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Original Article

The examination of VO_{2MAX} and anaerobic threshold values in elite soccer players by their positions

ÖMER AKSOY[1], TUBA KIZILET BOZDOĞAN[2], MEHMET SOYAL[3], MEHMET MURAT BEYAZ[4],
[1]Marmara University, Sport Science Faculty, Istanbul, TURKEY
[2]Marmara University, Sport Science Faculty, İstanbul, TURKEY
[3,4]İstanbul Gelişim University, School of Physical Education and Sports, İstanbul, TURKEY

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Abstract
Objective of the Study: This study was conducted to examine the parameters of maximal oxygen consumption capacity (VO_{2max}), anaerobic threshold heart rate, endurance heart rate, and recovery heart rate in elite soccer players according to their positions (goalkeeper, defenders, midfielders, and forwards). **Method:** The relational screening model was used in the study. And the study group consisted of a total of 88 players, including goalkeepers (n:11), defenders (n:33), midfielders (n:30) and forwards (n:14), from different teams and positions in the Turkish Super League. The SensorMedics 29 c ergospirometry was used with the breath and breath method as per the maximal oxygen consumption in the data collection process. In addition, the exercise testing protocol was applied to the soccer players on the treadmill, and their pulse values were recorded instantly with the polar watch. Plus, the V-Slope method was used to determine the anaerobic threshold values. Moreover, while the SPSS 25.0 package program was used for statistical analysis, correlation analysis was performed for the comparison between positions. **Findings:** A strong positive correlation was found between the anaerobic threshold, endurance training, and recovery heart rates of the goalkeeper, defenders, midfielders, and forwards participating in the research. Then again, while a strong negative correlation was determined between age, endurance training heart rate, and recovery heart rates of defenders and forwards, no statistical difference was found between the age (year), height (cm) and VO_{2max} (ml/kg/min.) parameters of the goalkeepers and midfielders and their other parameters. **Conclusion:** In conclusion, when the study results are evaluated, it is clear that the VO_{2max} values of soccer players playing in different positions were close to each other. Also, it is concluded that the reason why the anaerobic threshold heart rate, endurance heart rate, and recovery heart rate parameters of the soccer players in different positions vary; Their actions in the competitions or training.
Keywords: Soccer, position, maximal oxygen consumption, anaerobic threshold

Introductıon

The alteration of soccer into a fast and fluent playing style has prompted sports scientists and athletic performance experts to research different training methods. Also, performing high-intensity movements in a soccer match one after the other depends on the physical and physiological efficiency of the soccer players. In addition, soccer players need rapid recovery after the movements in the competition, which is believed to be related to the cardiovascular endurance.

Cardiovascular endurance is one of the essential health conditioning components in soccer (Md Noor, Karim, Hazley, & Nadzalan, 2017). Also, In recent studies, it is said that high-intensity interval training is very effective in improving aerobic capacity and therefore the cardiovascular system (Mohr et al., 2014). Based on this information, the running distances of the football players according to their positions on the field come to the fore as an issue that should be examined in terms of aerobic capacity values.

According to some research, athletes in different positions in a soccer team have different workloads during the competition. While it is stated that midfielders run the longest distances (11-11.5 km), it is seen that strikers and defenders have lower running distances than midfielders (Nilsson & Cardinale, 2015). In this situation, it can be said that the midfielders are in a wider area both in defense and attack, while strikers and defenders have a more regional situation. Also, the performance of a soccer team depends on the cooperation between the players playing in different positions. For instance, the primary duty of midfielders is to organize the attack with proper ball control and passes, while the main task of the defenders is to win aerial battles or intervene against the opposing team's attacks (Modric, Versic, & Sekulic, 2020). In this sense, while planning the training by considering the situations that the soccer players will encounter in the competitions, doing practices according to the energy metabolism needed will contribute positively to the performance of the soccer players. Soccer is a sport in which the aerobic energy system is interrupted (sudden stops, slowing down, etc.). It can be highly associated with mean maximum heart rates of around 85% and 98%, respectively, corresponding to approximately 70% of the maximum oxygen uptake (VO_{2max}) (Bangsbo, 2014). Also, players' performances

Corresponding Author: ÖMER AKSOY, Email: oaksoy@gelisim.edu.tr

can be evaluated according to their positions during the match. Plus, the developed aerobic capacity of soccer players contributes positively to their performances.

