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Study on Vitamin D, Cortisol and Testosterone Values in Male Skiers by Seasonal Cycles

Erkek Kayakçılarda Mevsimsel Döngülere Göre D Vitamini, Kortizol Ve Testosteron Değerlerinin Incelenmesi

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Abstract: Ski may be a branch which has the most important representation power of all winter sports. It has further been characterized by a high popularity and population which is divided into sub-branches among itself. One sometimes encounters different performance and physiological indicators in the athletes depending on seasonal cycles, training levels and living conditions during the year. The object of this study is to study vitamin D, cortisol and testosterone values in male skiers by seasonal cycles. Fourteen male skiers between 12 and 18 years of age participated in the study. Participants were studied in two groups by their age ranges. The Group 1 included 7 males whose age average was 13.0±0.8 years, height average was 153.2±8.0 cm and body weight average were 45.7±2.7 kg. The Group 2 included 7 males whose age average was 16.8±1.3 years, height average was 166.0±4.0 cm and body weight average were 64.2±6.6 kg. We determined the age, height and body mass data of the participants by standard methods. We performed a Wingate anaerobic test (WAnT) in order to determine the anaerobic power level. We took blood samples from the antecubital vein in a seated position. We performed all tests at an altitude of 2.000 meters once in January, April, June and November each. We found a significant difference in the cortisol, WBC, HCT, PP and MP parameters in the intra-group comparison results in the Group 1. And there was a significant difference in vitamin D, PP, AP and PD parameters in the Group 2. In the inter-group comparison results, we found a significant difference only in the testosterone hormone. We thought that the study results supported the literature to a great extent.

Keywords: Vitamin d, testosterone, cortisol, anaerobic power

Özet: *Amaç: Bu çalışmanın amacı, erkek kayakçılarda mevsimsel döngülere göre d vitamini, kortizol ve testosteron değerlerinin incelenmesidir. Yöntem: Çalışmaya 12-18 yaş aralığında 14 erkek kayakçı katıldı. Katılımcılar yaş aralıklarına göre iki grupta incelendi. 1. grupta; yaş ortalaması 13.0±0.8 (yıl), boy ortalaması 153.2±8.0 (cm) ve ortalama vücut ağırlığı 45.7±2.7 (kg) olan 7 erkek yer aldı. 2. grupta; yaş ortalaması 16.8±1.3 (yıl), boy ortalaması 166.0±4.0 (cm) ve ortalama vücut ağırlığı 64.2±6.6 (kg) olan 7 erkek yer aldı. Katılımcıların yaş, boy ve vücut kütlesi bilgileri standart yöntemlerle belirlendi. Anaerobik güç seviyesini belirlemek için Wingate anaerobik güç testi (WAnT) yapıldı. Antekübital venden, oturur pozisyonda, kan örnekleri alındı. Tüm testler; 2.000m rakımda, Ocak, Nisan, Haziran ve Kasım aylarında birer kez yapıldı. Bulgular: 1. grupta (n:7); kortizol hormonunda en yüksek düzeye Ocak ayında ulaşıldı (kış/test 1). Testosteron hormonunda en yüksek düzeye Haziran ayında ulaşıldı (yaz/test 3). D vitamininde ise en yüksek düzeye Kasım ayında ulaşıldı (sonbahar/test 4). Grup içi karşılaştırmalarda; kortizol hormonunda anlamlı farklılık saptandı (p<0,012). 2. grupta (n:7); D vitamini ve testosteron hormonunda en yüksek düzeye Kasım ayında (sonbahar/test 4) ulaşıldı. Kortizol hormonunda en yüksek düzeye Ocak ayında ulaşıldı (kış/test 1). Grup içi karşılaştırmalarda; D vitamininde anlamlı farklılık saptandı (p<0,012). Gruplar arası karşılaştırma sonucunda, sadece testesteron hormonunda anlamlı farklılık olduğu saptandı (p<0,012-p<0,05). Sonuç: Yaz aylarında testosteron artışının hava sıcaklığı ile ilişkili olduğu düşünüldü. Kış aylarında maksimum düzeyine ulaşan kortizolün antrenman, müsabaka, kamp dönemi gibi yoğunluklardan kaynaklandığı düşünüldü. Yaz aylarında artmaya başlayan ve sonbahar aylarında maksimum seviyeye ulaşan D vitamininin yazın bir uzantısı olduğu düşünüldü. Yine de farklı yaş gruplarını inceleyen çok denekli ve çok tekrarlı çalışmalara ihtiyaç vardır.*

Anahtar Kelimeler: *D vitamini, testosteron, kortizol, anaerobik güç.*

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INTRODUCTION

Ski has become the indispensable for the winter months. It is performed at low, medium and high altitudes as required by the environment where it is located. It therefore requires a certain period of time for both physical and physiological compatibility. And this increases the cold air effect. Physiological reactions of organisms may vary throughout the year, depending on the seasonal cycles. Hourly, daily and monthly reactions of the body are different particularly in terms of circadian (biological) rhythm.

