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Comparison of hematology parameters among elite male adolescent soccer players in different positions at the end of competition season

Asghar Kianzadeh [1], Rahim Mirnasuri [2]*, Masoud Rahmati [3], Omid Ali Adeli [4] , Mostafa Dehghan[5] .

[1] Ph.D. Student in Sports Physiology, Department of Physical Education, Faculty of Literature and Humanities, Lorestan University, Khorramabad, Iran.

[2]Assistant Professor of Sports Medicine, Department of Physical Education, Faculty of Literature and Human Sciences, Lorestan University, Khorramabad, Iran.

[3] Associate Professor of Sports Physiology, Department of Physical Education, Faculty of Literature and Human Sciences, Lorestan University, Khorramabad, Iran.

[4] Faculty member, Department of Pathology, Lorestan University of Medical Sciences and Health Services, Khorramabad, Iran.

[5] Ph.D. Physiology, Sports Department of Physical Education, Faculty of Literature and Human Sciences, Lorestan University, Khorramabad, Iran.

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Abstract:

Objectives: Understanding the blood differences between players of different soccer positions provides useful information for their clinical evaluation, but few studies have examined the blood parameters of soccer players in different positions. The aim of the present study is a comparison of hematology parameters among elite male adolescent soccer players in the positions of goalkeeper, defender, midfielder and strikers at the end of the competition season. **Methods:** Ninety-eight elite male adolescent soccer players were selected in the positions of goalkeeper (n=10), defender (n=32), midfielder (n=33) and strikers (n=23) by simple random sampling by calling for cooperation in the end of the Khorramabad city league matches in the 2023-2024 season. Hematological parameters were evaluated by blood sampling and by automatic cell counting machine. Data analysis was done by one-way analysis of variance (ANOVA) and Scheffe tests (P≤0.05). **Results:** The results showed that there were significantly higher soccer games in four positions the Mean Corpuscular Volume (MCV) in defenders compared to midfielders (respectively, 89.80±3.26 vs. 86.81±4.51, P=0.030), mean Hematocrit (HCT) in goalkeepers compared to midfielders (respectively, 46.73±1.94 vs. 44.39±2.25, P=0.032) and mean Platelet (PLT) in goalkeepers compared to strikers (respectively, 249.70±61.80 vs.219.65±39.61, P=0.042). **Conclusions:** As a result, at the end of the competition season, there are differences in some blood parameters of elite male adolescent soccer players in different positions, which may depend on the type of activity and physiological demands of their positions.

Key Words: Hematology Parameters, Adolescent, Soccer player, Positions.

Corresponding Author: mirnasuri.r@lu.ac.ir

Introduction :

Sports hematology is a sub-discipline of sports medicine that has been developed in the last 20 years (Worku et al., 2020). Hematological parameters in sports medicine are very vital and important for the diagnosis, control and prevention of goals. Complete blood cell count is a test that is performed for the basic evaluation of blood cells (Younesian et al., 2004) and provides information regarding circulating blood cell size and quantity (Brihi and Pathak., 2025) that in sports, it is a very important test to detect abnormalities in blood factors (Younesian et al., 2004), Although, training and competition can affect its results and normal ranges for highly active individuals are widely unknown (Meyer and Meister, 2011). Blood parameters have been shown to be useful in predicting physical performance (Worku et al., 2020). For this reason, researchers have recommended that in order to achieve the best performance of the players, the coaches should measure the hematology of the players (Anagnostakos et al., 2015). However, little emphasis has been placed on hematological evaluation of soccer players (Maria et al., 2013), and hematological parameters have rarely been investigated in professional (Aychiluhim and Abay, 2019), elite (Anđelković et al., 2015) and adolescent (Saddam et al., 2017) soccer players.