The total distance covered by the players in a soccer match can reach 9-14 km. Therefore, maximum oxygen consumption (VO_{2max}), which is accepted as the gold standard for evaluating aerobic fitness, is claimed to be very important for performance in soccer (Marcos, Koulla, & Anthos, 2018). Broadly, the amount of oxygen taken and used by the organism corresponding to VO_{2max} at maximum working speed varies between 55 and 65 ml kg-1 min-1 in professional soccer players (Modric et al., 2020). Another parameter that affects the endurance of soccer players is the anaerobic threshold.

The anaerobic threshold is significant in absolute terms (ml/kg/min), but it is highly dependent on VO_{2max} and is said to show little change in the percentage of VO_{2max} (Hoff, Wisløff, Engen, Kemi, & Helgerud, 2002). During a soccer match, players exert effort above and below the anaerobic threshold. In this sense, each short-term maximum intensity exercise can be considered an effort above the threshold. Also, doing such exercises by soccer players causes lactate blood levels to increase by 14 mmol-l-1 (Parus et al., 2017). In addition, the recovery speed of the players after high-intensity exercises during the soccer match is important in terms of their readiness for the next exercise.

During a soccer match, exercise-induced muscle damage is said to cause an acute inflammatory response that leads to deterioration in performance for 24-72 hours depending on the activity profile of the player during the match (Poulios et al., 2018). Also, the relationship between aerobic capacity and recovery after high-intensity exercise may exist with certain limitations. In addition, as aerobic fitness increases to levels approaching the population average, there will be reductions in fatigue (Hoffman et al., 2005). Based on this information, the development of aerobic capacity is crucial for the rapid recovery of the athletes both in and after the competition.

Accordingly, the playing style of soccer has recently evolved into fast gameplay; Hence the training loads vary by the positions of the soccer players. In this context, this study aims to examine the parameters of maximal oxygen consumption capacity (VO_{2Max}), anaerobic threshold heart rate, endurance heart rate, and recovery heart rate in elite soccer players according to their positions (goalkeeper, defenders, midfielders, and forwards).

Methods

Research Model

This study was carried out following the relational screening model, which is one of the screening models. These models aim to determine the presence and/or level of change between two or more variables and to specify the relationships between them. Although the relational screening model does not give a concrete cause-and-effect relationship, it allows the estimation of the other variable if the situation in one variable is known (Karasar, 2006). Ethics committee approval numbered E-77366270-302.08.01-49337 was obtained.

Study Group

The study group consisted of volunteer professional soccer players who competed on different teams in the Turkish Super League.

Data Collection

The maximum oxygen consumption of the athletes was measured by the breath-by-breath method using the SensorMedics 29 c ergospirometry (Carvalho et al., 2005). Also, their exercise tests were applied using the "athlete test protocol" treadmill. The test protocol was started at 9 km/h without incline then the speed was increased by 1 km/h every minute by asking them to continue with maximum effort (Midgley, 2006). In addition, the heart rate measurements were calculated with a Polar watch (Polar RS800 SD, Finland) (Hausswirth et al., 2009) and instantly recorded in the V-max program. Finally, their anaerobic threshold heart rate measurements were manually recorded using the Wasserman V-Slope method.

The V-Slope Method

The anaerobic threshold values of soccer players were determined with the V-Slope method (Beaver et al., 1986). In addition, the calculation method of this threshold is based on the work of Schneider et al. (1993). VT is detected at the intersection of two straight lines describing VCO_2 versus $\dot{V}O_2$ and determined by linear regression. In other words, the intersection point of the two regression lines is moved over the entire data range until the remaining sum of squares is minimized and designated as VT (Santos et al., 2004).