Vitamin D deficiency has been so widespread in the present day. We think that such deficiency may affect all living conditions. Vitamin D is effective on bone formation and on the balance of the calcium and phosphorus minerals in serum. Further, it is recognized as an antirachitic vitamin and calciferol. It facilitates absorption of calcium and phosphorus from the intestines and has an effect stimulating the reabsorption of phosphorus from the kidneys. Cholecalciferol (a type of vitamin D) is composed of 7-dehydrocolesterol available in the Malpighian layer of the skin with the effect of the UV rays with 290-320nm wavelengths (Floyd, Ayyar, Barwick, Hudgson & Weightman, 1974).

Vitamin D is taken in the form of ergocalciferol and cholecalciferol through diet. Ergocalciferol and cholecalciferol are metabolized in similar ways. They hormonally affect the receptors in the kidneys, intestines, osteoblasts, parathyroid pancreatic islet cells and mammary epithelium. Furthermore, vitamin D directly affects the bone mineral metabolism. It provides the calcium and phosphorus balance in the body fluids and tissues together with calcitonin and parathormone. Similarly, vitamin D provides the immune modulation (prevention of autoimmune diseases) and the regulation of cell proliferation (prevention of malignity) as well (Floyd, Ayyar, Barwick, Hudgson & Weightman, 1974).

When 25 (OH) D3 (25-hydroxyvitamin D3/calcidiol) which is the clearest indictor of vitamin D is lower than 50 nmol/L (~20 ng/mL), it is defined as deficiency. Such parameters as the changes in vitamin D-binding globulin, seasonal changes, ethnic differences and body composition may affect the normal levels of vitamin D (Ross et al., 2011).

Effects of vitamin D on muscles are little known. In a clinic, muscle weakness, pain and hypotony are observed in those individuals with severe vitamin D deficiency. Changes in the muscle fibre size are identified through a microscope by preferred atrophy of type 2 muscle fibres (Floyd, Ayyar, Barwick, Hudgson & Weightman, 1974; Girgis, Clifton-Bligh, Hamrick, Holick & Gunton, 2013).

Critical effects of vitamin D on the skeletal muscle have been discussed for many decades. The answer starts with vitamin D receptor (VDR) which is a nuclear receptor of the same origin to which the active hormone 25-hydroxy D adheres to apply both gnomic and non-genomic effects in cells (Bouillon et al., 2008; Johnson, Grande, Roche & Kumar, 1996).

Testosterone is an anabolic steroid and interacts with the androgynous receptors (AR) in the skeletal muscle (Vingren et al., 2010; MacLean et al., 2008). Studies support that androgens increase protein synthesis and reduces catabolism and autophagy (Rossetti, Steiner & Gordon, 2017; Pollanen et al., 2015). Moreover, it has been reported that testosterone replacement produces increases in fat-free mass and muscle strength (Bhasin et al., 2012; Borst et al., 2014). Testosterone accomplishes multi-ergogenic, anabolic and anti-catabolic functions in the skeletal muscle and neuronal tissue. And this causes the muscle strength, power, firmness and hypertrophy to increase (Kraemer, Ratamess & Nindl, 2017).

It has been reported that androgens may be stimulating with exercises in men (Jardi et al., 2018). In considering from this standpoint, androgens may mediate protein synthesis (in skeletal muscle) and resistance exercise adaptation (Kraemer et al., 2020). Testosterone may be anti-catabolic by reducing glucocorticoid receptor (GR) expression and intervening with cortisol binding. Other than this, the AR-testosterone complex may compete with the cortisol-GR complex for the Cis-element binding zones on DNA (MacKrell et al., 2015).

Besides anabolic hormones, glucocorticoids, especially cortisol, have a significant effect on the skeletal muscle (Sheffield-Moore & Urban, 2004). In stable physiological conditions, cortisol in circulation hits the top in the morning and gradually reduces during the day. And it displays a circadian rhythm reaching the lowest levels around midnight (Chan & Debono, 2010). Cortisol levels are regulated on both systemic and tissue levels in order to maintain glucocorticoid homeostasis (Kraemer et al., 2020; Hsu & DeFranco, 1995; Lamberts, Huizenga, de Lange, de Jong & Koper, 1996; Polman et al., 2012).