Soccer requires high intensity training (Worku et al., 2020); due to intense training, competition, and match-related stress, soccer players experience hemostatic, biochemical, and blood changes after a soccer match and during a competitive season (Banfi and Morelli, 2007; Nobari et al., 2021). Also, the preparation period increases the blood parameters of soccer players due to the improvement of aerobic capacity (Worku et al., 2020). Elite soccer players are characterized by significant changes in biochemical and hematological parameters over the half season, which are linked to training workload, as well as adaptation induced by the soccer training. (Anđelković et al., 2015). Indeed, at any time during the soccer season (at the beginning of the preparation period, during the competition season and even at the end of the season), Soccer players may experience hematological changes that could be detrimental to their health status (Bussollaro et al, 2018). For this reason, regular monitoring of biochemical and hematological parameters is essential to identify healthy status and optimal performance by physicians and sports trainers and to select the correct workload by trainers (Anđelković et al., 2015). In soccer, insight derived from the blood sample features could provide important information on the athletes’ status (Rossi et al., 2023).

Statement of problem :

In soccer, players’ physical and physiological demands vary across different positions and specific training regimens, with appropriately adjusted workloads, can increase players’ performance in different positions (Sanigavatee et al, 2024). From a practical point of view, the physician should consider the playing position of soccer players, because knowing and recognizing the hematological difference between players of different soccer playing positions provides useful information for the clinical evaluation of Soccer players (Aychiluhim and Abay, 2019). Although many studies have evaluated the hematology parameters of Soccer players (Anagnostakos et al., 2015; Anđelković et al., 2015; Joksimović et al., 2009; Özen et al., 2020; Saddam et al., 2017; Younesian et al., 2004) but few studies have investigated the hematology indicators of Soccer players in positions (Aychiluhim and Abay, 2019; Maria et al., 2013; Worku et al., 2020). Specifically, no study has investigated the hematology parameters of Soccer players in different positions at the end of the competition season. In fact, at the end of the competition season, it is unclear whether playing position of players affect the hematological profile of elite Soccer players (Aychiluhim and Abay, 2019).

Significance and Limitations of the Study :

1. Participation in soccer training and matches can affect blood parameters in soccer players, but these changes are unclear among soccer players of different positions. Accordingly, further studies are needed to determine these changes among soccer players of different positions.
2. The results of this research can be provided to soccer coaches and fitness coaches so that they can choose a suitable training program based on this information and use it to reach a high level of physical fitness and health of soccer players.

In this study, only blood parameters related to complete blood count were measured on male adolescent soccer players aged 15 to 18 years, in Khorramabad city, Lorestan province, Iran at the end of the 2023-2024 soccer season.

Objective of the Study :

Therefore, the aim of the present study is a comparison of hematology parameters among elite male adolescent soccer players in the positions of goalkeeper, defender, midfielder and strikers at the end of the competition season.

Material & Methods :

Research Design and Ethics :

The research method was a causal-comparative (retrospective) study, which was conducted with the permission of the Ethics Committee of the Department of Physical Education, Faculty of Literature and Humanities, Lorestan University, Khorramabad, Iran, and in collaboration with the Research Ethics Working Group of the Sports Sciences Research Institute, No. SSRI.REC-2411-2852.

Sampling Technique :

The statistical population consisted of 225 elite male adolescent soccer players who participated in the Khorramabad city league in the 2023-2024 season. The statistical sample consisted of 98 adolescent soccer players (goalkeepers=10, defenders=32, midfielders=33, strikers=23) who were selected by simple random sampling at the end of the competition season. In order to participate, with a call for cooperation, the soccer players were sent a notification among other adolescents of Khorramabad city by the head of the competition committee of Khorramabad city soccer team. Among the referrals, there were people who had the necessary conditions to participate in the study, with general, mental and cardiovascular health. They had no history of blood, diabetes or thyroid diseases. At the time of the tests, they were not suffering from an infectious disease, cold or covid-19 and had no history of taking drugs, sports supplements, tobacco and drugs. In terms of sports experience, they had at least 2 years of competition experience in the Toddlers and adolescent Soccer league and 5 years of training experience in soccer academies and schools in Khorramabad city or other cities and they were present in 70% of the adolescent Soccer league matches of Khorramabad city in the season of 2023-2024. All the selected players were involved in soccer training 6 months before the tests and two days before the tests. All the participants and their parents completed the consent forms before the study and after familiarizing themselves with the process of the experiments.

