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SEASONAL CHANGES IN THE AEROBIC PERFORMANCE OF YOUNG SOCCER PLAYERS¹

CAMBIO ESTACIONAL EN EL RENDIMIENTO AERÓBICO DE JUGADORES DE FÚTBOL JÓVENES

ALTERAÇÃO DA TEMPORADA NO DESEMPENHO AERÓBICO DE JOGADORES JUVENIS DE FUTEBOL

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ABSTRACT

Diker, G., Zileli, R., Özkamçı, H & Ön, S. (2021). Seasonal changes in the aerobic performance of young soccer players. **PENSAR EN MOVIMIENTO: Revista de Ciencias del Ejercicio y la Salud**, **19**(1), 1-16. Longitudinal studies evaluating seasonal changes in the aerobic capacity of young soccer players of different age categories are limited. The aim of this study was to investigate the seasonal changes in the aerobic level of young professional soccer players. This research study included 51 soccer players in the U14, U15, U16, U17, and U18 categories of an elite soccer team. Aerobic capacity in athletes was measured using the Yo-Yo_{IRT 1} Test. In the analyses, normal distribution of data was assessed with the Shapiro-Wilk test, and homogeneity of variance was tested with the Levene's Test. A one-way ANOVA test was used to analyze parametric data. All statistical evaluations were conducted with the help of the SPSS 21 software package. According to the Yo-Yo_{IRT 1} test, increases or decreases were determined in the pre-season, mid-season, and end-of-season evaluations. As a result, in the present study conducted to examine the seasonal changes of the young elite soccer players in the U14, U15, U16, U17, and U18 categories, Yo-Yo_{IRT 1} values in all categories increased significantly at the end of the season when compared to the pre-season and the mid-season. U14 and U16 age groups gained increasing acceleration since the pre-season. However, in U15, U17, and U18 age groups, acceleration decreased in the middle of the season and increased at the end of the season. Differences may be observed in the responses to the training loads during maturation. It can be suggested that the increase at the end of the season compared to the pre-season in all groups may be due to the athletes' adaptation to training programs is affected by the developmental characteristics regarding age categories over time.

Keywords: aerobic capacity, yo-yo_{IRT1}, soccer

RESUMEN

Diker, G., Zileli, R., Özkamçı, H y Ön, S. (2021). Cambio estacional en el rendimiento aeróbico de jugadores de fútbol jóvenes. **PENSAR EN MOVIMIENTO: Revista de Ciencias del Ejercicio y la Salud**, **19**(1), 1-16. Los estudios longitudinales que evalúan el cambio estacional en la capacidad aeróbica de los jugadores de fútbol jóvenes de diferentes categorías de edad son limitados. El objetivo de este estudio fue investigar los cambios estacionales del nivel aeróbico de los jugadores de la academia juvenil de un equipo de fútbol profesional. Esta investigación se realizó con un total de 51 futbolistas de las categorías U14, U15, U16, U17 y U18 de un equipo de fútbol de élite. Las capacidades aeróbicas de los atletas se midieron mediante la prueba Yo-Yo_{IRT 1}. En los análisis, las evaluaciones de distribución normal de los datos se realizaron con la prueba de Shapiro-Wilk y las homogeneidades de varianza se probaron con la prueba de Levene. Se utilizó la prueba ANOVA de una vía para analizar todos los datos paramétricos; todas las evaluaciones estadísticas se realizaron con la ayuda del programa SPSS 21. De acuerdo con la prueba Yo-

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Yo_{IRT 1}, se determinaron aumentos y/o disminuciones en las evaluaciones de pretemporada, mitad de temporada y final de temporada. Como resultado, los sujetos de todas las categorías aumentaron significativamente al final de la temporada en comparación con la pretemporada y la temporada media. Los grupos de edad U14 y U16 lograron una aceleración creciente a partir de la pretemporada. Sin embargo, en los grupos de edad U15, U17, U18, la aceleración disminuye en la mitad de la temporada y aumenta al final de la temporada. Se cree que se pueden observar diferencias en las respuestas a las cargas de entrenamiento durante el crecimiento y la maduración. Se puede sugerir que el incremento al final de la temporada respecto a la pretemporada, en todos los grupos, puede deberse a que la adaptación de los deportistas a los programas de entrenamiento se ve afectada por las características del desarrollo en cuanto a las categorías de edad a lo largo del tiempo.