Cortisol is effective in the regulation of energy homeostasis and metabolism in the skeletal muscle (Munck, Guyre & Holbrook, 1984). It increases the metabolic substrates and maintains the immune cell activity and vein integrity during exercises (Duclos, Gouarne & Bonnemaison, 2003).

It has also been reported that in case stress is high (scope/ intensity) in the application period, the cortisol response may reach the maximum levels (Kraemer et al., 1993; Kraemer et al., 1995). Following the acute exercise, tissue sensitivity is high against the glucocorticoids which prevent muscle inflammation, cytokine synthesis and muscle damage. Twenty-four hours after the exercise, reduction of sensitivity of monocytes to the glucocorticoids may act to protect the body from the long-term exercise-related cortisol secretion (Duclos, Gouarne & Bonnemaison, 2003; Gouarne, Groussard, Gratas-Delamarche, Delamarche & Duclos, 2005).

Purpose of The Research

The object of this study is to study the vitamin D, cortisol, testosterone, anaerobic power and some hemogram parameters in male skiers by seasonal cycles.

METHODS

Research Model: Experimental design, which is one of the quantitative research methods, was used in the research.

Group	Testing Area	1st test	2nd test	3rd test	4th test
Group 1 7 Male (Age 13.0±0.8)	Altitude 2000m	January Winter	April Spring	June Summer	November Autumn
Group 2 7 Male (Age 16.8±1.3)		WAnT / Blood Draw	WAnT / Blood Draw	WAnT / Blood Draw	WAnT / Blood Draw

Research Group

Fourteen male skiers (maintaining their standard training) between 12 and 18 years of age participated in the study. As the age range of the sample group was broad, it was studied in two separate groups. Pre- adolescence (10-12 age), early-adolescence (12-14 age), mid-adolescence (14-18 age), late-adolescence (18+++) were analyzed as two separate groups. The Group 1 included 7 males whose age average was 13.0±0.8 years, height average was 153.2±8.0 cm and body weight average were 45.7±2.7 kg. The Group 2 included 7 males whose age average was 16.8±1.3 years, height average was 166.0±4.0 cm and body weight average were 64.2±6.6 kg.

Data Collection

The study was carried out at a ski centre located at an altitude of 2.000 meters (it is also a sports camp site). The first test was performed in January (winter), the second test in April (spring), the third test in June (summer) and the fourth test in November (autumn).

We determined the age, height and body mass data of the participants by standard methods. We performed a WAnT (Monark 894 E bicycle ergometer) in order to determine the anaerobic power level.

Blood samples were taken from the antecubital vein in a fasted state in a seated position prior to the exercise test (at 9:00 AM) (for hemogram, vitamin D, cortisol and testosterone examination). We separated serum-plasma from the samples and centrifuged and then stored it at +4°C. We analysed all samples at a time. We performed the hemogram test by the low-frequency direct current impedance method (Sysmex Instrumentation, Roche Diagnostics Company-SE series, XE2100). We analysed the 25-OH-vitamin D, cortisol and testosterone by the Liquid Chromatography-Mass Spectrometer (LC-MS/MS) method (model: 4000 Q TRAP, serial number: AR26621105, manufacturer: AB SCIEX).

Statistical Analysis

We analysed the data obtained from the study in the IBM SPSS (Statistical Package for the Social Sciences) 24.0 package programme. We used the Shapiro-Wilk test to determine the distribution of the data and Descriptive Statistics to determine the averages in the demographical characteristics. We performed one-way analysis of variance analysis (ANOVA) to determine the intra-group variances, Mixed-Design ANOVA to determine the inter-group variances and Levene test for the variance homogeneity in repeated measurements. We conducted a Bonferroni correction in order to check the Type I error. We gave the results as arithmetic average and standard deviation ($\bar{X}$±SD), mean difference (MD), minimum observed value (Minimum) and maximum observed value (Maksimum). We considered the significance level to be p<0.012 for the four-repeat tests.

