ORIGINAL ARTICLE

Physiological parameters of professional football players in teams of various levels

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Abstract

Background and Study Aim Soccer is a demanding sport which, in addition to technical and motor characteristics, also requires exceptional functional abilities of athletes to play at a high level. The aim of this study: 1) To analyze the disparities in physiological parameters among professional soccer players in teams of varying levels. 2) To explore potential connections between team ranking positions and the physiological attributes of professional soccer players.

Material and Methods 91 professional soccer players who compete in Serbian Super league (age 24.14±5.15) were included in the study. Participants were classified into two groups. The first group consisted of players from teams that were ranked from third to sixth place at the end of 2021/2022 competitive season (n=49). The second group of participants consisted of the players of the teams that were ranked in the last two places at the end of the above-mentioned season (n=42). Maximal oxygen consumption (VO_2max), as well as running speeds and heart rates at first and second ventilatory thresholds (VT1 and VT2) were obtained by performing maximal cardiopulmonary exercise test.

Results The results showed a statistically significant difference in terms of VO_2max values, running speeds and heart rates at VT1 and VT2 when the top and bottom ranked teams were compared ($p < 0.001$).

Conclusions The results of the study imply that playing high-level soccer requires exceptional functional abilities, which go beyond technical and tactical characteristics. These exceptional abilities enable players to continuously perform at high intensities during the games in order to achieve top results. Coaches should be aware of the importance of high aerobic capacity for achieving top results, especially if the team consists of less talented players.

Keywords: functional abilities, competitive rank, soccer, training thresholds

Glossary:

VO_2max – maximal oxygen consumption;
VT1 – first ventilatory threshold;
VT2 – second ventilatory threshold;
HR at VT1 – heart rate at first ventilatory threshold;
HR at VT2 – heart rate at second ventilatory threshold;
V at VT1 – running speed (km/h) at first ventilatory threshold;
V at VT2 – running speed (km/h) at second ventilatory threshold.

Introduction

Soccer is an intense and physically demanding sport that is characterized by cyclic and acyclic movements, and apart from the technical, tactical, and motor characteristics of athletes, this sport also requires high aerobic and anaerobic endurance [1]. Soccer is primarily an anaerobic sport due to high intensity sprint sections performed in solving technical and tactical tasks in attack and defense. On the other hand, aerobic capacity ensures continuity in the implementation of these high-intensity anaerobic sections, as well as fast recovery after them.

Aerobic capacity represents the organism's ability to create energy for physical work through aerobic processes [2, 3]. The measure of aerobic capacity is maximal oxygen consumption (VO_2max) which, according to most authors, is the best indicator of athletes` cardiorespiratory fitness [4, 5]. Expected VO_2max values for professional soccer players range from 55 to 70 mL/kg/min [6, 7]. High VO_2max values enable training at a higher intensity while using oxygen to generate energy, which means reaching the first and second ventilatory thresholds (VT1 and VT2) at higher heart rates and delaying anaerobic fatigue.

The ventilatory (or anaerobic) thresholds represent the moment of increase in lactate and lactate/pyruvate ratio in muscles and arterial blood and occurs at that level of physical activity above which, in addition to the generation of energy in aerobic conditions, the energy is also produced during anaerobic metabolic processes, such as anaerobic glycolysis [8]. In different literature and by different authors, these thresholds are also called "first and second lactate thresholds",

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"anaerobic thresholds" or „aerobic and anaerobic thresholds" [9]. For this study purposes we use terms first and second ventilatory thresholds since the ergospirometry was performed to obtain these parameters.

Certain research shows that achieved work intensity at VT1 and VT2, in terms of obtained heart rates at these thresholds, is a better indicator of cardiorespiratory fitness in soccer players than VO_2max value itself [4]. In other words, the higher the running speed and heart rate at VT1 and VT2, the better the aerobic efficiency and endurance of an athlete [10]. The intensity of effort at which VT1 and VT2 are obtained can be improved by specific training sessions even without raising the VO_2max values and this is, according to some authors, much more important for performance of soccer players [11, 12, 13].

Determination of ventilatory thresholds and VO_2max is performed with a cardiopulmonary exercise test (CPET) by monitoring direct gas exchange (oxygen and carbon dioxide) [14, 15]. The first threshold is defined as the first increase of lactate in the blood, followed by an immediate increase of ventilation needed to deliver oxygen (O_2) to the cells, and export carbon dioxide (CO_2) to the outside environment. The second threshold is called the respiratory compensation point because above this threshold the work is performed in 100% anaerobic conditions, and hyperventilation is the only compensatory mechanism by which the body tries to prevent ongoing metabolic acidosis [16].