Palabras clave: capacidad aeróbica, yo-yo_{IRT 1}, fútbol.

RESUMO

Diker, G., Zileli, R., Özkamçı, H e Ön, S. (2021). Alteração da temporada no desempenho aeróbico de jogadores juvenis de futebol. **PENSAR EN MOVIMIENTO: Revista de Ciencias del Ejercicio y la Salud**, 19(1), 1-16. Os estudos longitudinais que avaliam a alteração da temporada na capacidade aeróbica dos jogadores juvenis de futebol de diferentes categorias de idade são limitados. Este estudo teve como objetivo pesquisar as alterações da temporada no desempenho aeróbico dos jogadores da academia juvenil de uma equipe de futebol profissional. Esta pesquisa foi realizada com um total de 51 jogadores de futebol das categorias U14, U15, U16, U17 e U18 de uma equipe de futebol de elite. As capacidades aeróbicas dos atletas foram medidas por meio do teste Yo-Yo_{IRT1}. Nas análises, as avaliações de distribuição normal dos dados foram realizadas com o teste de Shapiro-Wilk e as homogeneidades de variância foram aprovadas com o teste de Levene. Foi utilizado o teste ANOVA de uma via para analisar todos os dados paramétricos; todas as avaliações estatísticas foram realizadas com a ajuda do programa SPSS 21. De acordo com o teste Yo-Yo_{IRT1}, foram determinados aumentos e/ou reduções nas avaliações de pré-temporada, meio de temporada e final de temporada. Como resultado, os sujeitos de todas as categorias aumentaram significativamente no final da temporada em comparação com a pré-temporada e meados da temporada. Os grupos de idade U14 e U16 conseguiram uma aceleração crescente a partir da pré-temporada. Porém, nos grupos de idade U15, U17, U18, a aceleração diminui no meio da temporada e aumenta no final da temporada. Acredita-se que possam ser observadas diferenças nas respostas às cargas de treinamento durante o crescimento e a maturação. É possível sugerir que o aumento no final da temporada em relação à pré-temporada, em todos os grupos, deve-se ao fato de que a adaptação dos esportistas aos programas de treinamento se vê afetada pelas características do desenvolvimento no que diz respeito às categorias de idade ao longo do tempo.



Palavras-chave: capacidade aeróbica, yo-yo_{IRT1}, futebol.

Considering the duration of the soccer game, aerobic metabolism is dominant. This reveals that the aerobic endurance feature is an important condition for success in soccer. However, it is not possible to talk about aerobic metabolism as the key to success in soccer. Due to the multifactorial nature of soccer, besides the development of aerobic methods for success, many features such as anaerobic structures, technical and tactical dimensions, psychological state, among others, must be at a high level. The association of recovery between high-intensity activities in the game with aerobic metabolism makes the aerobic endurance feature more important (Vanttinen, Blomqvist, Nyman, & Hakkinen, [2011](#); Hammami et al., [2013](#); Sagelv et al., [2019](#)).

Physical characteristics of soccer players are known to improve with biological age and training age. It was emphasized that the soccer game is a sport that requires the fitness levels of soccer players to be constant at a high level, but the foundations of physical performance should be formed during their youth (Dragijsky, Maly, Zahalka, Kunzmann, & Hank, [2017](#)). In terms of talent development, soccer players between 15 and 18 years old are in a critical development period (Sæther & Aspvik, [2014](#)). It is known that the increases in aerobic performance with the training performed has positive improvements in combating the stress faced by soccer players during the match (Helgerud, Engen, Wisløff, & Hoff [2001](#); Impellizzeri et al., [2006](#)). The capacity of soccer players to gain and maintain good physiological performance throughout the season is very important (Reilly & Williams, [2003](#)). It is important to determine what effects this may have on pre-season and seasonal change levels (Caldwell & Peters, [2009](#)).