Statistical Analysis

The data to be obtained in the study were transferred to the electronic environment and entitled as mean and standard deviation. For the normality test of the data, skewness and kurtosis values were checked with the Kolmogorov-Smirnov test. Accordingly, the data were normally distributed; Hence correlation analysis was applied in the comparison between soccer players' positions.

Table 1. The Skewness and Kurtosis values and Significance Level of the data according to the Kolmogorov-Smirnov test

Variables	n	Skewness	Kurtosis
VO_{2Max} (ml/kg/min)	88	,142	0,96
Anaerobic Threshold (Heart Rate)	88	-,139	-,946
Endurance Training (Heart Rate)	88	-,116	-,973
Recovery (Heart Rate)	88	-,137	-,962

When the Kolmogorov-Smirnov test results are examined in Table 1, it is clear that there are no deviations from normality in the scores obtained from the data. The implementation of the Kolmogorov-Smirnov test is only one of the methods used to determine the normal distribution of data. According to the examination of the normally distributed curves, no extreme deviations from normality were determined. Also, there were no deviations from normality in the data in the range of ±1.5, resulting in a normal distribution of the data.

Results

Table 2. Descriptive Analysis of Data

Variables	Positions	n	Minimum	Maximum	Mean±SD
$VO_{2\ Max}$ (ml/kg/min)	Defender	33	36,00	69,80	53,06±7,18
	Midfielder	30	38,40	69,80	52,55±7,29
	Forward	14	43,80	60,30	53,40±5,09
	Goalkeeper	11	44,00	59,90	51,19±4,95
Anaerobic Threshold (Heart Rate)	Defender	33	145,00	183,00	164,51±9,00
	Midfielder	30	144,00	178,00	162,46±9,68
	Forward	14	144,00	180,00	159,14±12,84
	Goalkeeper	11	142,00	182,00	165,09±11,82
Endurance Training (Heart Rate)	Defender	33	131,00	165,00	148,09±8,12
	Midfielder	30	130,00	160,00	146,36±8,77
	Forward	14	130,00	162,00	143,42±11,42
	Goalkeeper	11	128,00	164,00	148,54±10,63
Recovery (Heart Rate)	Defender	33	94,00	119,00	106,93±5,80
	Midfielder	30	94,00	116,00	105,60±6,30
	Forward	14	94,00	117,00	103,50±8,37
	Goalkeeper	11	92,00	118,00	107,27±7,72

According to the data in Table 2, the mean VO_{2Max} (ml/kg/min) value of defenders is 53.06±7.18, of midfielders is 52.55±7.29, of forwards is 53.40±5.09, and of goalkeepers is 51,19±4,95.

The mean Anaerobic threshold (HR) value of defenders was determined as 164.51±9.00, midfielders as 162.46±9.68, forwards as 159.14±12.84, and goalkeepers as 165,09±11,82.

The mean value of Endurance Training (HR) for defenders was 148.09±8.12, for midfielders 146.36±8.77, for forwards 143.42±11.42, and goalkeepers 148.54±10.63.

The mean recovery (HR) value of defenders was determined as 106.93±5.80, midfielders as 105.60±6.30, forwards as 103.50±8.37, and goalkeepers as 107.27±7.72.

Table 3. The Correlation Analysis of participants' age, height and physiological parameters

Variables		1	2	3	4	5	6
Age (years)	**r**	1	-,027	-,099	**-,350****	**-,345****	**-,348****
	p	-	,400	,180	**,000**	**,000**	**,000**
Height (cm)	**r**	-0,27	1	-,096	-,132	-,128	-,132
	p	,400	-	,186	,110	,117	,110
$VO_{2\ Max}$ (ml/kg/min)	**r**	-,099	-,096	1	,041	,041	,042
	p	,180	,186	-	,352	,351	,348
Anaerobic Threshold (Heart Rate)	**r**	**-,350****	-,132	,041	1	**1,000****	**,999****
	p	**,000**	,110	,352	-	**,000**	**,000**
Endurance Training (Heart Rate)	**r**	**-,345****	-,128	,041	**1,000****	1	**,999****
	p	**,000**	,117	,351	**,000**	-	**,000**
Recovery (Heart Rate)	**r**	**-,348****	-,132	,042	**,999****	**,999****	1
	p	**,000**	,110	,348	**,000**	**,000**	-

