

# **Comparison of the Response of Perceived Exertion, Blood Lactate, VO<sub>2</sub> max and Maximum Heart Rate during a Match in Elite Soccer and Futsal Players**

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## **Abstract:**

The present study seeks to compare the response of perceived exertion, blood lactate, VO<sub>2</sub> max and maximum heart rate during a match in elite soccer and futsal players. In this study, 10 soccer players and 10 futsal players who had been invited to Iranian national teams of soccer and futsal were selected through convenient and purposeful sampling. On one day, the anthropometric and body composition measurements were performed and, on the day of the match, the physiological variables of perceived exertion, VO<sub>2</sub> max, lactate threshold, and maximum heart rate were measured. The measurements were performed by a single person and a single instrument. Next, ISAK method was used to measure the circumference of body parts (waist and hip) and length of body and extremities (standing height, arm span, and leg length) using an anthropometric meter on the right side of the body. Using IBM SPSS v25, independent sample t-test at a significance level of  $p < 0.05$  was performed to compare the means of the two groups. The results are indicative of differences between the two groups in some of the features. They suggest that there was no significant difference between soccer and futsal players in terms maximum heart rate, but there was a significant difference in perceived exertion, blood lactate level, and VO<sub>2</sub> max. Physiological, anthropometric, and body composition features are of great importance in the process of selecting players. Therefore, it is necessary for the coach to have a good knowledge of these features to select more talented soccer and futsal players.

**Keywords:** perceived exertion, VO<sub>2</sub> max, blood lactate, maximum heart rate, soccer, futsal

## **Introduction**

Soccer has various physiological requirements. In soccer, balance between these requirements depends on the player's performance, the position in which they play, and the team arrangement. Professional soccer players must fulfill different needs such as aerobic capacity for intensive activity for 90 minutes (up to 120 minutes), ability to accelerate in a short distance, and ability to suddenly reduce acceleration

or change direction. In addition, they must frequently produce high anaerobic power for jumping, tackling, and shooting. Soccer is distinguished from many other sports due to its various and complex physiological requirements [1, 2]. Physical and physiological indicators help to determine the position of the player in the team arrangement. Individual values of players also provide the coach with useful findings [2].

Today, it is widely agreed that physiological and anthropometric features as well as the physique of soccer players have a key role in the success or failure of soccer teams in competitions. In addition, factors such as body composition, strength, balance between aerobic and anaerobic power, and physiological abilities are among the most important criteria for the assessment of soccer players which are used by coaches to design and modify exercise programs [3, 4, 5]. The team's physiological profile determines its general and specific readiness and may transform various dimensions of its activity such as exercise methods and the number of competitions [5].

Futsal is a sport which requires high levels of activity. The nature of this sport and the size of the pitch entails a high level of physical fitness on the part of players. Professional futsal players need to do specialized exercises for improving their physical fitness [6]. To achieve their best levels of performance, they must improve their neuromuscular coordination, cardiovascular strength, power, strength, agility, and speed [7, 8]. In 2006, Dogramaci and Watsford concluded that futsal is a high-impact sport in which physical activities alter in an average period of 3 minutes and 28 seconds. They estimated that, a futsal player has high-impact activity in 26 percent of the total time of a match [9].

Soccer and futsal depend on various factors including technical and tactical skills, physical strength, aerobic capacity, and psychological conditions. Most of these factors can be improved through practice [10]. A soccer player may run 10 to 12 km with about 80 to 90% of his or her maximum heart rate during a 90-minute match [11], and this figure is 3 to 4 km for a futsal player in a 40-minute match. This indicates the importance of aerobic ability. Having a high level of aerobic capacity is a major determinant of performance in a match. There moments such as when the player is jumping or changing directions in which the activity is anaerobic, but research findings suggest that most of the activities performed in a soccer or futsal match are a function of aerobic metabolism [11, 12, 13] and aerobic capacity strongly affects a player's technical and tactical performance [14]. Aerobic

