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Original article

Relationship between certain biochemical parameters and maximal aerobic speed of elite soccer players

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Abstract. *Study Objectives:* In this study, it was aimed to evaluate the relationship between vitamin D and lipid profiles of athletes playing football professionally during the season and some metabolic parameters and maximal rate. *Methods:* 52 male elite soccer players performing in Super League, TFF 2nd League, and TFF 3rd League whose mean age 22.86±3.55 years, participated in our study. The sport age of the soccer players was 12.2±1.70 years. The participants attended in at least five 80-minute training periods and performed at least one official competition weekly (through 11 months). In November, blood samplings of the athletes and other parameters were obtained between 09:00 and 10:00 a. m. leading a 12-hour fasting period. The Maximal Aerobic Speed (MAS) measurement developed by Buchheit (2008) to evaluate aerobic power and capacity was used to carry out the study. In order to determine the relationship between the variables of individuals, Pearson Correlation Test was used as the data showed normal distribution. *Results:* Albumin, Alp, Alt, Ast, B12 vitamin, Ca, Phosphorus, Creatinine, Mg, Free T3, Sodium, Tsh, Ferritin, Folic Acid, Potassium Triglyceride, Glucose, Total Cholesterol, and Free T4 values were found within normal limits. It can be said that athletes had low vitamin D values. It was observed that the participants had low LDL cholesterol values. Variables don't have any significant effects on running time, peak velocity, true vift and VO_2max of biochemical parameters (p>0,05). *Conclusion:* As a result, it can be concluded that despite the positive relationship between the maximal aerobic velocity test parameters of the footballers and their pre-test biochemical results, it wasn't statistically a meaningful relationship.

Key words: Biochemical, Professional Soccer Players, 30-15 IF

Introduction

Measurements of biochemical and haematological parameters guide sports scientists and coaches to determine the required energy levels of athletes and their training schedules. For an optimized performance, biochemical and haematological parameters should be kept to an appropriate level (1).

Vitamin D is crucial for protecting the musculoskeletal integrity of athletes. Current studies suggest that vitamin D deficiency is a serious health problem not only for the overall world population but also for athletes specifically (2). In demanding sports, like soccer, the musculoskeletal system of professional athletes may subject to overstraining as they need optimum musculoskeletal functioning (3). Vitamin D deficiency may cause musculoskeletal regulation disorder, so it leads to a sports injury, stress fractures, and degenerations of tendons. Other possible results of Vitamin D deficiency are a decrease in quality of training sessions,

extensions in disease and injury periods, and, finally, a drop in athletic performance (4).

Soccer is a field of sports that demands both aerobic and anaerobic efforts during competitions and training periods (5-7). Notably, soccer players are confronted with rather more physiological stressors during competitions. Some studies have revealed that frequentative intensive exercises are associated with a decrease in total cholesterol and triglyceride levels, rather minor improvements in LDL levels, and an increase in HDL levels of soccer players (8,9). Moreover, it has been proved that short or long training terms may cause changes in the lipoprotein metabolism of soccer players.

Recently, there has been a growing interest in biochemical and haematological parameters of soccer players. In particular, their lipid profiles and vitamin D levels have been one of the most frequently investigated research contents nowadays (11-13). High-intensity aerobic training in team sports mostly include intermittent and shuttle runs to appeal to competitive running models (14,15). 30-15 Interval Fitness Test (IFT) is an efficient maximal aerobic speed test that has been specifically designed for soccer players and it has been gaining more and more popularity day by day. 30-15 IFT which is a test for intermittent and shuttle runs includes some sessions in which both aerobic and anaerobic energy systems and directing ability of athletes are engaged. This study aims to find out the relationship between the professional football players' vitamin D levels, their lipid profiles, and some certain metabolic parameters, and their maximal speed rates.

Material and Methods

Participants

Fifty-two male elite soccer players in the Super League, TFF 2nd League (Turkish Football Federation Second League), TFF 3rd League (Turkish Football Federation Third League) whose mean age 22.86±3.55 years, participated in our study. The sport age of the soccer players was 12.2±1.70 years. The participants attended in at least five 80-minute training periods and performed at least one official competition weekly (through11 months).