Yo-Yo_{IRT1} is a valid field test widely used in soccer. The widespread use of Yo-Yo_{IRT1} is due to its simplicity, low cost, and the ability to test several players at the same time. (Fanchini et al., [2014](#)). Yo-Yo_{IRT1} gives results similar to laboratory tests in the evaluation of VO_{2max} (Sylejmani et al., [2019](#)). Studies have shown that it is associated with the high-intensity activities during a match and it informs about competition levels throughout the season (Bangsbo, laia, & Krustu, [2008](#); Mohr & Krustu, [2014](#)). Yo-Yo_{IRT1} has significant correlations with the total distance ($r = 0.62$) and the high-intensity distance ($r = 0.73$) of sports athletes in the underage teams (Roe & Malone, [2016](#)).

Although there are studies investigating the seasonal changes of soccer players, there is no study investigating the aerobic levels of the players of different age groups of a professional soccer team with the same soccer culture. Knowing the changes in aerobic capacity of youth academy players in pre-season, mid-season and end-of-season will provide important information for optimal performance and enable critical periods to be determined. This study predicts that aerobic capacity increase as the soccer players' ages increase. Within the frame of this hypothesis, we assumed that there would be differences in seasonal variation depending on the age of the teams in different categories. If looked from, it is anticipated that this research would contribute significantly to the identification of critical stages in the development of soccer players trained in youth academies. In addition, being aware of the weaknesses of the players during their youth



and training for them are considered to be important in reaching the optimal performance level by eliminating these weaknesses until adulthood. Based on the above information, the purpose of this study is to investigate the seasonal changes in the aerobic levels of the youth academy players in the U14, U15, U16, U17, and U18 categories of a professional team.



MATERIAL AND METHODS

Participants

This research study was carried out with the participation of 51 soccer players in the categories of U14, U15, U16, U17, and U18 of a professional soccer team (for U14 n: 12, the average age is 13.06 ± 0.32 years, height is 167.08 ± 7.66 cm, body weight is 54.40 ± 7.35 kg; for U15 n: 9, the average age is 14.50 ± 0.30 years, height is 174.66 ± 6.42 cm, body weight is 65.55 ± 5.81 kg; for U16 n: 12, the average age is 15.60 ± 0.34 years, height is 174.83 ± 6.32 cm, body weight is 66.08 ± 7.08 kg; for U17 n: 8, the average age is 16.30 ± 0.57 years, height is 175.25 ± 0.08 cm, body weight is 68.30 ± 4.86 kg; for U18 n: 10, the average age is 17.50 ± 0.55 years, height is 176.50 ± 5.12 cm, body weight is 69.30 ± 4.83 kg) (Table 1). Ethics committee report was received from Bilecik Şeyh Edebali University Ethics Committee before the study started (2019/3/5). After all the volunteers were verbally informed prior to the study, the written informed consent was obtained from their parents.

Measures

The heights of the athletes participating in the test were measured with a Holtain brand (England) stadiometer with an accuracy of ± 1 mm. Body weights of the volunteers participating in the test were measured with a TANITA MC780 (JAPAN) scale, which measures with an accuracy of ± 0.1 kg. Test Signals were implemented with the help of PRO SPORT TMR ESC 1000 TEST TIMER developed by Tümer Prosport Limited Company, and speed signals were given according to the speeds set from the tempo timer.

Anthropometric Measurements

The heights of the subjects were measured in an anatomical posture, bare feet, toe heels united, and while the subject was holding the breath. The head was measured in the frontal plane after the overhead table was positioned at the vertex point, and the values were recorded in centimeters. Body weights were taken in kg when the subjects were in bare feet and an anatomical posture, with only shorts on.