Measurement methods :

General characteristics were recorded, including age (self-reported in years), height, and body mass. Height was measured as the distance from the soles of the feet to the top of the head using a 2 m Chinese wall-mounted metal stadiometer (accuracy: 1 mm). Body mass was assessed without shoes and with minimal clothing using a digital scale (Beaver model PS240, Germany; accuracy: 0.01 g).

Blood Sample Collection :

The hematology variables were White Blood Cells (WBC) (4500-11000 cells/microliter) count, Red Blood Cell (RBC) (4.3-5.9 cells/ml) count, hemoglobin (HeG) concentration (13.5-17.5 g/dL), HCT (41-53%), PLT (140-450 thousand/microliter) count, red blood cell indices [MCV (80-100 femtoliters), Mean Corpuscular Hemoglobin (MCH) (24.5-34.6 pictograms/cell), Mean Corpuscular Hemoglobin Concentration (MCHC) (31-36 grams/dL)] and Red Cell Distribution Width (RDW) (11.6-15%) or red blood cell morphology index (Wahed and Dasgupta, 2015; Walker et al, 1990).

Blood sampling was performed from all soccer players one day after the last game of the season between 8 and 10 a.m. at laboratory temperature (18 to 24°C). In order to match the nutritional conditions of the soccer players and the possibility of its influence on some variables, all players under test were asked to fast for at least 12 hours. Hematology variables in the pathology laboratory of Dr. Adeli (Khorramabad city, Lorestan province, Iran), by a specialist doctor by taking 5 cc of blood with needles and devices from the brachial vein of the right hand of the subjects in a sitting position (after two minutes of sitting in a quiet state) and blood samples were immediately transferred to tubes containing K2EDTA anticoagulant .Then, the blood samples were centrifuged for 15 minutes at a speed of 3500 rpm, and the values of each sample were stored at -80°C until analysis. Blood sample analysis was performed by Sysmex automatic blood cell counter (KX-21) made in Japan. All tests were performed by technical laboratory users.

Statistical Analysis :

Mean and standard deviation tests were used to describe the data. One-way analysis of variance test was used to compare between groups, and Scheffe's post hoc test was used to determine the differences of two to two groups. All statistical tests were performed using SPSS software version 25 (Chicago, IL, USA) at a significance level of 0.05.

Results :

Table (1) below show that the mean ages in different positions were Goalkeepers: 16.40±0.96 years, defenders: 16.18±0.89 years, midfielders: 16.00±0.82 years, and Strikers: 16.00±0.85 years; the mean heights in different positions were Goalkeepers: 185.20±4.64 cm, defenders: 176.86±25.6 cm, midfielders: 172.99±6.40 cm, and

Table 1: Individual characteristics among elite male adolescent soccer players in four positions at the end of the competition season

	Soccer Positions			
Variables	**Goalkeepers** (n=10)	**Defenders** (n=32)	**Midfielders** (n=33)	**Strikers** (n=23)
age (years)	16.40±0.96≠	16.18±0.89	16.00±0.82	16.00±0.85
height (cm)	185.20±4.64	176.86±6.25	172.99±6.40	177.19±6.23
weight (kg)	71.13±6.72	61.54±9.18	57.34±9.41	61.05±9.32

≠ Values based on standard deviation ± mean

Strikers: 177.19±6.23 cm; and the mean weights in different positions were Goalkeepers: 71.13±6.72 kg, defenders: 61.54±9.18 kg, midfielders: 57.34±9.41 kg and Strikers: 61.05±9.32 kg.

Table (2) below show that that in the four positions of goalkeepers, defenders, midfielders and Strikers. In the means of WBC (F=1.066, P=0.367), RBC (F=0.950, P=0.420), HeG (F=1.476, P=0.226), MCH (F=1.217, P=0.308), MCHC (F=1.773, P=0.158) and RDW (F=0.564, P=0.640) no difference was observed, but in the means, HCT (F=3.949, P=0.011), PLT (F=3.502, P=0.018) and MCV (F=3.365, P=0.022) have a significant difference was observed.