Collection of Data

The volunteers were informed about how the tests would be applied and their possible risks. Then, a written contest form was requested. In November, blood samplings of the athletes and other parameters were obtained between 09:00 and 10:00 a. m. leading a 12-hour fasting period. Height, body weight (BW), body mass index [BMI = BW (kg) / (height, m)^2] values of the participants were identified. Their biochemical test results were evaluated through the Beckman DXC-800 model autoanalyzer and the enzymatic-colorimetric method in the biochemistry laboratory at Lokman Hekim Hospital in Ankara providence. The maximal Aerobic Speed (MAS) test which was developed by Martin Buchheit (2008) to evaluate aerobic strength and capacity was applied to only twenty of 52 participants who were volunteer (17). MAS consists of 30-second shuttle running and 15-minute recovery periods. The first 30-second period of the running part starts at a speed of 8 km/h and increases at a speed of 0.5 km / h in each period. The process ends either when the person gets exhausted with this order or when he cannot manage to reach 3-meters areas three times with beep sound simultaneously. The maximal speed rate that the participant reaches at the end of the test is recorded as the final score. A player's resultant end test velocity (VIFT) was determined as the last stage they completed successfully. Maximal running speeds, body weights, gender and age variables of the participants are put in process to calculate the MaxVO$_2$: VO$_2$max (ml.kg–1.min–1) = 28.3 – (2.15 x 1) – (0.741 x Age) – (0.0357 x Kg(Body Weight + (0.0586 x Age x Speed + (1.03 x Speed).

Statistical Analysis

To analyse the data, IBM SPSS (Statistical Package for the Social Sciences) version 24.0 was used. Descriptive statistics of the obtained data were given as mean and standard deviation. In order to determine the relationship between the variables of participants, Pearson Correlation Test was used as the data showed normal distribution.

Results

The mean age of the participants was 22,86±3,55, average height was 180,38±5,89 cm, average weight was 74,16±6,87 and BMI was 22,77±1,59.

Discussion

Metabolism and Biochemical parameters differ according to energy systems during training periods and competitions and upon the severity of the exercise (18). In this study, biochemical parameters of 20 elite soccer players were obtained before 30-15 IFT assessing maximal aerobic speed (MAS). Then, MAS test was assessed, and it was intended to seek for a statistically meaningful difference between biochemical parameters of soccer players and their 30-15 IFT test results. Also, in the study, there are average biochemical values of the soccer players and reference ranges of these values. 46,2% of the athletes suffered from vitamin D deficiency. The level of vitamin D deficiency in the participants was nearly the same with global athletic populations (19-24). When vitamin D levels of professional athletes were analysed, it was seen that they were all similarly affected by the situation. According to a similar study about vitamin D levels of athletes, 32% of the professional basketball players suffer from vitamin D deficiency and 47% of them have insufficient vitamin D levels. Also, 26% of soccer players performing in the United States National Soccer League suffer from vitamin D deficiency and 42-80% of them have insufficient vitamin D levels. Furthermore, 36% of the soccer players in Liverpool Football team in England Premier League suffer from vitamin D deficiency or they have insufficient vitamin D level (25,26). A study from Turkey shows that 50% of elite soccer players have severe vitamin D deficiency (27). Donmez et al. (2018) found that 23,2% of 56 male soccer players living in Ankara had vitamin D deficiency (<10 ng/mL), 66,1% had insufficient vitamin D level (10-24,9 ng/mL) but just 10,7% of them had sufficient vitamin D (≥25 ng/mL). Some researchers have found out that a great many professional dancers, swimmer, volleyball players, taekwondo athletes, jockeys, runners, and weightlifters suffer from vitamin D deficiency or insufficiency (24,29). Todd et al. (2015) stated that all athletes tend to have low vitamin D levels (30).