performance depends on factors including  $VO_2$  max, anaerobic threshold, and work economy. During a soccer match, the mean intensity of activity cannot exceed the lactate threshold and players are not able to go through prolonged periods of lactate threshold. Work economy in a soccer match depends on various factors such as the psychological conditions created by the coach and spectators, exercise conditions, and the situations in the match [13]. To increase a team's chance of winning, their fatigue should be reduced during the match. If a team has higher aerobic endurance, it will be more likely to maintain activity levels and score a goal towards the end of the match [15]. Moreover, analysis of motion patterns in soccer matches has led researchers to the conclusion that, in addition to enhancing aerobic indicators in players, exercise programs should also emphasize their functional skills in a match, and many functional tests have so far been developed for this purpose [16].

The American College of Sports Medicine (ACSM) has determined an impact threshold according to the intensity and duration of exercise with the aim of general fitness; therefore, a successful schedule for exercise protocols requires an evaluation of the perceived exertion of exercise [17]. Between 2000 and 2008, more than 200 scientific articles studied perceived exertion as a physical-psychological indicator for evaluating the intensity of athletic responses [18]. The Borg Rating of Perceived Exertion (RPE) is a feasible method of adjusting the intensity of physical activity which was developed by Gunnar Borg in 1970 [19]. The Borg Exertion Perception Index consists of a range of numbers, each of which indicating a degree of difficulty and exertion which the individual perceives during exercise. This range is expressed in two forms: one ranging from 0 (no exertion) to 10 (maximum tolerable exertion), and the other ranging from 6 (no exertion) to 20 (maximum tolerable exertion) [20].

Given the nature of soccer and futsal (such as pitch size, playing environment, duration of match, systems of playing, skills, and conflicts), different factors play a role in these two sports. Thus, it follows that they require certain anthropometric, physiological, motor, and body composition needs based on which exercise programs could be developed [21]. The first step in developing an exercise program in any sport is to be aware of the requirements. To achieve maximum performance, athletes have to improve their anthropometric, physiological, and body composition features and increase their coordination, endurance, strength, power, agility, and speed [22]. Also, the exercise should fit the individual's conditions and capacity [23]. According to research findings, elite players need very high levels of anthropometric, physiological, motor, and body composition features to achieve

success in a match [24]. In general, these features are crucial in the quality of an athlete's performance and winning a match [25].