Previous research shows that the first rise in blood lactate (reaching the first ventilatory threshold) in professional soccer players occurs at average treadmill running speeds of 12.3 km/h (VT1 = 2 mmol/L of blood lactate), while second pronounced rise in blood lactate (second ventilatory threshold) is reached at speeds higher than 15 km/h (VT2 = 4–6 mmol/L of blood lactate) [17]. Heart rates obtained during CPET at first and second ventilatory thresholds are extremely important for adequate dosage of training, which ensures the achievement of supercompensation and positive training effects [18].

Hypothesis. Hypothesis suggests that significant differences in physiological parameters, including oxygen consumption, heart rates, and running speeds, will be observable among professional soccer players based on the ranking positions of their respective teams.

The aim of the study: 1) To analyze the disparities in physiological parameters among professional soccer players in teams of varying levels. 2) To explore potential connections between team ranking positions and the physiological attributes of professional soccer players.

Material and Methods

Participants

For the purposes of this research, the sample of participants consisted of 91 senior professional soccer players from five different Serbian teams (age 24.14±5.15, height 181.84±6.11 cm, weight 75.69±6.62 kg). They were classified into two study groups. The first group was made up of players from 3 different soccer teams (n=49) which were ranked from third to sixth place at the end of competitive season. The participants from the second study group were players who played for two soccer teams which ended up in the last two places et the end of 2021/2022 Serbian Super league. The criteria for inclusion in the study were players age ⩾ 18 to ⩽ 35 years, training age ⩾ 6 years, without recent injury (> 12 months). Cardiopulmonary exercise testing was conducted at the beginning of the macrocycle, as a part of pre-participation medical screening, and before the start of the competitive season. Each participant voluntarily provided written informed consent before participating in the study and performing the CPET. The conducted research does not violate the rights of the examined players, according to the ethical standards of the Helsinki Declaration of the Committee on Human Rights (WMA Declaration of Helsinki, 2013). The Research Ethics Committee for human test subjects of Sports Cardiology Association of Serbia approved all study procedures.

Procedures

The sample of variables used in the research represent the parameters of morphological and functional abilities of soccer players. Determination of body height was done using a Seca altimeter (unit of measure is 1 cm). The Tanita® BC-418MA scale (bioimpedance method) was used to determine body weight (kg), BMI (kg/m^2), and FAT%. An electrocardiogram of the heart at rest was performed using a 12-channel ECG (Fukuda®). To implement CPET, a treadmill (HP-COSMOS®) was used, while VO_2max, as a measure of aerobic capacity, and heart rates and running speeds at VT1 and VT2, were determined by using the Quark CPET system (Cosmed®) while direct monitoring of gas exchange (O_2 and CO_2). A protocol for professional soccer players was used to perform the test, with an initial speed of 6 km/h and an elevation of 3°. The treadmill running speed was increased by 1 km/h every 40 seconds until the player had reached volitional exhaustion, as well as maximal heart rate is achieved (at least 90% of maximal heart rate in theory according to formula 220 – age), plateau in oxygen consumption is obtained and respiratory quotient is above 1.10. Heart rate was continuously monitored with a short-range telemetry HR monitor and 12-lead Stress ECG.

Determination of first and second ventilatory thresholds (VT1 and VT2) were obtained during CPET by using Wasserman 9-Panel Plot and Omnia software. The VT1 and VT2 are usually obtained by analyzing all Wasserman panels, with particular attention to VO_2 vs. VCO_2 (V-*slope* method), ventilatory equivalents for O_2 and CO_2 (VE/VO_2; VE/VCO_2), respiratory quotient ($RQ = CO_2/O_2$), and $PetO_2$ and $PetCO_2$ panels. The VT1 was determined according to different validated methods: modified V-*slope* method, ventilatory equivalent method (VE/VO_2 panel), and end tidal O_2 pressure method ($PetO_2$ panel). The VT2 was determined by using the ventilatory equivalent method (VE/VCO_2 panel), at the point where ventilation (VE) increases out of proportion to VCO_2 and RQ is ⩾ 1 and end tidal $PetCO_2$ method ($PetCO_2$ panel) [19].