The running time value of the soccer players participating in the study 1141,55±123,11sec., Peak Velocity is 20,66 ± 1,36 km/h-1, 30-15 True Vift is 20,40 ± 1,39, and VO_2max is 54,68 ± 3,26 (Table 1).A study on soccer players playing in the Iranian football league, under the age of 16, showed that their 30-15 IFT peak velocity value was 17.4 ± 1.1 km/h-1 (31). In his study, Peso (2021) found that at the end of 30-15 IFT, VO_2max values of elite soccer players were 49,85 ± 2,76 and the peak velocity was 18,04 ± 1,32 km/h-1(32). Rasater (2016) declared that the 30-15 IFT VO_2max value of 15 non-elite soccer players aged 20.6 was 48.3 ml/kg/min ±3.8(33). Buchheit and et al. (2009) made a study on team athletes (football, handball, and basketball) and determined the 30-15IFT VO_2max value of the participants as 54.5 ± 6.6 ml/kg/min (34). In a study on 59 young athletes whose average age was 16,2 ± 2,3, 30-15IFT peak velocity value of the participants was 18,2 ± 1,6 km/h-1(16). In our study, it has been observed that VO_2max and peak velocity values are higher than ones obtained in previous studies (Table 1). It can be reasoned upon sampling group which consists of professional soccer players. There was no a meaningful relationship between Hydroxy Vitamin D, HDL and LDL Cholesterol, Fasting Blood Glucose, Albumin, Alp, Alt, Ast, B12, Ca, Ferritin, Folic acid, Phosphorus, Creatinine, Mg, Potassium, Free T3 and T4, Sodium, Triglyceride, Uric acid and Tsh values and Runing Time, Peak Velocity, True Vift, VO_2max values ($p>0,05$) (Table 3).

In his study aimed to research the effects of the Yo-Yo intermittent recovery test on biochemical parameters of soccer players, Doruk (2019) found that there was a statically meaningful difference related to only glucose values in both inter groups and intra group comparisons made in the morning and in evening sessions. He didn't find any meaningful differences related to participants' insulin values. As far as their lipidemic profiles, except LDL profiles (HDL, cholesterol, VDL, and Triglyceride) were concerned, statistically meaningful differences were found in inter groups and intra group comparisons in morning and evening sessions. When metabolic and sexual hormones were

Table 1. Biochemical distributions of the participants

Variable	Value	N	Percent (%)	Mean ± S.D.
Hydroxy Vitamin D (ng/mL)	<20	24	%46,2	21,85± 6,91
	20-30	20	%38,5	
	>30	8	%15,4	
	Total	52	%100	
HDL Cholesterol (mg/dL)	<40	13	%25,5	44,96± 8,03
	40-45	12	%23,5	
	45-50	14	%27,5	
	Above 50	12	%23,5	
	Total	51	%100	
LDL Cholesterol (mg/dL)	<100	32	%61,5	93,44 ±26,74
	100-130	15	%28,8	
	130-160	4	%7,7	
	160-190	1	%1,9	
	Total	52	%100	
Fasting Blood Glucose (mg/dL)	<84	10	%19,2	88,26±6,58
	84-100	39	%75	
	>100	3	%5,8	
	Total	52	%100	
Albumin	35-52	48	%92,3	48,35± 3,05
	>52	4	%7,7	
	Total	52	%100	
ALP (U/L)	<45	2	%4,2	74,50± 20,37
	45-87	34	%70,8	
	>87	12	%25	
	Total	48	%100	
ALT (U/L)	0-33	46	%88,5	21,26± 13,05
	>33	6	%11,5	
	Total	52	%100	
AST (Unit/L)	0-32	41	%82	23,96± 18,66
	>32	9	%18	
	Total	52	%100	
B12 (pg/mL)	<197	13	%25,5	310,84± 144,90
	197-771	37	%72,5	
	>771	1	%2	
	Total	51	%100	
Ca (mg/dL)	<8,6	1	%1,9	9,43± 0,43
	8,6-10,2	47	%90,4	
	>10,2	4	%7,7	
	Total	52	%100	