RESULTS

Tablo 1: Determination of intra-group means in repeated differences in repeated measurements (group 1)

Variables	1st test ($\bar{X}$±SD)	2nd test ($\bar{X}$±SD)	3rd test ($\bar{X}$±SD)	4th test ($\bar{X}$±SD)
Vitamin D (ng/mL)	20.4±6.8	21.2±7.6	23.6±11.9	24.9±8.6
Cortisol (µg/dL)	19.5±4.4	14.3±6.8	19.3±3.6	18.1±3.9
Testosterone (µg/dL)	272.3±207.7	220.2±236.0	466.0±229.3	453.5±212.4
WBC (x10^)	6.0±1.6	7.7±.8	6.2±1.3	5.0±.5
RBC (x10…)	5.2±.2	5.4±.4	5.2±.2	5.1±.2
HGB (g/L)	14.9±.9	15.4±1.8	14.9±.9	15.1±1.0
HCT (%)	43.3±2.8	44.6±4.9	43.7±2.8	54.0±3.3
PLT (cell/mL)	238.0±91.7	252.8±88.1	224.0±116.5	196.0±37.2
PP (W)	583.2±654.7	588.5±665.0	596.0±667.5	593.4±665.1
AP (W)	440.8±508.0	443.3±512.2	445.0±513.2	444.0±514.1
MP (W)	267.2±328.1	267.7±326.5	270.1±326.4	269.8±327.0
PD (W)	316.0±329.2	317.4±329.9	320.5±332.4	319.2±331.3

WBC: Leukocyte, RBC: Erythrocyte, HGB: Hemoglobin, HCT: Hematocrit, PLT: Thrombocyte, PP: Peak power, AP: Avarage power, MP: Minimum power, PD: Power drop, W: Watt

When we reviewed Table 1, we found out that while vitamin D (24.9±8.6ng/mL) and HCT (%54.0±3.3) reaches the maximum level in the fourth test, cortisol (19.5±4.4µg/dL) reaches the maximum level in the first test. We found out that while testosterone (466.0±229.3µg/dL), PP (596.0±667.5W), AP (445.0±513.2W), MP (270.1±326.4W) and PD (320.5±332.4W) reached the maximum level in the third test, WBC (7.7±.8 x10^), RBC (5.4±.4 x10…), HGB (15.4±1.8g/L) and PLT (252.8±88.1 cells/mL) reached the maximum level in the second test (table 1).

Tablo 2: Determination of intra-group means in repeated differences in repeated measurements (group 2)

Variables	1st test ($\bar{X}$±SD)	2nd test ($\bar{X}$±SD)	3rd test ($\bar{X}$±SD)	4th test ($\bar{X}$±SD)
Vitamin D (ng/mL)	17.6±4.0	18.9±4.2	17.6±4.3	21.3±3.2
Cortisol (µg/dL)	21.1±6.9	17.6±6.8	16.9±2.8	20.2±4.6
Testosterone (µg/dL)	504.3±95.4	413.8±98.0	618.58±171.2	628.1±140.5
WBC (x10^)	6.5±.7	6.9±1.6	6.6±.6	6.1±.7
RBC (x10…)	5.4±.3	5.4±.5	5.5±.3	5.1±.3
HGB (g/L)	15.4±.2.2	15.6±2.0	15.6±2.1	14.9±1.2
HCT (%)	45.3±5.2	46.2±4.8	45.7±4.6	53.5±3.6
PLT (cell/mL)	283.1±59.6	244.0±126.4	298.4±67.9	228.5±15.9
PP (W)	809.0±330.6	813.8±336.1	819.8±336.9	818.2±335.2
AP (W)	653.8±318.1	656.4±322.1	658.2±323.0	656.9±323.1
MP (W)	451.3±253.2	452.1±252.5	454.2±251.8	453.9±252.3
PD (W)	357.6±130.1	360.0±131.7	362.3±132.1	361.7±132.5

WBC: Leukocyte, RBC: Erythrocyte, HGB: Hemoglobin, HCT: Hematocrit, PLT: Thrombocyte, PP: Peak power, AP: Avarage power, MP: Minimum power, PD: Power drop, W: Watt

When we reviewed Table 2, we found out that while vitamin D (21.3±3.2ng/mL), testosterone (628.1±140.5µg/dL) and HCT (%53.5±3.6) reached the maximum level in the fourth test, cortisol (21.1±6.9µg) /dL) reached the maximum level in the first test, WBC (6.9±1.6 x10^) in the second test and HGB (15.6±2.0g/L) in the second and third tests. We found out that RBC (5.5±.3 x10…), PLT (298.4±67.9 cells/mL), PP (819.8±336.9W), AP (658.2±323.0W), MP (454.2±251.8W) and PD (362.3±132.1W) reached the maximum level in the third test (table 2).