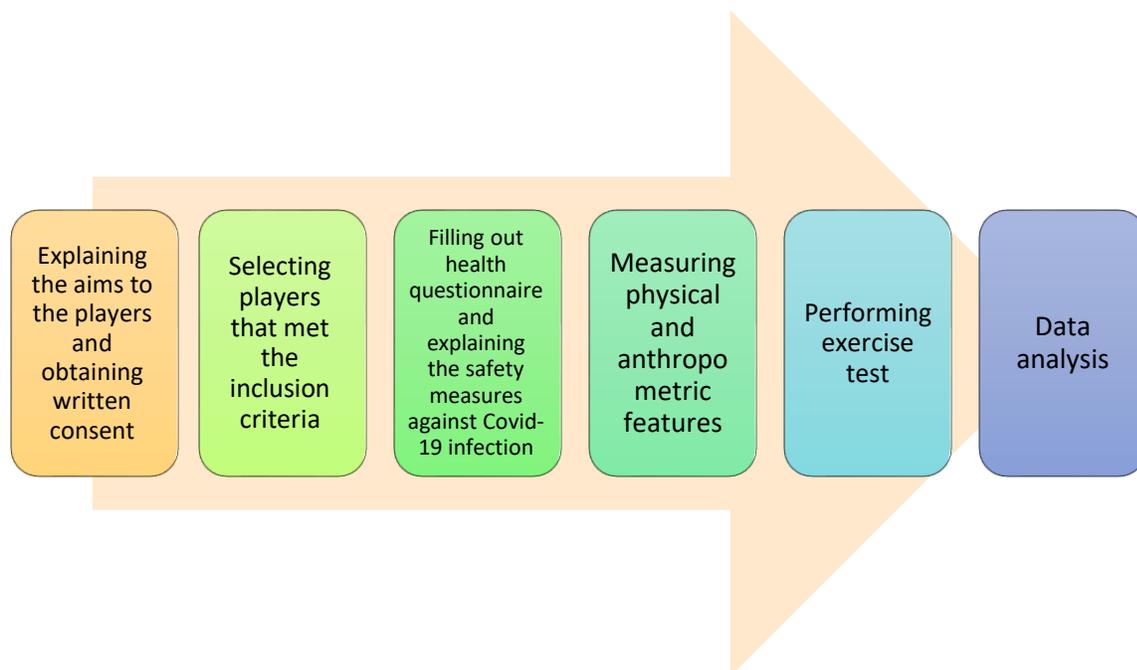
Elite players are defined as those who professionally play on a national level [26]. In Dictionary of Sport and Exercise Science [27], an elite athlete refers to an individual who is better, more talented, and more practiced than others/ Few studies have compared the physiological features of professional soccer and futsal players. Due to the importance of these features and their role in the selection of players for a team, the present study aims to compare soccer and futsal players in terms of their physiological features. In addition, knowledge about the anthropometric, physiological, motor, and body composition features of soccer and futsal players opens a new avenue ahead of coaches, managers, and practitioners in the field of soccer and futsal.

## **Research Method**

This study is a causal-comparative study and its population consists of the players of Iran's national soccer and futsal teams. In this study, 10 soccer players and 10 futsal players who had been invited to Iranian national teams of soccer and futsal were selected through purposeful (convenient) sampling. All the participants were informed about the research procedure and expressed their consent to participate voluntarily in the study. We had certain criteria for including the players in the study. Due to the Covid-19 pandemic and the necessity of protecting the subjects and the researchers against infection, all the participants were required to fill out the Covid-19 infection questionnaire on the website of Iran's Ministry of Health and Medical Education <https://salamat.gov.ir> and receive a health confirmation before being allowed to enter the study. Next, the subjects participated in an introductory session held under safety protocols (a social distance of 1.5 meters and wearing face masks). In this session, the significance of the project and some necessary theoretical and practical issues were explained to the participants. The posture of the participants was measured using a stadiometer with a precision of 0.1 cm. For this purpose, the individual stood barefoot and upright with eyes looking forward and the weight distributed equally on both legs. In this state, the horizontal headpiece was put on the head in a way that it would make a right angle with the vertical ruler. Thus, the person's height could be measured in centimeters [28]. The weights were measured using a digital scale with a precision of 0.5 kg. To do this, after emptying their bladder, the subjects stood on the scale without shoes and with the least amount of clothing. Their body composition features were measured using InBody body composition analyzer. All the measurements were done with the least amount of clothing and without carrying any physical accessories or electrical gadgets. The

subject stood upright with his hands stretching forwards and the fingers and toes touching the metal plates on the points specified on the device. In addition, our anthropometric measurements followed the international recommendations of ISAK (The International Society for the Advancement of Kinanthropometry) [29]. To minimize the variance, all the measurements were done by a single person who had been trained. In line with our research design, on one day, the anthropometric and body composition measurements were performed and, on the day of the match, the physiological variables of perceived exertion,  $VO_2$  max, lactate threshold, and maximum heart rate were measured. The measurements were performed by a single person and a single instrument. According to the ISAK method, all the anthropometric measurements including circumference (waist and hip) and length (standing height, arm span, and leg length) were done by an anthropometric tape on the right side of the body [30]. The study was conducted in the fall of 2021 during the exercise sessions of Iranian nation soccer and futsal teams on the soccer and futsal pitches of Azadi Sport Complex, Tehran, Iran. The conditions of the soccer and futsal match was to try as best as possible to win the match. Each player had to use all of his physical and physiological features for the success of the team. The Borg Rating of Perceived Exertion was used and the maximum heart rate of each player was measured with a Polar heart rate monitor. The blood lactate level was measured by a lactometer in mmol/l after the end of the match. The  $VO_2$  max of the players was calculated according to the following equation:

$$VO_2 \text{ max} = 132.853 - 0.0769W - 0.3877A + 6.315G - 3.2649T - 0.1565H$$



## Data Analysis

The data were analyzed using both descriptive and inferential statistics. We used descriptive statistics to calculate the measures of central tendency (mean) and dispersion (standard deviation). The tests of inferential statistics used included Kolmogorov-Smirnov test to examine the normality of the data; Levene test to assess the homogeneity of the variance of the groups; and independent t-test to compare the means of the groups at a significance level of  $p \leq 0.05$ . All the analyses were conducted in IBM SPSS v25.

## Findings

The mean and standard deviation (SD) values of the anthropometric features and body composition of the participants are listed in Table (1).

Table 1: The mean and SD values of the descriptive features of the subjects.

<b>Variables</b>	<b>Soccer players M ± SD</b>	<b>Futsal players M±SD</b>
<b>Age (years)</b>	26.78 ± 2.24	23.15 ± 2.47
<b>Height (cm)</b>	182.28 ± 10.21	179.58 ± 7.21
<b>Weight (kg)</b>	75.31 ± 4.78	77.87 ± 7.49
<b>BMI (kg/m<sup>2</sup>)</b>	22.73 ± 1.48	23.34 ± 2.58
<b>Arm span (cm)</b>	181.31 ± 2.65	174.06 ± 7.65
<b>Sitting height (cm)</b>	89.87 ± 2.12	86.68 ± 3.49
<b>Leg length (cm)</b>	92.48 ± 4.74	89.36 ± 3.94
<b>Waist-to-hip ratio (cm)</b>	0.693 ± 0.016	0.673 ± 0.49

Table 2: Description and comparison of the physiological features of the groups

<b>Variables</b>	<b>Soccer players M ± SD</b>	<b>Futsal players M ± SD</b>	<b>t</b>	<b>P</b>
<b>Perceived exertion</b>	5.91 ± 1.25	7.24 ± 0.54	4.282	0.000*
<b>Blood lactate level (mmol/l)</b>	5.8 ± 1.7	12.56 ± 2.04	3.235	0.000*
<b>VO<sub>2</sub> max (mL.kg<sup>-1</sup>.min<sup>-1</sup>)</b>	58.52 ± 3.24	48.45 ± 2.14	3.689	0.000*
<b>Maximum heart rate (beats per minute)</b>	192.8 ± 3.5	190.1 ± 2.8	0.235	0.125

\* Significant difference in the mean scores of variables ( $P \leq 0.05$ )

Table 1 describes and compares two groups of Iranian soccer and futsal players in terms of anthropometric features including age, weight, height, arm span, sitting height, WHR, and BMI. Table 2 compares the physiological features of the two groups including perceived exertion, blood

lactate level, VO<sub>2</sub> max, and maximum heart rate. The results show that there is no significant difference in the maximum heart rate between the two groups but the difference in perceived exertion, blood lactate level, and VO<sub>2</sub> max is significant (P<0.05).