When Table 3 is examined, it is clear that there is a weak negative correlation between the age parameters of the participants and their Anaerobic Threshold (HR) parameters (p=.000, r= -.350).

Also, there is a weak negative correlation between participants' age parameters and their Endurance Training (HR) parameters (p=, 000,r= -,345).

In addition, there is a weak negative correlation between their age parameters and Recovery (HR) parameters (p=.000, r= -.348).

A strong correlation was found between participants' Anaerobic Threshold (HR) parameters and Endurance Training (HR) parameters (p=.000, r= 1.000).

Plus, a strong positive correlation was found between their Anaerobic Threshold (HR) parameters and Recovery (HR) parameters (p= .000, r= .999).

While there is a strong positive correlation between participants' Endurance Training (HR) parameters and Recovery (HR) parameters (p= .000, r= .999), there is no statistically significant difference between their age (years), height (cm), and VO_{2Max} (ml/kg/min) parameters.

Table 4. The Correlation Analysis of age, height, and physiological parameters of defenders

Variables		1	2	3	4	5	6
Age (years)	**r**	1	**-,111**	-,216	**-,426***	**-,417***	**-,418***
	p	-	,538	,227	**,013**	**,016**	**,016**
Height (cm)	**r**	**-,111**	1	**-,352***	,127	,126	,133
	p	,538	-	**,045**	,481	,485	,461
$VO_{2\ Max}$ (ml/kg/min)	**r**	-,216	**-,352***	1	-,020	-,025	-,024
	p	,227	**,045**	-	,912	,888	,893
Anaerobic Threshold (Heart Rate)	**r**	**-,426***	,127	-,020	1	**,999****	**,999****
	p	**,013**	,481	,912	-	**,000**	**,000**
Endurance Training (Heart Rate)	**r**	**-,417***	,126	-,025	**,999****	1	**,998****
	p	**,016**	,485	,888	**,000**	-	**,000**
Recovery (Heart Rate)	**r**	**-,418***	,133	-,024	**,999****	**,998****	1
	p	**,016**	,461	,893	**,000**	**,000**	-

When Table 4 is examined, it is clear that there is a moderate negative correlation between the age parameters of the participants and their Anaerobic Threshold (HR) parameters (p=.013, r= -.426).

Also, there is a moderate negative correlation between participants' age parameters and their Endurance Training (HR) parameters (p= .016, r= -.417).

In addition, a moderate negative correlation was found between their age parameters and Recovery (HR) parameters (p= .016, r= -.418).

A weak negative correlation was found between their height parameters and VO_{2Max} (ml/kg/min) parameters (p= .045, r= -.352).

Plus, there is a strong positive correlation between their Anaerobic Threshold (Heart Rate) parameters and Endurance Training (HR) parameters (p= .000, r= .999).

Moreover, there is a strong positive correlation between their Anaerobic Threshold (HR) parameters and Recovery (HR) parameters (p= .000, r= .999).

While there is a strong positive correlation between their Endurance Training (HR) parameters and Recovery (HR) parameters (p= .000, r= .998), there is no statistically significant difference between participants' age (years), height (cm), and VO_{2Max} (ml/kg/min) parameters.