Figures 1, 2 and 3 show that the means HCT in goalkeepers compared to midfielders (respectively, 46.73±1.94 versus 44.39±2.25, P=0.032), means PLT in goalkeepers compared to strikers (respectively, 249.70±61.80 vs. 219.65±39.61, P=0.042) and means MCV in defenders compared to midfielders (respectively, 89.80±3.26 versus 86.81±4.51, P=0.030) were significantly higher.

Table 2: Hematology indicators of elite male adolescent soccer players in four positions at the end of the competition season

	Soccer Positions					
Variables	**Goalkeepers**	**Defenders**	**Midfielders**	**Strikers**	**F**	**P**
WBC (×/ µL)	6660.00±685.07≠	6190.62±76.73	6576.75±1133.03	6491.30±1141.73	1.066	0.367
RBC (×106/µL)	5.23±0.22	5.07±0.26	5.11±0.26	5.13±0.32	0.950	0.420
HeG (g/dl)	15.82±0.80	15.52±0.83	15.21±0.91	15.62±1.20	1.476	0.226
HCT (%)	46.73±1.94	45.66±2.13	44.39±2.25	45.38±2.78	3.949	0.011*
PLT (×103/ µL)	249.70±61.80	232.87±27.16	233.12±35.68	219.65±39.61	3.502	0.018*
MCV (fL)	89.46±3.18	89.80±3.26	86.81±4.51	88.37±4.19	3.365	0.022*
MCH (pg)	30.05±1.03	30.50±1.26	29.80±2.11	30.45±1.57	1.217	0.308
MCHC (g/dl)	33.78±0.88	34.09±0.82	34.33±1.06	34.50±0.93	1.773	0.158
RDW (%)	13.37±0.37	13.45±0.52	13.56±0.78	13.61±0.49	0.564	0.640

Discussion :

Blood parameters are directly related to the intensity and duration of training and therefore should be examined more carefully (Maria et al., 2013; Schumacher et al., 2000). Adequate and timely monitoring of blood parameters is one of the most important measures for controlling training intensity and preventing overtraining in endurance sports such as soccer, while also taking into account different playing positions (Aychiluhim and Abay, 2019). The aim of the present study was the comparison of hematological parameters among elite male adolescent soccer players in the positions of goalkeepers, defenders, midfielders, and strikers at the end of the competitive season. The findings of the present study showed that the mean values of WBC, RBC, Hb, MCH, MCHC, and RDW did not differ significantly among goalkeepers, defenders, midfielders, and strikers at the end of the season, and all values remained within the reference range across positions. Previous research has concluded that hematological parameters in soccer players are influenced by factors such as age, gender, training altitude, training program characteristics, nutrition, and ethnicity (Maria et al., 2013). Moreover, it is believed that changes in these parameters depend on the level of physical activity and the increase in oxygen metabolism during training (Özen et al., 2020). During the competition season, soccer players are exposed to various physical and mental stresses caused by training, preparation, and competition (Sporis et al., 2016). Clemente et al. (2021) showed that pre-season training in soccer can induce changes in biological markers in circulation. Anđelković et al. (2015) reported that elite soccer players experience significant changes in biochemical and hematological parameters over half a season, which are associated with training workload and adaptations to training. It was shown that one of the stable indicators of blood status is one of the key factors that determine optimal sports performance, especially in endurance sports such as soccer (Anđelković et al., 2015). Bussollaro et al. (2018) soccer players may

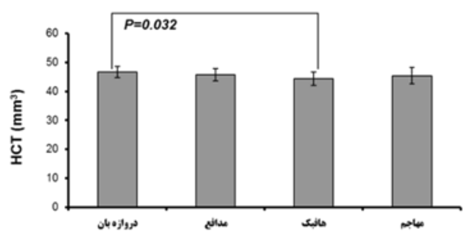

Figure 1: The mean difference of HCT in elite male adolescent soccer players in four positions at the end of the competition season.