Variable	Value	N	Percent (%)	Mean ± S.D.
Ferritin (ml/ng)	13-150	35	%74,5	109,80± 60,80
	>150	12	%25,5	
	Total	47	%100	
Folic acid (ng/mL)	<3,89	12	%23,5	5,46± 2,12
	3,89-27	39	%76,5	
	Total	51	%100	
Phosphorus (mg/dl)	2,5-4,5	45	%97,8	3,64± 0,44
	>4,5	1	%2,2	
	Total	46	%100	
Creatinine (mg)	0,5-1	52	%100	0,98± 0,11
Mg (mg/dl)	1,6-2,6	47	%100	1,99± 0,13
Potassium (mg/dl)	3,5-5,1	51	%98,1	4,32± 0,31
	>5,1	1	%1,9	
	Total	52	%100	
Free T3 (pg/mL)	2,56-5,00	47	%100	3,83± 0,38
Free T4 (pg/mL))	0,98-1,63	50	%96,2	1,34± 0,17
	>1,63	2	%3,8	
	Total	52	%100	
Sodium (mEq/L)	135-145	51	98,1	139,42± 2,24
	>145	1	1,9	
	Total	52	%100	
Triglyceride (mg/dl)	<150	43	%84,3	98,00± 43,20
	150-300	8	%15,7	
	Total	51	%100	
Uric acid (mg/dl)	2,4-5,7	29	%59,2	5,52± 0,80
	>5,7	20	%40,8	
	Total	49	%100	
Tsh (mL)	0,51-4,3	50	%96,2	2,22±0,94
	>4,3	2	%3,8	
	Total	52	%100	

Biochemical test results of the participants were presented in Table 1.

Table 2. Scores of the participants attended in 30-15 vfit shuttle run test

Variable	N	Mean ± S.D.
Running Time (s)	20	1141,55±123,11
Peak Velocity (km·h-1)	20	20,66±1,36
True Vift (km·h-1)	20	20,40±1,39
VO_2max (ml.min.kg)	20	54,68±3,26

30-15 vfit shuttle run test results of the participants were presented in Table 2.

checked, it was seen that there was a statistically meaningful difference between testosterone and TSH values in the morning, and there was a statically meaningful difference in Free T3, testosterone, and TSH values in inter groups' comparisons in the evening session. Also, there were statically meaningful differences in T3 and testosterone hormone levels according to measurements taken in morning and evening sessions. Therefore, it can be concluded that metabolic and sexual hormones differ in the morning and evening sessions.

Table 3. Pearson correlation analysis of biochemical parameters of participants' running time, peak velocity, true vift and VO_2max

Variable (n:20)		Runing Time	Peak Velocity	True Vift	VO_2max
Hydroxy Vitamin D (ng/mL)	r	-,103	-,099	-,092	-,152
	p	,665	,67	,699	,521
HDL Cholesterol (mg/dL)	r	-,196	-,197	-,220	-,189
	p	,407	,404	,351	,425
LDL Cholesterol (mg/dL)	r	,234	,232	,248	,128
	p	,321	,325	,304	,591
Fasting Blood Glucose (mg/dL)	r	,177	,181	,175	,088
	p	,454	,446	,460	,713
Albumin	r	,006	,009	,019	-,054
	p	,980	,971	,938	,820
Alp (U/L)	r	,432	,422	,429	,299
	p	,057	,064	,059	,200
Alt (U/L)	r	,005	,006	-,023	-,094
	p	,983	,979	,923	,693
Ast (Unit/L)	r	,156	,155	,116	,080
	p	,511	,514	,628	,738
B12 (pg/mL)	r	,237	,235	,219	,288
	p	,314	,319	,354	,218
Ca (mg/dL)	r	-,058	-,057	-,057	-,181
	p	,808	,813	,810	,445
Ferritin (ml/ng)	r	,134	,131	,095	,128
	p	,574	,583	,690	,592
Folic acid (ng/mL)	r	-,092	-,092	-,120	-,138
	p	,700	,699	,613	,561
Phosphorus (mg/dl)	r	-,112	-,101	-,105	-,027
	p	,640	,672	,660	,912
Creatinine (mg)	r	,065	,072	,058	,192
	p	,785	,762	,807	,417
Mg (mg/dl)	r	,291	,295	,293	,264
	p	,214	,207	,209	,260
Potassium (mg/dl)	r	-,004	-,012	-,020	,001
	p	,988	,960	,934	,998
Free T3 (pg/mL)	r	,090	,094	,121	,021
	p	,705	,693	,612	,930
Free T4 (pg/mL)	r	-,247	-,235	-,241	-,047
	p	,295	,319	,306	,844
Sodium (mEq/L)	r	,379	,384	,368	,084
	p	,100	,095	,111	,726
Triglyceride (mg/dl)	r	,069	,074	,072	,075
	p	,772	,756	,763	,753