Aerobic Fitness

Maximal aerobic capacities of the soccer players were measured in meters with Yo-Yo_{IRT1}. This is a test in which speed increases regularly. The test consists of a track with 20 meters of shuttle runs; there is a 5+5-meter recovery section where athletes actively rest at the end of each round. If the athlete fails to reach the finish line twice in time, the test is considered to be completed and the distance covered by the athlete is evaluated as the Yo-Yo_{IRT1} performance. At the first level of this test, there are a total of 4 shuttle runs and the speed is 10-13 km/h; At the second level, there are 7 shuttle runs and speeds are 13.5-14 km/h; and the next levels consist of 8 shuttle runs and a 0.5 km/h speed increase, which continued until the athlete was exhausted or two successive mistakes were made. Besides, the following formula was used in order to calculate VO_{2max} :

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Yo-Yo_{IRT 1}VO_{2max} (ml·kg⁻¹·min⁻¹):

Running Distance x 0.0084+36.4 (Bangsbo et al., [2008](#)).

Design and Procedures

All tests were conducted at the end of the first preparation period (pre), at the end of the first competition period (mid), and at the end of the second competition period (end) at the same time of the day. Warm-up was performed for 10 minutes before all tests. During the tests, verbal suggestions were made so that the athletes could reach their maximum effort levels.

Statistical Analysis

After the descriptive statistics of the volunteers were calculated, the data was tested using the Shapiro-Wilk test to determine whether it showed a normal distribution and the variance homogeneities were evaluated with the Levene test separately for each category. As the data were all parametric, the analysis was carried out using One Way ANOVA test. Then, a post hoc test-Bonferroni- was used. Cohen's d effect sizes were also calculated and the outputs were described as follows: <0.20 (trivial), 0.20–0.59 (small), 0.6–1.19 (moderate), 1.2–1.99 (large); ≥2.0 (very large) (Hopkins, Marshall, Batterham, & Hanin, [2009](#)). Furthermore, the development ratio (%) was calculated. Statistical data was tested using the SPSS 21 Package program. The significance level was set at p<0.05.

RESULTS

Table 1

Physical Properties of the Participants Playing in U14, U15, U16, U17 and U18 Categories

	U14	U15	U16	U17	U18
	$\bar{x} \pm SD$	$\bar{x} \pm SD$	$\bar{x} \pm SD$	$\bar{x} \pm SD$	$\bar{x} \pm SD$
Age (years)	13.06±0.32	14.50±0.30	15.60±0.34	16.30±0.57	17.50±0.55
Height (cm)	167.08±7.66	174.66±6.42	174.83±6.32	175.25±0.08	176.50±5.12
Body Weight (kg)	54.40±7.35	65.55±5.81	66.08±7.08	68.30±4.86	69.30±4.83

Note. \bar{x} : mean SD: standard deviation. Source: the authors



Table 2

Yo-Yo_{IRT 1(m)} Values and Development Rates of the Participants Pre-season, Mid-season and End-of-season

	Pre $\bar{x} \pm SD$ (m)	Mid $\bar{x} \pm SD$ (m)	End $\bar{x} \pm SD$ (m)	f	p	pre-mid (%)/Cohen d/p	mid-end (%)/Cohen d/p	pre-end (%)/Cohen d/p
U14	1473.33±184.36	1583.33±326.06	1800.00±293.57	4.39	.001*	7.47/0.41/0.238	13.68/0.69/0.002*	22.17/1.33/0.002*
U15	1520.00±311.13	1315.55±395.19	1968.88±300.52	537.39	.001*	- 13.45/0.57/0.256	49.66/1.86/0.024*	29.53/1.46/0.042*
U16	1626.67±404.10	1870.00±272.43	2360.00±276.08	773.82	.001*	14.95/0.71/0.189	26.20/1.79/0.001*	47.54/2.12/0.001*
U17	2255.00±178.80	2102.50±242.24	2660.00±249.34	2873.99	.001*	- 6.76/0.72/0.688	26.52/2.27/0.015*	17.96/1.87/0.005*
U18	2024.00±282.34	1904.00±444.30	2272.00±330.28	459.66	.001*	- 5.93/0.32/0.878	19.33/0.94/0.045*	12.25/0.81/0.0028*

Note. \bar{x} : arithmetic mean, SD: standard deviation, pre: pre-season measurement (meter), mid: mid-season measurement (meter), end: end-season measurement (meter), % development rate (%), effect size: Cohen d, * $p < 0.05$. Source: the authors