Statistical analysis

To describe parameters of importance, depending on their nature, the following were used: frequency, percentages, sample mean value, sample median, sample standard deviation, rank and 95% confidence intervals. The Shapiro Wilk tests were used, to test the normality of the distribution, as well as the graphs: histogram and normal QQ plot. To test the differences in maximal oxygen consumption, running speed and heart rates at ventilatory thresholds between the study groups of soccer players the Independent simple T test with Levene's Test for Equality of Variances was used, as well as Mann Whitney U test. Statistical data processing was performed in the statistical package SPSS 20.0 for Windows. Differences were considered significant when the p value was less than 0.05.

Results

A comparative statistic of measured variables which represent functional abilities (cardiorespiratory fitness) of soccer players is shown in Table 1. In the field of functional abilities, a statistically significant difference ($p < 0.001$) was observed in terms of VO_2max values (Figure 1), and heart rates at VT1 and VT2, respectively (Figure 2 and Figure 3). Furthermore, a statistically significant

Table 1. A comparative statistic of functional abilities of soccer players from top and bottom ranked teams.

Variables	Top ranked teams	Bottom ranked teams	t value	p value
	$\bar{X}$ ±SD	$\bar{X}$ ±SD		
N° of participants	49	42		
VO_2max (mL/kg/min)	61.37±5.07	54.57±5.96	10.109	0.000
HR at VT1 (bpm)	157.49±11.21	150.52±12.06	3.469	0.001
HR at VT2 (bpm)	176.18±10.27	170.76±8.04	3.510	0.001
V at VT1 (km/h)	12.53±1.52	9.57±1.57	11.020	0.000
V at VT2 (km/h)	16.41±1.91	12.83±1.87	11.212	0.000

Abbreviations: VO_2max (maximal oxygen consumption); HR (heart rate); HR at VT1 (heart rate at first ventilatory threshold); HR at VT2 (heart rate at second ventilatory threshold); V (running speed).

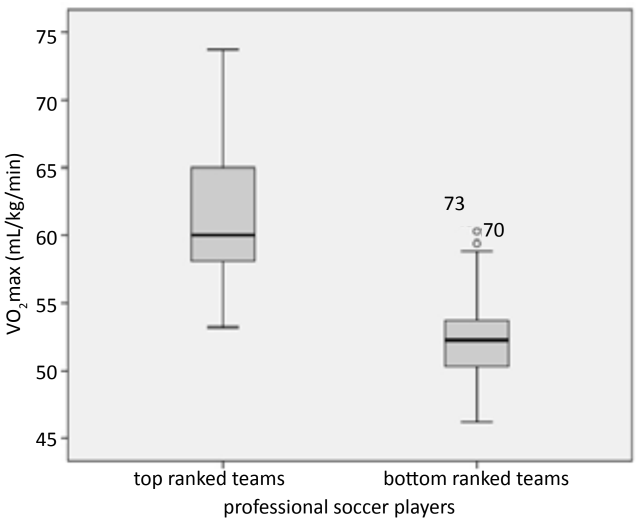

Figure 1. Distribution of VO_2max values within different ranked soccer teams at the end of the competitive season.

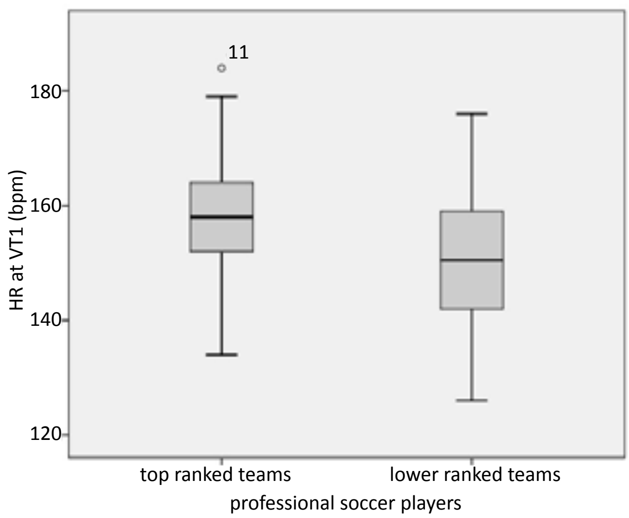

Figure 2. Distribution of HR values at VT1 within different ranked soccer teams at the end of the competitive season.