Variable (n:20)		Runing Time	Peak Velocity	True Vift	VO_2max
Uric acid (mg/dl)	r	,245	,245	,216	,314
	p	,297	,299	,361	,177
Tsh (mL)	r	-,318	-,312	-,330	-,231
	p	,172	,180	,155	,326

Variables don't have any significant effects on running time, peak velocity, true vift an VO_2max of biochemical parameters in Table 3 (p>0,05).

The result has always been the same in the study of this topic, and it can be said that this may be related to the body's biological time which is called circus rhythm. There are several statistically meaningful differences between the parameters tested in the morning and evening sessions. It could be related to that soccer players were the members of the same team and they participated in the same training schedules and resting programmes. Doruk (2019) also interpreted this situation as the result of different physiological and metabolic characteristics of individuals (18).

Kaynar and et al. (2016) engaged 23 volunteer kickboxing athletes aged 15- 46 in three 2-minute kickboxing competitions (1-minute resting) after 40-minute warm-up, stretching, and 50- minute tactical periods. Concerning the blood samples of athletes taken before and after training periods, there was a statistically meaningful increase in their HDL, LDL, triglyceride, and cholesterol serum levels. On the other hand, there weren't any meaningful differences in their triglyceride levels (35). Kaynar (2015) spotted a meaningful difference between kickboxing athletes' TSH, T3, and T4 levels when their blood results were compared before and after training periods (p>0.05) (36). Kocahan (2018) studied 20 elite male swimmers aged 18-22 and he found that there were increases in their TSH and T4 levels after some short, medium, and long term training sessions. There was a statistically meaningful difference in their TSH and T4 levels according to pre and post-test results. There weren't any meaningful differences in their T3 results (37). Doruk (2019) stated that AST hormone levels of soccer players tend to increase after Yo-Yo testing in morning and evening samplings and they got back to normal levels in two hours after training. In inter groups comparisons, no meaningful difference was detected (18). Colakoglu (2014) concluded that there was a statistically meaningful difference in AST hormone level after 20-minute running training at the speed of 4 mlm lactate threshold (38).

Conclusion

Albumin, ALP, Alt, Ast, B12 vitamins Ca, Phosphorus, Creatinine, Mg, Free T3, Sodium, TSH, Ferritin, Folic acid, Potassium Triglyceride, Glucose, Total Cholesterol and Free T4 values of the soccer players were found within normal limits. It can be said that athletes have low vitamin D values. It was observed that the participants had low LDL cholesterol values. Variables has no significant effect on running time, peak velocity, true vift an VO_2max of biochemical parameters (p>0,05). As a result, it can be concluded that despite the positive and negative relationship between the maximal aerobic velocity test parameters of the footballers and their pre-test biochemical results, it wasn't statistically a meaningful relationship.

Conflicts of interest: The authors declare that there is no conflict of interest in this manuscript.

References

1. Krustrup, P., Nielsen, J. J., Krustrup, B. R., Christensen, J. F., Pedersen, H., Randers, M. B., ... & Bangsbo, J. Recreational soccer is an effective health-promoting activity for untrained men. British journal of sports medicine 2009;43(11): 825-831.
2. Farrokhyar F, Tabasinejad R, Dao D, Peterson D, Ayeni OR, Hadioonzadeh R, et al. Prevalence of vitamin D inadequacy