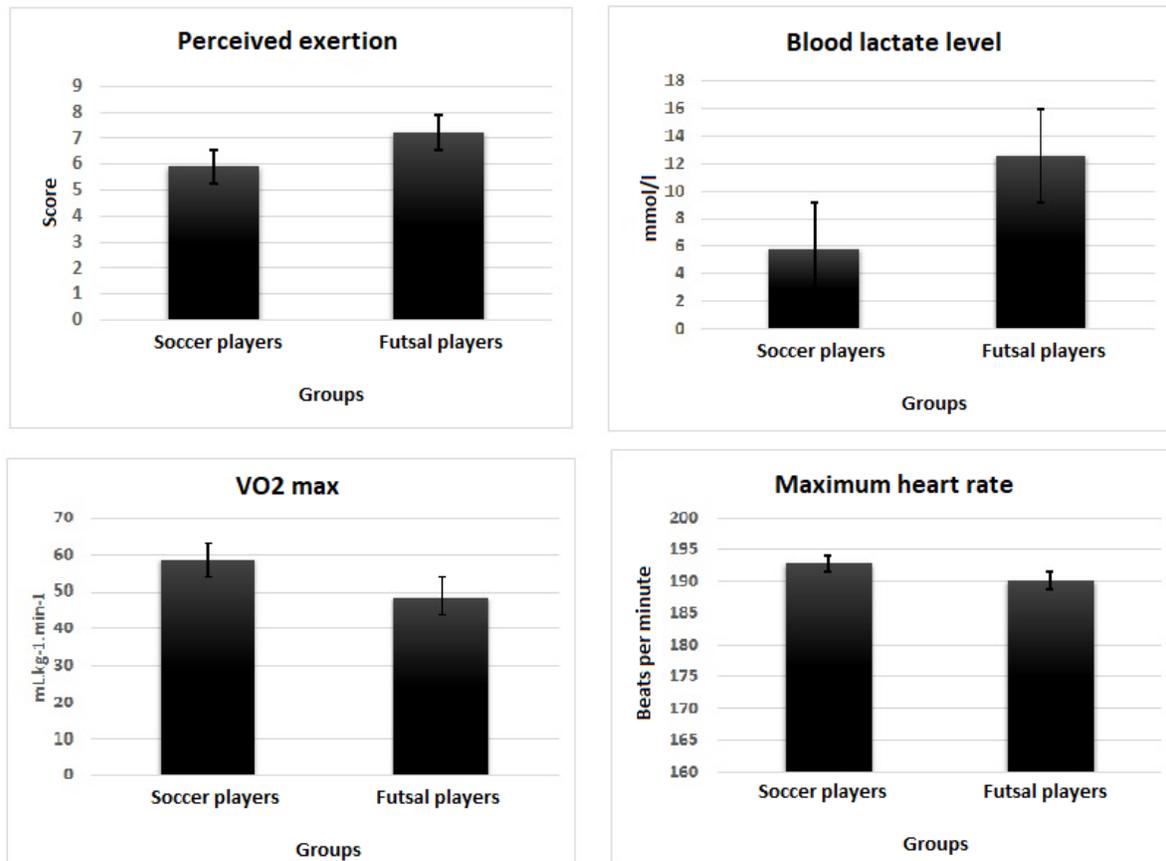


Diagram 1: Summary of the results of the physiological features

### Discussion and Conclusion

The present study seeks to compare the response of perceived exertion, blood lactate, VO<sub>2</sub> max and maximum heart rate during a match in elite soccer and futsal players. The results are indicative of differences between the two groups in some of the features. They suggest that there was no significant difference between soccer and futsal players in terms maximum heart rate, but there was a significant difference in perceived exertion, blood lactate level, and VO<sub>2</sub> max.

Soccer and futsal are exciting sports that involve a high degree of mobility and have succeeded in assuming a prominent status as two specialized sports. Given the nature of soccer and futsal (such as pitch size, playing environment, duration of match, systems of playing, skills, and conflicts), different factors play a role in these two sports. Thus, it follows that they require certain physiological and motor needs based on which exercise programs could be developed [31, 32].