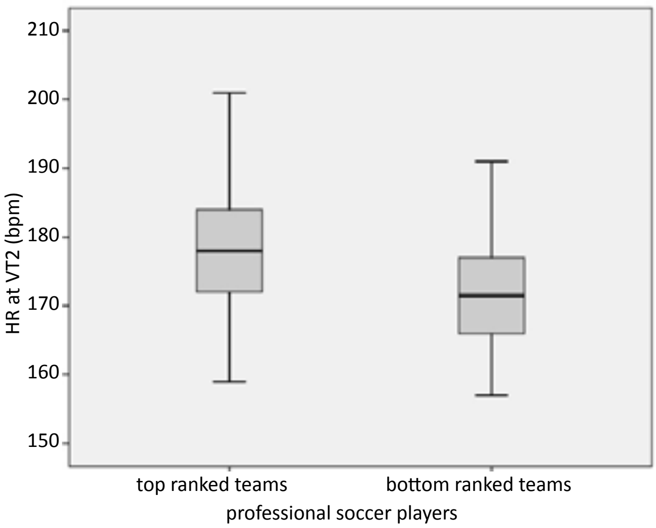

Figure 3. Distribution of HR values at VT2 within different ranked soccer teams at the end of competitive season.

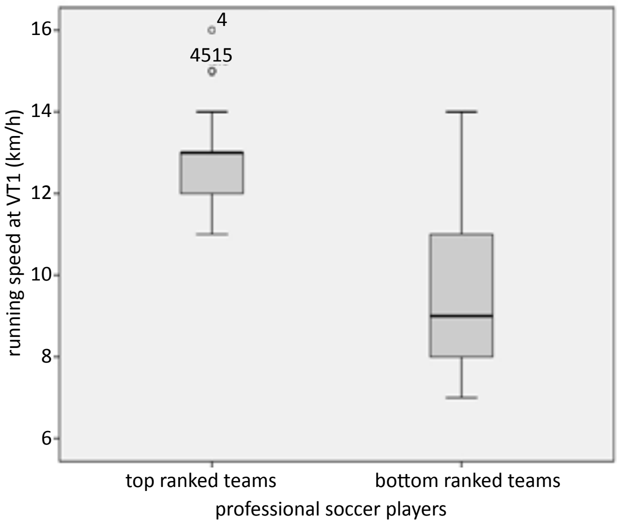

Figure 4. Distribution of running speed values at VT1 within different ranked soccer teams at the end of competitive season.

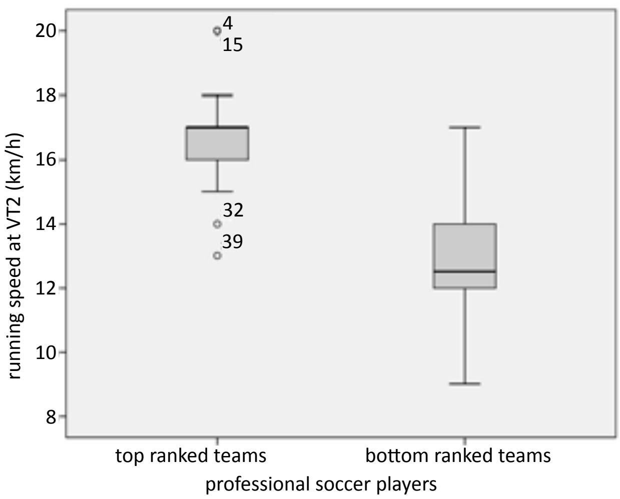

Figure 5. Distribution of running speed values at VT2 within different ranked soccer teams at the end of competitive season.

difference ($p < 0.001$) was also found in running speed at VT1 and VT2 (Figure 4 and Figure 5).

Discussion

Aerobic capacity

The results of our study showed that functional abilities (cardiorespiratory fitness) are very important for playing top level soccer, which agrees with previous research on this topic [1, 6, 9]. Primary findings of this research support the fact that players from the top ranked teams, during competitive season, had statistically better results in terms of all functional (cardiorespiratory) parameters compared to soccer athletes from bottom ranked teams. Although evaluated athletes played in the same level of competition, where the physical demands of the sport are equal, the difference in VO_2max values was obvious, which could explain the differences in ranking during and at the end of the competition. The study showed that players from top ranked teams had a statistically much better aerobic capacity (VO_2max 61.37 mL/kg/min vs. 54.37 mL/kg/min) than players from the bottom ranked teams. Soccer players from lower ranked teams had similar aerobic abilities as professional basketball players from the EuroLeague basketball competition [20], even though it is expected for soccer players to obtain much higher VO_2max values then senior basketball players. At the same time, the results of maximal oxygen consumption obtained by top ranked players were within the values for the sports discipline, described in earlier studies [21, 22, 23]. Furthermore, considering aerobic capacity, soccer players from Serbian top ranked teams achieved higher VO_2max values than professional soccer players from Croatia, Brazil and Greece [24, 25, 26]. Comparing the aerobic capacity of bottom ranked teams from our research, a lower oxygen consumption values are obtained compared to semi-professional soccer players of the 3rd and 4th League from Italy, which could also explain low ranking at the end of the season [27].