Yo-Yo_{IRT1} results of all groups at different times are given in [Table 2](#). Yo-Yo_{IRT1} development percentage in the U14 age category increased by 7.47% in the mid-season compared to the beginning of the season, by 13.68% at the end of the season compared to the middle of the season, and by 22.17% at the end of the season compared to the beginning of the season. In the U15 age category, it decreased by 13.47% in the mid-season compared to the beginning of the season, increased by 49.66% at the end of the season compared to the mid-season and increased by 29.53% at the end of the season compared to the beginning of the season. In the U16 age category, it increased by 14.95% in the mid-season compared to the beginning of the season, increased by 26.20% at the end of the season compared to the mid-season and increased by 47.54% at the end of the season compared to the beginning of the season. In the U17 age category, it decreased by 6.76% in the mid-season compared to the beginning of the season, increased by 26.52% at the end of the season compared to the mid-season, and increased by 17.96% at the end of the season compared to the beginning of the season. In the U18 age category, it was observed to decrease by 5.93% in the mid-season compared to the beginning of the season, increase by 19.33% at the end of the season compared to the mid-season, and increase by 12.25% at the end of the season compared to the beginning of the season.



Table 3

Estimated VO_{2max} Values of the Participants Pre-season, Mid-season and End-of-season

	Pre $\bar{x} \pm SD$ (ml*kg ⁻¹ *min ⁻¹)	Mid $\bar{x} \pm SD$ (ml*kg ⁻¹ *min ⁻¹)	End $\bar{x} \pm SD$ (ml*kg ⁻¹ *min ⁻¹)	f	p	pre-mid p	mid-end p	pre-end p
U14	48.77±1.55	49.71±2.74	51.52±2.45	6659.491	.001*	0.387	0.001*	0.001*
U15	49.15±2.61	47.43±3.31	52.93±2.54	7478.072	.001*	0.261	0.024*	0.042*
U16	50.07±3.39	52.13±2.30	56.21±2.31	8114.228	.001*	0.192	0.001*	0.001*
U17	55.34±1.52	54.07±2.04	58.74±2.09	23534.002	.001*	0.711	0.008*	0.016*
U18	53.43±2.38	52.39±3.73	55.49±2.77	4392.713	.001*	0.828	0.044*	0.029*

Note. \bar{x} : arithmetic mean, SD: standard deviation, pre: pre-season measurement (ml*kg⁻¹*min⁻¹), mid: mid-season measurement (ml*kg⁻¹*min⁻¹), end: end-season measurement (ml*kg⁻¹*min⁻¹). * p<0.05. Source: the authors



VO_{2max} results of all groups at different times are given in [Table 3](#). Change in VO_{2max} in all age categories for mid-seasons, the beginning of the season and the end of the season was observed.

In the U14 age category, maximum oxygen uptake increased from $48.77 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ at the beginning of the season to $49.71 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ in mid-season and to $51.52 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ at the end of the season. In the U15 age category, it decreased from $49.15 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ at the beginning of the season to $47.43 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ in mid-season, but it increased to $52.93 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ at the end of the season. In the U16 age category, there was an increase from $50.07 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ at the beginning of the season to $52.13 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ in mid-season, and then up to $56.21 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ at the end of the season. In the U17 age category, estimated maximum oxygen uptake decreased from $55.34 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ at the beginning of the season to $54.07 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ in mid-season, but then increased to $58.74 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ at the end of the season. In the U18 age category, it decreased from $53.43 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ at the beginning of the season to $52.39 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ in mid-season, but increased to $55.49 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ at the end of the season.

DISCUSSION

The purpose of this study was to investigate the seasonal changes in the aerobic levels of the youth academy players of a professional soccer team in the U14, U15, U16, U17, and U18 categories.

The aerobic system and the anaerobic system are considered to be very important in soccer game. However, during a 90-minute soccer match, the main source of Adenosine Triphosphate (ATP) production is regarded as the aerobic system. The maximum aerobic power determined by the maximum oxygen intake can vary depending on the league and the positions in which the soccer players participate (Vanttinen et al., [2011](#); Teplan et al., [2012](#)).