Most sport scientists maintain that a high level of aerobic capacity is a prerequisite of high anaerobic performance in prolonged alternating activities [33]. As research findings show, in order to show a successful performance, elite players require high levels of physiological and motor features such as aerobic capacity, anaerobic capacity, speed, agility, and flexibility [34, 35]. In general, these features are crucial in the quality of an athlete's performance and winning a match [22]. Characteristic of soccer is the variety of activities and exercises involved in it such as 400-meter sprint which has a very high intensity and marathon running with a medium level of intensity [7]. More emphasis on developing aerobic capacity can positively influence the quality of retaining the ball. Increasing aerobic capacity can significantly increase the amount of work. When two teams with equal levels of skill are matched with each other, the team with higher capacity can play at a higher pace all throughout the match. Studies suggest that although aerobic capacity alone does not guarantee success in soccer, a minimum threshold of 60 ml per kilogram of body weight is necessary. When the aerobic capacity of players is less than this threshold, their performance is likely to fluctuate. Bangsbo (2002) showed that a high capacity in all the players of a team will result in more work and good technical and tactical performance during a match [13]. In a study of the physiological profiles of Gaelic soccer players, hurlers, and futsal players, McIntyre (2005) showed that soccer players had a significantly higher aerobic capacity than the other two groups [19]. Although aerobic metabolism is responsible for the energy systems of the body in soccer, there are various activities involved in soccer such as quick sprints, tackling, and quick returns and the energy of all these activities is produced by phosphagen and lactic acid energy systems [24].

In the present study, the  $VO_2$  max of soccer players was greater than that of futsal players. Aerobic capacity is the main source of energy in soccer and futsal and there is a strong relationship between the exercise type and the intensity or duration intervals of aerobic exercise. In addition, a general comparison between soccer and futsal players in terms of their level of activity and playing conditions was indicative of a significant difference in their aerobic capacity, which might be due to different skills and exercise conditions between the two groups [39]. Having a suitable level of aerobic capacity can facilitate the player's recovery in resting periods and coaches should not underestimate the role of aerobic capacity in athletic performance. Research shows that, although aerobic metabolism is the dominant energy system in soccer players [41], there are various activities in futsal such as quick sprints, rapid motions with or without balls, changing directions quickly, and tackling [7].

In the present study, the lactate level of futsal players was higher than that of soccer players. Studies show that short-time alternating activities like futsal have been used in longer alternating activities with high intensity to increase blood lactate level and enhancing the ability to uptake it as well as the processes involved in this path [42]. The perceived exertion of futsal players was

found to be higher than that of soccer players. Continuing high-intensity activity increases an individual's perceived exertion, which may hinder the performance of the activity and limit its duration. This will make it difficult to continue an activity with high intensity and limit the duration of the activity. The more the work-rest intervals extend and the duration of activity and rest increase, the higher the individual's perceived exertion. In long alternating activities, it is possible to decrease perceived exertion by reducing work-to-rest ratio (either decreasing work intervals or increasing rest intervals). Some studies have suggested that, by reducing the work interval more than the increase in the rest interval, the person's perceived exertion during an activity will decrease [44]. Increase in the perceived exertion during an intensive activity will limit its duration and increase the total time that the person can remain in high-intensity performance.

Lack of difference in the maximum heart rate of soccer and futsal players may be due to the longer duration of activity intervals and thus the longer duration of high-intensity activity ( $VO_2$  max) in a work interval in both sports.

Knowledge about the differences between elite soccer and futsal players can help both players and coaches to identify and reinforce the features required to reach high levels of performance. It can also help coaches in developing appropriate exercise plans. Therefore, selection of players in different sports including soccer and futsal is a process in which coaches are constantly involved. Development of criteria for identifying elite players will be of great use to coaches. Some of these criteria include skills, physiological and anthropometric features, and body composition. Since skills are more difficult to measure, physiological and anthropometric features as well as body composition are particularly important. Therefore, it is necessary for the coach to have a good knowledge of these features to select more talented soccer and futsal players. It is suggested that the identified factors and indicators be studied as a whole in future research. Of course, partial studies such as the present study can be useful for coaches and other individuals who are in charge of selecting players.

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