in athletes: a systematic-review and meta-analysis. Sports Medicine. 2015;45(3):365-78.
3. Duca A, John A, Norwig Joseph C, et al. Vitamin D profile in national football league players. Am J Sports Med 2015; 3: 1-5
4. Sercan, C. Yavuzsoy, E. Yuksel, I. Can, R. Oktay, S. Kirac, D. Ulucan, K. Sporcu sagligi ve atletik performansta d vitamini ve reseptorunun onemi. Journal of Marmara University Institute of Health Sciences, 2015, 5(4) - 259-264.
5. Kucuk H. Kadin futbolcularda statik ve dinamik dengenin mevkilere gore karsilastirilmasi. Uluslararasi Spor Egzersiz ve Antrenman Bilimi Dergisi, 2020; Supp.(4): 53-56.
6. Kucuk, H. Erim, V. Comparison of elite judo and wrestler's balance performances. Journal of ROL Sport Sciences, 2021, 2(1), 1-7.
7. Ziv, G., & Lidor, R. (2009). Physical attributes, physiological characteristics, on-court performance and nutritional strategies of female and male basketball players. *Sports Medicine*, *39*(7), 547–568.
8. N. Apostolidis, G. C. Bogdanis, N. Kostopoulos, A. Souglis & Ch. Papadopoulos (2014) Changes in the Lipid Profile of Elite Basketball and Soccer Players After a Match, Research in Sports Medicine: An International Journal, 22:1, 100-110,
9. Sotiropoulos, A., Papapanagiotou, A., Souglis, A., Giosos, G., Kotsis, G., & Bogdanis, G. C. (2008). Changes in hormonal and lipid profile after a soccer match in male amateur players. Serbian Journal of Sports Sciences, 2(1), 31–36.
10. Brites, F., Verona, J., De Geitere, C., Fruchart, J. C., Castro, G., & Wikinski, R. (2004). Enhanced cholesterol efflux promotion in well-trained soccer players. Metabolism, 53(10), 1262-1267.
11. Rahnama, N., Younesian, A., Mohammadion, M., & Bambaeichi, E. (2009). A 90 minute soccer match decreases triglyceride and low density lipoprotein but not high-density lipoprotein and cholesterol levels. Journal of research in medical sciences: the official journal of Isfahan University of Medical Sciences, 14(6), 335.
12. Bezuglov, E., Tikhonova, A., Zueva, A., Khaitin, V., Waśkiewicz, Z., Gerasimuk, D., ... & Knechtle, B. (2019). Prevalence and treatment of vitamin D deficiency in young male Russian soccer players in winter. Nutrients, 11(10), 2405.
13. Rebolledo, B.J.; Bernard, J.A.; Werner, B.C.; Finlay, A.K.; Nwachukwu, B.U.; Dare, D.M.; Warren, R.F.; Rodeo, S.A. The association of vitamin D status in lower extremity muscle strains and core muscle injuries at the national football league combine. Arthrosc. J. Arthrosc. Relat. Surg. 2018, 34, 1280–1285.
14. Dupont, G, Akakpo, K, and Berthoin, S. The effect of in-season, high-intensity interval training in soccer players. J Strength Cond Res 18: 584–589, 2004.
15. Hoff, J and Helgerud, J. Endurance and strength training for soccer players: physiological considerations. Sports Med 3: 165–180, 2004.
16. Buchheit, M. The 30–15 intermittent fitness test: accuracy for individualizing interval training of young intermittent sport players. J Strength Cond Res 22: 365–374, 2008.
17. Buchheit, M. 30-15 Intermittent Fitness Test and repeated sprint ability. Science & Sports. 2008, 23: 26-28,.
18. Doruk, M. Sabah aksam yapilan yo-yo aralikli toparlanma testinin (seviye-1) metabolik hormonlar ve biyokimyasal parametreler uzerine akut etkisi. 2019, Yuksek Lisans Tezi, 42-50.
19. Ceylan, L. D vitaminin sporcu sagligi ve performansina etkisi. Sporda Bilimsel ve Akademik Yaklasimlar-3 2020, 155-175.
20. Bikle, D.D. Vitamin D Metabolism, Mechanism of Action, and Clinical Applications. Chem. Biol. 2014, 20, 319–329.
21. Koundourakis, N.E.; Androulakis, N.E.; Malliaraki, N.; Margioris, A.N. Vitamin D and exercise performance in professional soccer players. PLoS ONE 2014, 9, e101659.
22. Morton, J.P.; Iqbal, Z.; Drust, B.; Burgess, D.; Close, G.L.; Brukner, P.D. Seasonal variation in vitamin D status in professional soccer players of the English Premier League. Appl. Physiol. Nutr. Metab. 2012, 37, 798–802.
23. Larson-Meyer, D.E.; Willis, K.S. Vitamin D and athletes. Curr. Sports Med. Rep. 2010, 9, 220–226.
24. Carter, G.D. 25-hydroxyvitamin D assays: The quest for accuracy. Clin. Chem. 2009, 55, 1300–1302.
25. Dubnov-Raz, G.; Livne, N.; Raz, R.; Rogel, D.; Constantini, W. Vitamin D concentrations and physical performance in competitive adolescent swimmers. Pediatr. Exerc. Sci. 2014, 26, 64–70.
26. Morton, J.P.; Iqbal, Z.; Drust, B.; Burgess, D.; Close, G.L.; Brukner, P.D. Sea-sonal variation in vitamin D status in professional soccer players of the English Premier League. Appl. Physiol. Nutr. Metab. 2012, 37, 798–802.
27. Sariakcali, B; Ceylan, L; Elioz, M. Evaluation of end-seasonal vitamin d, plasma lipid and other biochemical measurements in professional football players: The case of sivas province in turkey. 2020. Progress in Nutrition 2020; Vol. 22 (2): 5-17.
28. Donmez G, Torgutalp SS, Babayeva N, Yargic MP, Ozkan O, Korkusuz F, et al. Vitamin D status in soccer players with skeletal muscle injury, Ankara. Turkish Journal of Sports Medicine. 2018;53(3):94-100.
29. Close, G.L.; Russell, J.; Cobley, J.N.; Owens, D.J.; Wilson, G.; Gregson, W.; Fraser, W.D.; Morton, J.P. Assessment of vitamin D concentration in non-supplemented professional athletes and healthy adults during the winter months in the UK: Implications for skeletal muscle function. J. Sports Sci. 2013, 31, 344–353.
30. Todd JJ, Pourshahidi LK, McSorley EM, Madigan SM, Magee PJ. Vitamin D: re-cent advances and implications for athletes. Sports Med. 2015;45(2):213-29.
31. Buchheit, M. Rabbani, A. 30-15 Intermittent Fitness Test vs. Yo-Yo Intermittent Recovery Test Level 1: Relationship and Sensitivity to Training. International Journal of Sports Physiology and Performance, 2013, 9(3), 522-524.