In the present study, aerobic development increased statistically significantly at the end of the season compared to the mid-season and similarly at the end of the season compared to the beginning of the season in all age categories ($p < 0.05$). At the end of the season, the highest development was in the U16 category (47.54%), followed by the U15 (29.53%), U14 (22.17%), U17 (17.96%) and U18 (12.25%) categories. In U15, U17, and U18 categories, a decreasing percentage was observed in mid-season compared to the beginning of the season, but these rates were not statistically significant ($p < 0.05$). All teams reached their highest running distance at the end of the season. While the percentage of development at the end of the season is higher in U16 and the younger age groups, the running distance is higher in U16 and older age groups ([Table 2](#)). Besides, VO_{2max} increased at the end of the season compared to the beginning of the season in all age categories (U14 from $48.77 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ to $51.52 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$, U15 from $49.15 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ to $52.93 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$, U16 from $50.07 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ to $56.21 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$, U17 from $55.34 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ to $58.74 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$, U18 from $53.43 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ to $55.49 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$) ([Table 3](#)). Standard deviation in $Yo-Yo_{IRT1}$ and VO_{2max} parameters of athletes differ in terms of the data obtained at the beginning, in the middle and at the end of the season. This change shows that all of the athletes were affected disparately from the training.



The increase in aerobic capacity is expected to be the usual effect of pre-season training (Jastrzębski, Dargiewicz, et al., [2011](#)). Nevertheless, there are studies revealing that VO_{2max} increases at the end of the preparation period (McMillan et al., [2005](#); Jastrzębski, Barnat, Konieczna, Rompa, & Radzimiński, et al., [2011](#); Charalampos, Zisis, Asterios & Nikolaos, [2013](#)). Other studies asserting that VO_{2max} decreases at the end of the competition period (Mohr, Krstrup, & Bangsbo et al., [2002](#); Mohr, Krstrup, & Bangsbo, [2003](#), Dragijsky et al., [2017](#)). Besides, evidence shows that VO_{2max} increases during the entire competition period (Edwards, Clark, & Macfadyen, [2003](#)). When the literature is reviewed, it is possible to come across some contradictory findings.

Dragijsky et al. ([2017](#)) reported that in their study carried out with the participation of 28 players from the U13 category of a professional team in the Czech League, the average Yo-Yo_{IRT 1} values of the players gradually increased at a statistically significant level compared to the beginning of the season and decreased at the end of the competition period (t1-beginning of the pre-season training period 625.26m; t2-start of the competitive period 858.95m; t3-middle of the competitive period 953.68m; t4-end of the competitive period 924.21m).

Multi-stage Fitness Test and Yo-Yo_{IRT 1} Test can be interchangeably used to predict VO_{2max} (Thomas, Dawson, & Goodman, [2006](#)). Caldwell & Peters also found the VO_{2max} value ($56 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$) at the beginning of the season lower than other periods of the season using the Multi-stage Fitness Test (Caldwell & Peters, [2009](#)). Similar to the U14 and U16 age group results in the present study; Silva et al. ([2015](#)), in their study with elite young soccer players aged 17, reported that the running distance increased (35%) according to the Yo-Yo_{IRT 1} test results obtained at the end of the week 5 of a 7-week preparation period. In the study where the development of the male soccer players in the U16 category was followed for an 8-week period, Hammami et al. ([2013](#)) reported an increase in Yo-Yo_{IRT 1} (VO_{2max} from 47.9 to 55.7 $\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$) performances of the players. Vanttinen et al. ([2011](#)) in their study with the (Yo-Yo_{IRT 1}) 14($d=0.29$ -small), 15($d=0.21$ -small), and 16($d=0.03$ -trivial)-year-old finnish soccer players in the a-year follow-up in response to cardiovascular endurance reported identical findings to the current study.