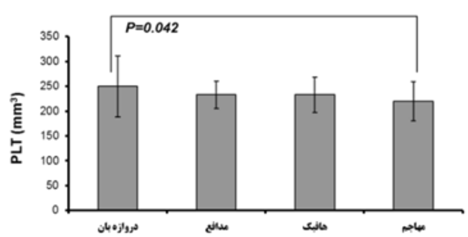

Figure 2: The mean difference of PLT in elite male adolescent soccer players in four positions at the end of the competition season

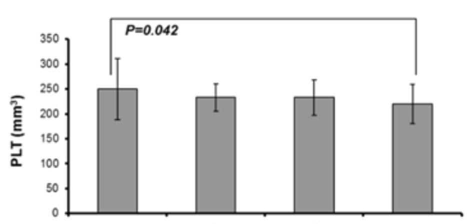

Figure 3: The mean difference of MCV in elite male adolescent soccer players in four positions at the end of the competition season

experience blood changes that can be harmful to their health. Regular monitoring of biochemical and hematological parameters is fundamental for identifying a healthy status, determining optimal performance, and selecting an appropriate workload for athletes (Anđelković et al., 2015). Aychiluhim and Abay (2019) found no significant differences in hematological variables among soccer players in different positions, except for WBC, RBC, and MCH. They reported that HeG and MCHC levels were lower in goalkeepers compared to other positions, and that defensive players had lower MCH levels than players in other positions. Maria et al. (2013), in a study on Brazilian soccer players, found no statistically significant differences in RBC and HeG when comparing six playing positions (goalkeepers, fullbacks, central defenders, central midfielders, wing midfielders, strikers). They also observed that these two blood parameters were within the reference range. Similarly, Worku et al. (2020) reported no differences in hematological indices among soccer players of different positions. Overall, any discrepancies in results are likely explained by multiple factors such as age, nutrition, and training (Bezci and Kaya, 2010; Ostojic and Ahmetovic, 2009; Savucu, 2012; Maria et al., 2013; Schumacher et al., 2002).

The findings of the present study show that the mean values of HCT, PLT, and MCV differed significantly across soccer positions, including goalkeepers, defenders, midfielders, and strikers, at the end of the season. However, the values of these three variables remained within the reference range. These changes in elite male adolescent soccer players may reflect the unique physical and physiological demands associated with each playing position (Vishaw et al., 2015).

Intense anaerobic efforts, one-on-one competitive conditions, physical encounters with rival players, and ball control can alter players' hematological parameters during competition, potentially affecting performance (Owen et al., 2018). In addition to the competitive demands of soccer, environmental stressors can also influence hematological factors (Athanasios, 2014). Therefore, sports science coaches and researchers should consider regional and positional differences, as well as players' training status, when assessing blood profiles (Worku et al., 2020). Bussollaro et al. (2018) observed small but significant hematological changes throughout the competitive year, likely related to training workload and adaptations resulting from soccer training (Anđelković et al., 2015).

Specifically, the mean HCT was significantly higher in goalkeepers than in midfielders. The lower HCT in midfielders may reflect the greater physical demands of their position, including frequent high-intensity runs during matches. Previous research has shown that a decrease in HCT during a competitive season may indicate heavy exertion (Anđelković et al., 2015). Conversely, the type of training and exercise performed by goalkeepers may stimulate red blood cell production, leading to increased HCT (Younesian et al., 2004). Worku et al. (2020) reported that midfielders had higher HCT than goalkeepers, defenders, and strikers, although the differences were not statistically significant. This discrepancy with the present study may be attributed to the timing of hematological measurements.

Age-specific studies provide additional context. Joksimović et al. (2009) found that HCT did not exceed reference ranges in soccer players under 14, 15, and 16 years of age. Biancotti et al. (1992) reported no significant differences in HCT between soccer players and athletes from other sports, whereas Nikolaidis et al. (2003) observed significant differences between athletes and non-athletes. Similarly, Saddam et al. (2017) showed that HCT in 17-year-old Algerian soccer players increased after six months of training.