Table 5. The Correlation Analysis of age, height, and physiological parameters of midfielders

Variables		1	2	3	4	5	6
Age (years)	**r**	1	-,296	,021	-,213	-,210	-,197
	p	-	,113	,913	,258	,265	,296
Height (cm)	**r**	-,296	1	,324	-,184	-,175	-,196
	p	,113	-	,081	,330	,355	,299
$VO_{2\ Max}$ (ml/kg/min)	**r**	,021	,324	1	-,007	,003	-,008
	p	,913	,081	-	,970	,985	,965
Anaerobic Threshold (Heart Rate)	**r**	-,213	-,184	-,007	1	**,999****	**,999****
	p	,258	,330	,970	-	**,000**	**,000**
Endurance Training (Heart Rate)	**r**	-,210	-,175	,003	**,999****	1	**,999****
	p	,265	,355	,985	**,000**	-	**,000**
Recovery (Heart Rate)	**r**	-,197	-,196	-,008	**,999****	**,999****	1
	p	,296	,299	,965	**,000**	**,000**	-

When Table 5 is examined, it is clear that there is a strong positive correlation between the Anaerobic Threshold (HR) parameters of the participants and their Endurance Training (HR) parameters (p= .000, r= .999).

In addition, a strong positive correlation was found between their Endurance Training (HR) parameters and Recovery (HR) parameters (p= .000, r= .999).

Also, a strong positive correlation was found between their Anaerobic Threshold (HR) parameters and Recovery (HR) parameters (p= .000, r= .999).

Yet, there is no statistical difference between the participants' age (year), height (cm), VO_{2Max} (ml/kg/min) values, and other parameters (p>0.05).

Table 6. The Correlation Analysis of age, height, and physiological parameters of forwards

Variables		1	2	3	4	5	6
Age (years)	**r**	1	-,053	-,163	**-,759****	**-,756****	**-,767****
	p	-	,858	,579	**,002**	**,002**	**,001**
Height (cm)	**r**	-,053	1	-,097	,035	,033	,035
	p	,858	-	,742	,906	,910	,905
$VO_{2\ Max}$ (ml/kg/min)	**r**	-,163	-,097	1	,229	,222	,242
	p	,579	,742	-	,431	,445	,404
Anaerobic Threshold (Heart Rate)	**r**	**-,759****	,035	,229	1	**1,000****	**,999****
	p	**,002**	,906	,431	-	**,000**	**,000**
Endurance Training (Heart Rate)	**r**	**-,756****	,033	,222	**1,000****	1	**,999****
	p	**,002**	,910	,445	**,000**	-	**,000**
Recovery (Heart Rate)	**r**	**-,767****	,035	,242	**,999****	**,999****	1
	p	**,001**	,905	,404	**,000**	**,000**	-

According to the data in Table 6, there is a strong negative correlation between the age parameters of the participants and their Anaerobic Threshold (HR) parameters (p=.002, r= -.759).
Also, there is a strong negative correlation between their age parameters and Endurance Training (HR) parameters (p= .002, r= -.756).

In addition, a strong negative correlation was found between their age parameters and Recovery (HR) parameters (p= .001, r= -.767).

Plus, there is a strong positive correlation between their Anaerobic Threshold (Heart Rate) parameters and Endurance Training (HR) parameters (p= .000, r= .1000).

Furthermore, there is a strong positive correlation between their Anaerobic Threshold (HR) parameters and Recovery (HR) parameters (p= .000, r= .999).

While there is a strong positive correlation between participants' Endurance Training (HR) parameters and Recovery (HR) parameters (p= .000, r= .999), there is no statistical difference between their height (cm) and VO_{2Max} (ml/kg/min) parameters, and other parameters (p>0.05).