Running speed at ventilatory thresholds

In terms of running speed at ventilatory thresholds a statistically significant difference ($p < 0.001$) was obtained comparing soccer players from the top and bottom ranked teams. Soccer athletes from the top ranked teams were reaching the first and second ventilatory threshold at much higher running speeds, which means that they were using oxygen for energy production much longer during the effort and were postponing absolute anaerobic metabolic onset and fatigue. These results could be explained by the fact that top ranked teams are usually playing certain qualifying matches for different European competitions, and therefore they must be prepared to compete at a higher level of intensity in those matches. Compared to other studies, the Serbian soccer players from the top ranked teams were reaching ventilatory thresholds at higher running speeds [15, 26], but compared to elite football players from Croatia, the average running speeds at ventilatory thresholds were the same [24]. At the same time, soccer players from the lower ranked teams were achieving anaerobic fatigue much faster and at lower running speeds, and these results are weaker compared to the soccer players from other countries [28].

Heart rate response on ventilatory thresholds

Considering heart rate values at the first and second ventilatory thresholds a statistically significant difference was observed between the two study groups of players. Athletes who played for top ranked teams were reaching ventilatory thresholds at much higher heart rates. This means that they were able to perform physical activity in aerobic conditions at much higher effort intensity compared to players from low ranked teams. Oxygen, as a substrate for the creation of adenosine triphosphate, was used significantly longer and at a higher intensity during CPET, which is a good indicator of a great cardiorespiratory fitness [5, 6]. These results could explain better ranking position at the end of competition since high level of aerobic capacity and efficiency, with prolonged utilization of oxygen during matches makes it possible to perform anaerobic tasks in soccer during the entire 90 minutes of the game at the same intensity level [16].

The obtained results of the study showed that the achieved heart rate values at the second ventilatory threshold match the results obtained with Greek soccer players [15, 26]. At the same time, Serbian soccer players who played for top ranked teams were achieving second ventilatory threshold much earlier (at lower heart rates) compared to soccer players from Brazil and Croatia, which could generally explain the better results of these countries on the world soccer scene compared to Serbia [9, 29, 30].

The limits of this study are the tests performed only before the beginning of the competitive season, and it is not known how and with what intensity the players from both groups trained during the one-year competitive macrocycle. The implications for further research should address the importance of regular functional screening of soccer players (pre-season, after pre-season training camps, half-season, and at the end of the competitive season) to follow changes in functional capacity of athletes, which enables adequate training corrections with the aim of improving sports results.

Conclusion

The research rejected the H° hypothesis which stated that there would be no difference between the two study groups in terms of functional abilities. The results of the study confirmed the H^1 hypothesis and statistically significant difference in terms of VO_2max values and heart rates, as well as, running speeds achieved at first and second ventilatory thresholds. Professional soccer players who played for top ranked teams in Serbian Super league had better aerobic both capacity and economy. Furthermore, these players were able to postpone the onset of absolute anaerobic metabolic pathways for producing energy for work, which can explain better ranking at the end of competitive season, since they could utilize O_2 much longer and more efficient compared to players from bottom ranked teams. This means that VO_2max is not the only value important for sports success, but also the intensity of effort at which ventilatory thresholds are reached. Very often, a lack of talent, as well as technical and tactical elements of a sport can be compensated by adequately developed cardiorespiratory fitness. Considering this fact, the practical application of this research could lead to the implementation of specific training by soccer teams (especially bottom ranked ones) with the aim of increasing the VO_2max values and both heart rates and running speeds at which ventilatory thresholds are reached during the effort.

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Conflicts of Interest

The authors declare no conflict of interest.