Hematocrit (HCT) represents the proportion of red blood cells in a given blood volume, also referred to as packed cell volume (Younesian et al., 2004). The normal HCT range for adult males is 40–54% (Issiako et al., 2013). HCT is influenced primarily by red blood cell number and size, but hydration status also plays a role (Younesian et al., 2004). Increases in HCT are generally associated with enhanced blood oxygen-carrying capacity and aerobic performance; however, elevated HCT may also increase blood viscosity (Hu et al., 2008). Conversely, low HCT can indicate anemia, blood loss, bone marrow dysfunction, leukemia, malnutrition, overhydration, or rheumatoid arthritis. Endurance athletes often present with relatively low HCT (~40%) due to increased plasma volume, a phenomenon sometimes referred to as "sports anemia."

Seasonal and training effects on HCT have been documented. Hu et al. (2008) reported significant seasonal fluctuations in HCT, while Malcovati et al. (2003) and Ostojic and Ahmetovic (2009) noted higher HCT values at the beginning of the season, followed by a decrease during competition. This reduction is likely attributable to increased plasma volume over the course of the season (Shaskey and Green, 2000). Overall, the findings underscore the importance of considering positional, physiological, and seasonal factors when interpreting hematological profiles in soccer players.

The findings of the present study show that the mean platelet count (PLT) in goalkeepers was significantly higher than in strikers. Evidence indicates that physical exercise can alter both platelet number and function (Hilberg et al., 2003), partly due to the mobilization of mature platelets by catecholamines (Möckel et al., 2001). Although regular exercise improves performance and modulates platelet activation at rest, intense activity can acutely activate platelets (Heber and Volf, 2015). Joksimović et al. (2009) reported no significant increases in PLT values beyond the reference range in soccer players under 14, 15, and 16 years of age. In contrast, Saddam et al. (2017) observed increased platelet counts in 17-year-old Algerian soccer players after six months of training.

Platelets are small oval structures (1–4 µm in diameter) derived from megakaryocytes in the bone marrow. Their most critical function is the formation of stable hemostatic clots at sites of vascular injury (Joksimović et al., 2009). They adhere rapidly to damaged endothelium, initiating the clotting cascade (El-Sayed et al., 2004). Platelets play a central role in hemostasis and blood coagulation (Heber and Volf, 2015). Moreover, as key mediators linking inflammation and thrombosis, their increased activity and tendency to form clots may lead to thrombotic complications (Gawlita et al., 2015).

The present study also revealed that the mean corpuscular volume (MCV) in defenders was significantly higher than in midfielders. Elevated MCV levels may result from increased red blood cell regeneration and enhanced iron transfer from the bone marrow into circulating red cells (Mackinnon et al., 1997). The higher MCV in defenders compared to midfielders could be attributed to positional demands. Midfielders typically perform more frequent and intense running than defenders. Continuous foot-ground contact and the physical intensity of play can damage red blood cells in the vessels of the legs and in gastrointestinal capillaries during intense exercise (Silva et al., 2008; Skarpańska-Stejnborn et al., 2015). This damage, combined with endurance-related reductions in hemoglobin concentration, may contribute to the lower MCV observed in midfielders.

Joksimović et al. (2009) found that MCV values in soccer players under 14, 15, and 16 years remained within the reference range. Andelkovic et al. (2015) reported a significant decrease in MCV within 45 days of regular training, a result likely related to the timing of measurements. In their study, MCV was assessed during the pre-season, whereas in the present study it was measured at the end of the competitive season.

Mean corpuscular volume (MCV) reflects the average size of red blood cells and is a key parameter in the evaluation of anemia. Along with hemoglobin (Hb) and hematocrit (HCT), MCV is used to classify anemia into microcytic (low MCV), normocytic (normal MCV), or macrocytic (high MCV) types (Maner and Moosavi, 2022).

