur footballers and 2nd league footballers ($p< 0.05$).

Prior to the study, elite players were anticipated to have better values. However, the data obtained in the study revealed that there was no difference between Regional Amateur League and Super League players in terms of some parameters, while those that differed were found to be in favour of Super League players. Regarding the parameters that did not differ, it was seen that despite a difference between the players' HR Zone 2 and Zone 4 usage percentages, there was no difference in the players' HR use, and both their mean HR_{max} and caloric expenditure values were at the same level. In terms of the players' heart rate use and mean values analysed by level, it was seen that elite-level players used their heart rates in a more balanced way, which suggests that the higher the difficulty level, the more the heart rate use in sub-elite players will be at maximum level, and thus, the faster they will reach exhaustion during the match. In conclusion, given that elite-level players' use of heart rate zones by percentage is predominantly in the lower zones, they will achieve better results in terms of aerobic capacity use both during training and playing time. Furthermore, elite-level players have lower heart rates during performance, which enables them to use their current

performance more economically and with maximum efficiency. This study is expected to play an important role in encouraging training scientists to conduct studies aimed at determining the potential of using heart rate percentages in athletes of different levels and branches, and thus, making further contributions to the subject.

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