Table 7. The Correlation Analysis of age, height, and physiological parameters of goalkeepers

Variables		1	2	3	4	5	6
Age (years)	**r**	1	-,058	,050	,008	,008	-,016
	p	-	,866	,884	,980	,982	,964
Height (cm)	**r**	-,058	1	-,363	-,336	-,328	-,334
	p	,866	-	,273	,312	,325	,316
$VO_{2\ Max}$ (ml/kg/min)	**r**	,050	-,363	1	,269	,260	,272
	p	,884	,273	-	,424	,441	,419
Anaerobic Threshold (Heart Rate)	**r**	,008	-,336	,269	1	**1,000****	**,999****
	p	,980	,312	,424	-	**,000**	**,000**
Endurance Training (Heart Rate)	**r**	,008	-,328	,260	**1,000****	1	**,999****
	p	,982	,325	,441	**,000**	-	**,000**
Recovery (Heart Rate)	**r**	-,016	-,334	,272	**,999****	**,999****	1
	p	,964	,316	,419	**,000**	**,000**	-

According to the data in **Table 7**, there is a strong positive correlation between the Anaerobic Threshold (HR) parameters of the participants and their Endurance Training (HR) parameters (p=,000, r=,1000).
In addition, a strong positive correlation was found between their Anaerobic Threshold (HR) parameters and Recovery (HR) parameters (p= .000, r= .999).

Also, a strong positive correlation was found between their Endurance Training (HR) parameters and Recovery (HR) parameters (p= .000, r= .999). Yet, there was no statistical difference between the participants' height (cm) and VO_{2Max} (ml/kg/min) parameters and other parameters (p>0.05).

Discussion

This study was carried out to examine the effect of the endurance training programs applied to elite soccer players in different positions on their anaerobic threshold and maximal oxygen consumption capacities.
According to the statistical analysis results, the mean VO_{2Max} value of the defenders is 53.06±7.18 ml/kg/min, of midfielders 52.55±7.29 ml/kg/min, of forwards 53.40±5.09 ml/kg/min, and goalkeepers 51.19±4.95 ml/kg/min.
When the literature is examined, Modric et al. (2021) analyzed the aerobic performance and running performance among professional soccer players according to their positions and found that the mean VO_{2Max} value of the defenders was 57.3±1.3 ml/kg/min, of midfielders 57.7±5.0 ml/kg/min, and forwards 54.8±1.9 ml/kg/min. In another study, Cihan et al. (2012) examined the aerobic capacity and recovery times of elite soccer

players according to their playing positions and found that the mean VO_{2Max} value of defenders was 52.5±1.42 ml/kg/min, of midfielders 53.0±2.17 ml/kg/min, of forwards 50.9±2.93 ml/kg/min, and goalkeepers 47.0±0.72 ml/kg/min. Also, Gjonbalaj et al. (2018), in their study, which examines some specific parameters of elite young soccer players playing in different positions competing in Kosovo, found that the mean VO2max value of defenders was 52.08±5.00 ml/kg/min, of midfielders 53.53±6.12 ml/kg/min, of forwards 53.36±5.73 ml/kg/min, and goalkeepers as 49.31±3.73 ml/kg/min. As a result, some studies in the literature show similar results to our study.

As per the statistical analysis results, the mean Anaerobic threshold (HR) value of defenders is 164.51±9.00, of midfielders 162.46±9.68, of forwards 159.14±12.84, and goalkeepers 165,09±11,82.

Under the literature examination, Bizati (2016) evaluated the physiological characteristics of elite soccer players by their positions and found that the mean Anaerobic threshold (HR) value of midfielders was 174.43±10.61, of forwards 179.29±7.32, and goalkeepers 175.33±5.78. In another study by Kafedžić et al. (2018), where they examined the pre-season physiological characteristics of professional soccer players, they found that the mean Anaerobic threshold (HR) value of defenders was 181±9.0, of midfielders 173±9.0, and forwards 172±6.0. In the study of Modric et al. (2021), where they investigated the aerobic condition and game performance of professional soccer players by their positions, they found that the mean Anaerobic threshold (HR) value of defenders was 185.26±6.20, of midfielders 180.22±10.45, and forwards 182.82±7.28. In another study, Soyal et al., (2017), when they examined the anaerobic threshold values of football players and handball players, determined the anaerobic threshold values of handball players as 85.5±3.3 and of football players as 86.6±5.6. The content of the training program or the fact that the soccer players are in different age groups can be the reason for these results.