Conclusions :

It is possible that the changes in hematological parameters in soccer players depend on the level of physical activity performed in different positions and the different metabolic needs of the playing positions during the training period. During the competition season, soccer players of different positions are exposed to various physical and psychological pressures caused by training and competition, which may cause soccer players to experience changes in hematological parameters at the end of the competition season, as occurred in the present study, which is probably related to the workload of training and competition as well as physical adaptation during the competition season.As a result, at the end of the competition season, there are differences in some blood parameters of elite male adolescent soccer players in different positions, which may depend on the type of activity and physiological demands of their positions. A lack of research results related to hematology parameters is observed among basic age groups and even veterans, female, ethnicities and different geographical regions in soccer players of different positions. In the future, for more accurate scientific conclusions, it is necessary to examine blood parameters among different age groups, different genders, different ethnicities, and different geographical regions among soccer players of different positions.

In fact, regular monitoring of hematological parameters in soccer players is necessary and essential for physicians to identify the health status and select the correct workload and optimal performance by sports coaches.

Recommendations :

1. It is suggested that a future study be conducted to compare the blood parameters of lite male and female soccer players of different positions in adult and veteran players.
2. It is suggested that conducting a study in the future with the title the compare of hematological parameters of elite female adolescent soccer players at the pre, during and end of the competition season.
3. It is suggested that a future study be conducted to compare the blood parameters of elite male or female soccer players of different positions with different ethnicities such as Persians, Arabs, and Kurds.
4. It is suggested that in the future, a study be conducted to compare the blood parameters of elite male and female soccer players of different positions in different geographical regions, such as Asian with European or African with American, etc.

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مقارنة المؤشرات الدموية بين لاعبي كرة القدم من الذكور المراهقين في مراكز مختلفة في نهاية موسم المنافسة

الملخص :

كان الهدف من الدراسة الحالية هو مقارنة المؤشرات الدموية بين لاعبي كرة القدم من الذكور المراهقين في مراكز حراس المرمى والمدافعين ولاعبي الوسط والمهاجمين في نهاية موسم المنافسة. تم اختيار ثمانية وتسعين لاعب كرة قدم من الذكور المراهقين في مراكز حراس المرمى (عدد = 10) والمدافعين (عدد = 32) ولاعبي الوسط (عدد = 33) والمهاجمين (عدد = 23) عن طريق أخذ عينات عشوائية بسيطة من خلال الدعوة للتعاون في نهاية مباريات دوري مدينة خرم آباد في موسم 2023–2024. تم تقييم معايير الدم عن طريق أخذ عينات الدم وآلة عد الخلايا الأوتوماتيكية. تم تحليل البيانات عن طريق تحليل التباين أحادي الاتجاه (ANOVA) واختبارات شيفه .($P \leq 0.05$) وأظهرت النتائج وجود فروق ذات دلالة احصائية في بعض المؤشرات الدموية بين المراكز المختلفة. حيث سجل المدافعون متوسط حجم كريات الدم الحمراء (MCV) اعلى مقارنة بلاعبي الوسط (89.80±3.26) مقابل (86.81±4.51)، ($P = 0.030$)، كما اظهر حراس المرمى متوسطاً اعلى للهيماتوكريت (HCT) مقارنة بلاعبي الوسط (46.73±1.94)، مقابل (44.39±2.25)، $P =$ (0.032)، متوسط أعلى من الصفائح الدموية (PLT) مقارنة بالمهاجمين (249.70±61.80) مقابل (219.65±39.61) (P=0=0.42)، وتشير النتائج الى وجود اختلافات في بعض المؤشرات الدموية بين لاعبي كرة القدم النخبة من الذكور المراهقين تبعاً لمراكز اللعب وذلك نهاية الموسم التنافسي، وقد تعكس هذه الفروق طبيعة النشاط والمتطلبات الفسيولوجية الخاصة بكل مركز.

الكلمات المفتاحية: المؤشرات الدموية، المراهق، لاعب كرة القدم، المراكز.