References

1. Dolci F, Hart NH, Kilding AE, Chivers P, Piggott B, Spiteri T. Physical and Energetic Demand of Soccer: A Brief Review. *Strength & Conditioning Journal*, 2020;42(3): 70–77. https://doi.org/10.1519/SSC.0000000000000533
2. Hoppeler H, Howald H, Conley K, Lindstedt SL, Claassen H, Vock P, et al. Endurance training in humans: aerobic capacity and structure of skeletal muscle. *Journal of Applied Physiology*, 1985;59(2): 320–327. https://doi.org/10.1152/jappl.1985.59.2.320
3. Vaitkevicius PV, Fleg JL, Engel JH, O'Connor FC, Wright JG, Lakatta LE, et al. Effects of age and aerobic capacity on arterial stiffness in healthy adults. *Circulation*, 1993;88(4): 1456–1462. https://doi.org/10.1161/01.CIR.88.4.1456
4. Ranković G, Mutavdžić V, Toskić D, Preljević A, Kocić M, Nedin-Ranković G, et al. Aerobic Capacity as An Indicator in Different Kinds of Sports. *Bosnian Journal of Basic Medical Sciences*, 2010;10(1): 44–48. https://doi.org/10.17305/bjbms.2010.2734
5. Rusko H, Havu M, Karvinen E. Aerobic performance capacity in athletes. *European Journal of Applied Physiology and Occupational Physiology*, 1978;38(2): 151–159. https://doi.org/10.1007/BF00421531
6. Helgerud J, Engen LC, Wisl??Ff U, Hoff J. Aerobic endurance training improves soccer performance: *Medicine and Science in Sports and Exercise*, 2001;33(11): 1925–1931. https://doi.org/10.1097/00005768-200111000-00019
7. Wisl??Ff U, Helgerud J, Hoff J. Strength and endurance of elite soccer players: *Medicine &amp Science in Sports &amp Exercise*, 1998;30(3): 462–467. https://doi.org/10.1097/00005768-199803000-00019
8. Binder RK, Wonisch M, Corra U, Cohen-Solal A, Vanhees L, Saner H, et al. Methodological approach to the first and second lactate threshold in incremental cardiopulmonary exercise testing. *European Journal of Cardiovascular Prevention & Rehabilitation*, 2008;15(6): 726–734. https://doi.org/10.1097/HJR.0b013e328304fed4
9. Modric T, Versic S, Sekulic D. Does aerobic performance define match running performance among professional soccer players? A position-specific analysis. *Research in Sports Medicine*, 2021;29(4): 336–348. https://doi.org/10.1080/15438627.2021.1888107
10. Zignoli A, Fornasiero A, Stella F, Pellegrini B, Schena F, Biral F, et al. Expert-level classification of ventilatory thresholds from cardiopulmonary exercising test data with recurrent neural networks. *European Journal of Sport Science*, 2019;19(9): 1221–1229. https://doi.org/10.1080/17461391.2019.1587523
11. Michaelides MA, Parpa KM, Zacharia AI. Effects of an 8-Week Pre-seasonal Training on the Aerobic Fitness of Professional Soccer Players. *Journal of Strength and Conditioning Research*, 2019. https://doi.org/10.1519/JSC.0000000000003209
12. University of Central Lancashire - Cyprus Campus, University Avenue 12-14, 7080 Pyla, Cyprus, Parpa K, Michaelides M, University of Central Lancashire - Cyprus Campus, University Avenue 12-14, 7080 Pyla, Cyprus. Comparison of Ventilatory and Blood Lactate Thresholds in Elite Soccer Players. *Sport Mont*, 2022;20(3): 3–7. https://doi.org/10.26773/smj.221001
13. Zych M, Stec K, Pilis A, Pilis W, Michalski C, Pilis K, et al. Approaches to describe ventilatory threshold in professional sports. *Physical Activity Review*, 2017;5: 113–123. https://doi.org/10.16926/par.2017.05.16
14. Buchheit M, Simpson BM, Lacome M. Monitoring Cardiorespiratory Fitness in Professional Soccer Players: Is It Worth the Prick? *International Journal of Sports Physiology and Performance*, 2020;15(10): 1437–1441.https://doi.org/10.1123/ijspp.2019-0911
15. Stergiopoulos DC, Kounalakis SN, Miliotis PG, Geladas ND. Second Ventilatory Threshold Assessed by Heart Rate Variability in aMultiple Shuttle Run Test. *International Journal of Sports Medicine*, 2021;42(01): 48–55. https://doi.org/10.1055/a-1214-6309
16. Anselmi F, Cavigli L, Pagliaro A, Valente S, Valentini F, Cameli M, et al. The importance of ventilatory thresholds to define aerobic exercise intensity in cardiac patients and healthy subjects. *Scandinavian Journal of Medicine & Science in Sports*, 2021;31(9): 1796–1808. https://doi.org/10.1111/sms.14007
17. Schwesig R, Schulze S, Reinhardt L, Laudner KG, Delank KS, Hermassi S. Differences in Player Position Running Velocity at Lactate Thresholds Among Male Professional German Soccer Players. *Frontiers in Physiology*, 2019;10: 886. https://doi.org/10.3389/fphys.2019.00886
18. Cottin F, Médigue C, Lopes P, Leprêtre PM, Heubert R, Billat V. Ventilatory Thresholds Assessment from Heart Rate Variability during an Incremental Exhaustive Running Test. *International Journal of Sports Medicine*, 2007;28(4): 287–294. https://doi.org/10.1055/s-2006-924355
19. Neder JA, Stein R. A Simplified Strategy for the Estimation of the Exercise Ventilatory Thresholds. *Medicine & Science in Sports & Exercise*, 2006;38(5): 1007–1013. https://doi.org/10.1249/01.mss.0000218141.90442.6c
20. Stojmenović D, Trunić N, Stojmenović T. A comparative study of aerobic capacity among elite basketball players according to five different positions in the team. *Journal of Physical Education & Sport,* 2022; 22(10):2522 – 2529. https://doi.org/10.7752/jpes.2022.10320
21. Evangelos B, Lefteris M, Aristotelis G, Ioannis G, Natalia K. Aerobic and anaerobic capacity of professional soccer players in annual macrocycle. *Journal of Physical Education and Sport*, 2016; 16(2), 527-533. https://doi.org/10.7752/jpes.2016.02083
22. Slimani M, Nikolaidis PT. Anthropometric and physiological characteristics of male soccer players according to their competitive level, playing position and age group: a systematic review. *J Sports*