When the statistical analysis results are evaluated, the mean Endurance Training (HR) value of defenders was found as 148.09±8.12, of midfielders 146.36±8.77, of forwards 143.42±11.42, and goalkeepers as 148.54±10.63.

To give an example of some studies in the literature, Mohr et al. (2020) investigated some physiological responses of soccer players to training after the Covid pandemic and found that the average heart rate of soccer players is 160 (140-180) in endurance training. In another study, Kırdan (2018) found that 5x5 narrow field games with continuous runs at the beginning of training increased the endurance levels of soccer players. In addition, Bekris et al. (2012) investigated the physiological effects of small-sided games in soccer players and found that the mean endurance heart rate of the defenders in 1x1 game was 178.7±7.57 and that of forwards in 2x2 games was 180.7±3.36. Also, Evangelos et al. (2012) investigated the physiological effects of small-sided games on soccer players and found that the mean endurance heart rate of soccer players was 185.8±8.01 in the 3x3 game, yet it was 177.0±7.76 in the 4x4 game. On the other hand, when some studies in the literature are examined, they do not show parallelism with our research. The reason for this may be the applied unit training intensity is high or that the athletes are not fully ready physiologically.

According to the statistical analysis results, the mean recovery (HR) value of defenders is 106.93±5.80, of midfielders 105.60±6.30, of forwards 103.50±8.37, and goalkeepers 107.27±7.72.

Looking at the studies in the literature, Bayrakdaroğlu et al. (2021) examined some physiological responses of yo-yo IR tests (level 1-2) applied to soccer players and found that the mean YoYo-1 IR heart rate was 106.6±1.98 (9 minutes later), whereas, the YoYo-2 IR heart rate was 107.0±2.58. Harbili (2016), in his study on repetitive sprint performance and recovery process with soccer players in the regional amateur league, found that their recovery heart rate was 123.28±3.79 (5 minutes after the repeated sprint), 98.14±2.76 (15 minutes later), and 85.92±3.17 (30 minutes later). In another study by Kurtay et al. (2021) conducted with soccer players competing in the development league, the recovery heart rate in the first minute after the Yo-Yo-1 test was 165.80±14.74 in the pretest and 153,28±18,06 in the posttest. In addition, they found that in the pretest the mean recovery heart rate at the second minute was 140.76±13.36 and in the posttest as 134.16±13.18. Plus, when some studies in the literature are examined, they do not show parallelism with our study. It is thought that this is because the athletes compete in different league levels, the training programs show variability, and the differences in physiological characteristics of individuals.

Conclusion

The VO_{2Max} values of soccer players playing in different positions are close to each other. According to the study results, the VO2max values of soccer players playing in different positions are close to each other. This situation arises from the training programs of soccer players competing at the same league level at the beginning of the season or in the middle of the season. In addition, even if the values of the goalkeepers participating in the research are low compared to other positions, their aerobic capacity is at a good level regarding their actions in the competition. This situation suggests that although the activities of the goalkeepers in the competition are anaerobic, they train for the development of the aerobic capacity to spread their performance throughout the competition and to shorten the recovery time between high-intensity activities.

In addition, the averages of the forwards' inter-position anaerobic threshold heart rate, endurance training heart rate, and recovery heart rate were slightly lower than the average values of the defenders,

midfielders, and goalkeepers. This situation depends on the action of the forwards more during training and competition than the players in other positions, hence this affects their physiological characteristics.

Also, when the relations of the parameters with the positions of soccer players are examined, there is a negative significant relationship between the anaerobic threshold heart rate, endurance heart rate, and recovery heart rate values according to the ages of the forwards and defenders. Moreover, a moderately negative relationship was found in defenders, and a strong negative relationship was found in forwards. This is in parallel with the average heart rate parameters of the forwards. Furthermore, the heart rate decreases as the age of the forwards increases, which is connected to the belief that training age and experience depending on the position have a positive effect on the cardiovascular system.

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