In soccer-related studies, it was emphasized that the short off-season (8 weeks) was associated with a decrease in aerobic fitness level (Reilly & Williams, [2003](#)) and an increase in body fat percentage (Hoshikawa et al., [2005](#)). In the studies which showed that the level of aerobic fitness in soccer players increased in the mid-season compared to the pre-season and decreased at the end of the season, the reason for the increase in VO_{2max} in the mid-season compared to the beginning of the season stemmed from the training and competitions, and this situation was associated with the decrease in body fat percentage. They emphasized that the decrease in VO_{2max} in the second half of the season might be caused by overload/overtraining and fatigue at the end of the season (Haritonidis, Koutlianos, Koudi, Haritonidou, & Deligiannis, [2004](#); Caldwell & Peters, [2009](#)).

Aerobic performance development in young adolescents is related to the performance in the matches. The development of aerobic performance is affected by the process of biological maturation and weekly training volume (Teixeira et al., [2014](#)). The most important factor that can affect the sportive condition of the player and the whole team in a comprehensive way is the



training load (Jastrzębski, Dargiewicz, et al., [2011](#)). Studies show that exposure to training loads among elite young soccer players increased between the ages of 11 and 19 (Baxter-Jones & Helms, [1996](#); Brito et al., [2012](#); Malina et al., [2000](#)). “Practice makes perfect” is a well-known expression in most sports, including soccer. However, severe training and match load increase the risk of injury, weariness and burnout (Sæther & Aspvik, [2014](#)). The pressure to be successful for talented players is felt at earlier ages (Hill, [2013](#)).

Researchers have suggested that such players, who had a low level of condition at the start of the season, had to work extremely hard to reach the high level they required. They also argue that to start the season in such a short time may be associated with a potentially high catabolic condition, causing mental and physical fatigue later in the season (Kraemer et al., [2004](#)). Pressure to be successful can lead to a potential lack of motivation and burnout (Sæther & Aspvik, [2014](#)). Hill ([2013](#)) stated that one out of four 13-16 years-old players selected for a British professional club experienced burnout at least once in their career (Hill, [2013](#)).

According to the research findings of young soccer players, the period in which growth / development and individual differences are most evident is between 11 and 16 years old. On the other hand, there is limited information about late adolescent soccer players aged 17-19 (Sylejmani et al., [2019](#)).

Furthermore, it should be noted that the training process in young players has an important role in their development and positively affects the development of individual components of their athletic performance (Dragijsky et al., [2017](#)) because systematic young academy soccer education increases physical and physiological development in young soccer players, but maturity status is affected by these processes in different ways (Morris et al., [2018](#)).

In addition to the positive adaptations from training, changes in performance in youth athletes will also reflect the effects of normal growth and maturation, therefore any conclusions regarding the magnitude of performance improvement to specific training must account for changes in maturation. As such this highlights the importance of considering physical testing results in the context of maturation status when evaluating the performance of youth soccer players (Emmonds, Sawczuk, Scantlebury, Till, & Jones, [2020](#)).

Moreover, to the beneficial improvements of training, changes in the success of young athletes will likely demonstrate the results of natural development and maturation, thus all assumptions on the extent of skill adjustment of individual preparation will account for the changes in maturation. This emphasizes the importance of considering the results of physical testing in the context of maturation status when evaluating the performance of young soccer players (Emmonds et al., [2020](#)).

CONCLUSIONS

The present study aimed to examine the seasonal changes of the young elite soccer players in the U14, U15, U16, U17, and U18 categories. The findings show that the aerobic performance of U14 and U16 age groups increased from the beginning of the season to the end of the season.

When we look at the mean values the aerobic performance of the U15, U17, U18 age groups, we can state that there is a decrease in the middle of the season and increase at the end



of the season. While the increase is statistically significant, the decrease is not statistically significant. However, this decrease is worthy of notice. It is thought that some differences in the responses to the training loads during maturation can be observed (Roe & Malone, 2016). Significant increase at the end of the season compared to the beginning of the season in all groups may be due to the fact that the adaptation of the athletes to the training programs was positively affected by the development characteristics according to the age categories. For this reason, carefully selected trainings should be performed in all age categories according to the developmental characteristics of the athletes. Furthermore, the development of the athletes should be tested at short intervals.

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