32. Peso, D. Descriptive study of 30-15IFT TEST. https://30-15ift.com/wp-content/uploads/2015/09/peso-30-15ift-at-2800m-altitude.pdf erisim tarihi: 22.01.2021.
33. Råsäter, K. Difference in estimated VO_2max between the 30-15 intermittent fitness-test and 20-meter shuttle test in amateur floorball-players. Bachelor Thesis 2016, Halmstad, 12-13.
34. Buchheit, M, Al Haddad, H, Millet GP, Lepretre, PM, Newton, M, and Ahmaidi, S. Cardiorespiratory and cardiac autonomic responses to 30–15 Intermittent Fitness Test in team sport players. J Strength Cond Res. 2009, 23(1): 93–100.
35. Kaynar O., Ozturk N., Kiyici F., Baygutalp K.N., Bakan E., Kick Boks Sporcularinda Kisa Sureli Yogun Egzersizin Karaciger Enzimleri ve Serum Lipit Duzeyleri Uzerine Etkileri., Dicle Tip Dergisi 2016, 43(1):130-134
36. Kaynar O, Kiyici F, Ozturk N, Bakan E. Elit gurescilerde akut egzersizin plazma lipit duzeylerine etkisi, Beden Egitimi ve Spor Bilimleri Dergisi 2015;17:33.
37. Kocahan S., Dundar A. Yuzuculerde farkli egzersiz yuklerinin tiroid hormon duzeyleri ve serum lipid profili uzerine etkileri Cevrimici Yayincilik: 2018-11-14
38. Colakoglu F., 8 Haftalik Kos- Yuru Egzersizinin Sedanter Orta Yasli Obez Bayanlarda Fizyolojik, Motorik ve Somatotip Degerleri Uzerine Etkisi. Gazi Egitim Fakultesi Dergisi, 2014, Cilt 23, Sayi 3.

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