Med Phys Fitness. 2017; 59(1): 141-163. https://doi.org/10.23736/S0022-4707.17.07950-6
23. Ingebrigtsen J, Bendiksen M, Randers MB, Castagna C, Krustrup P, Holtermann A. Yo-Yo IR2 testing of elite and sub-elite soccer players: Performance, heart rate response and correlations to other interval tests. *Journal of Sports Sciences*, 2012;30(13): 1337–1345. https://doi.org/10.1080/02640414.2012.711484
24. Modric T, Versic S, Sekulic D. Aerobic fitness and game performance indicators in professional football players; playing position specifics and associations. *Heliyon*, 2020;6(11): e05427. https://doi.org/10.1016/j.heliyon.2020.e05427
25. Silva ASR, Santhiago V, Papoti M, Gobatto CA. Hematological parameters and anaerobic threshold in Brazilian soccer players throughout a training program. *International Journal of Laboratory Hematology*, 2008;30(2): 158–166. https://doi.org/10.1111/j.1751-553X.2007.00919.x
26. Metaxas TI. Match Running Performance of Elite Soccer Players: Vo 2max and Players Position Influences. *Journal of Strength and Conditioning Research*, 2021;35(1): 162–168. https://doi.org/10.1519/JSC.0000000000002646
27. Riboli A, Coratella G, Rampichini S, Limonta E, Esposito F. Testing protocol affects the velocity at VO_{2max} in semi-professional soccer players. *Research in Sports Medicine*, 2022;30(2): 182–192. https://doi.org/10.1080/15438627.2021.1878460
28. Santos-Silva PR, Pedrinelli A, Greve JMD. Blood lactate and oxygen consumption in soccer players: comparison between different positions on the field. *Medical Express*, 2017;4(1). https://doi.org/10.5935/MedicalExpress.2017.01.02
29. Ribeiro GS, Pereira UR, Lopes AL. Can Heart Rate Variability Predict the Second Metabolic Threshold in Young Soccer Players? *International Journal of Exercise Science,* 2018;11(2):1105-1111.
30. Marcos MA, Koulla PM, Anthos ZI. Preseason Maximal Aerobic Power in Professional Soccer Players Among Different Divisions. *Journal of Strength and Conditioning Research*, 2018;32(2): 356–363. https://doi.org/10.1519/JSC.0000000000001810

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