Tablo 3: Determination of intra-group differences in repeated measurements (group 1)

Variables		1st test			2nd test			3rd test			4th test		
		2nd test	3rd test	4th test	1st test	3rd test	4th test	1st test	2nd test	4th test	1st test	2nd test	3rd test
Vit. D	*MD*	-.8	-3.1	-4.4	.8	-2.3	-3.6	3.1	2.3	-1.2	4.4	3.6	1.2
	±SD	.4	2.9	1.3	.4	2.7	1.1	2.9	2.7	1.8	1.3	1.1	1.8
	p	.8	1.0	.1	.8	1.0	.1	1.0	1.0	1.0	.1	.1	1.0
Cort.	*MD*	5.9	-.7	1.0	-5.9	-6.6	**-4.8***	.7	6.6	1.8	-1.0	**4.8***	-1.8
	±SD	1.9	1.9	1.3	1.9	1.5	**.8**	1.9	1.5	1.0	1.3	**.8**	1.0
	p	.2	1.0	1.0	.2	.08	**.03**	1.0	.08	.9	1.0	**.03**	.9
Testo.	*MD*	71.0	-186.2	-188.4	-71.0	-257.3	-259.4	186.2	257.3	-2.1	188.4	259.4	2.1
	±SD	40.5	99.6	91.6	40.5	113.1	106.2	99.6	113.1	10.2	91.6	106.2	10.2
	p	.9	.8	.6	.9	.5	.4	.8	.5	1.0	.6	.4	1.0
WBC	*MD*	-1.4	.09	1.3	1.4	1.4	**2.7***	-.09	-1.4	1.2	-1.3	**-2.7***	-1.2
	±SD	.4	.04	.5	.4	.4	**.3**	.04	.4	.5	.5	**.3**	.5
	p	.1	.6	.4	.1	.1	**.00**	.6	.1	.5	.4	**.00**	.5
RBC	*MD*	-.2	-.03	.09	.2	.1	.3	.03	-.1	.1	-.09	-.3	-.1
	±SD	.1	.04	.03	.1	.1	.1	.04	.1	.06	.03	.1	.06
	p	1.0	1.0	.3	1.0	1.0	.6	1.0	1.0	.6	.3	.6	.6
HGB	*MD*	-.6	-.1	-.2	.6	.5	.3	.1	-.5	-.1	.2	-.3	.1
	±SD	.3	.08	.1	.3	.3	.3	.08	.3	.1	.1	.3	.1
	p	1.0	1.0	.5	1.0	1.0	1.0	1.0	1.0	1.0	.5	1.0	1.0
HCT	*MD*	-1.5	-.6	**-10.0***	1.5	.8	**-8.5***	.6	-.8	**-9.3***	**10.0***	**8.5***	**9.3***
	±SD	.9	.3	**.5**	.9	.9	**1.3**	.3	.9	**.8**	**.5**	**1.3**	**.8**
	p	1.0	.7	**.00**	1.0	1.0	**.01**	.7	1.0	**.00**	**.00**	**.01**	**.00**
PLT	*MD*	9.2	7.8	72.8	-9.2	-1.4	63.6	-7.8	1.4	65.0	-72.8	-63.6	-65.0
	±SD	49.9	11.9	28.1	49.9	61.3	26.8	11.9	61.3	39.7	28.1	26.8	39.7
	p	1.0	1.0	.3	1.0	1.0	.4	1.0	1.0	1.0	.3	.4	1.0
PP	*MD*	-7.2	-14.7	-12.1	7.2	**-7.4***	**-4.8***	14.7	**7.4***	2.6	12.1	**4.8***	-2.6
	±SD	5.4	6.8	5.4	5.4	**1.4**	**.04**	6.8	**1.4**	1.3	5.4	**.04**	1.3
	p	1.0	.5	.5	1.0	**.03**	**.00**	.5	**.03**	.7	.5	**.00**	.7
AP	*MD*	-3.1	-5.0	-4.1	3.1	-1.9	-1.0	5.0	1.9	.8	4.1	1.0	-.8
	±SD	2.2	2.7	3.2	2.2	.5	.9	2.7	.5	.4	3.2	.9	.4
	p	1.0	.8	1.0	1.0	.1	1.0	.8	.1	.8	1.0	1.0	.8
MP	*MD*	-,.2	-2.6	-2.4	.2	**-2.4***	**-2.1***	2.6	**2.4***	.2	2.4	**2.1***	-.2
	±SD	.8	.9	.6	.8	**.1**	**.2**	.9	**.1**	.3	.6	**.2**	.3
	p	1.0	.2	.09	1.0	**.00**	**.00**	.2	**.00**	1.0	.09	**.00**	1.0
PD	*MD*	-1.5	-5.0	-3.4	1.5	-3.4	-1.9	5.0	3.4	1.5	3.4	1.9	-1.5
	±SD	.3	1.7	1.1	.3	1.3	.7	1.7	1.3	.6	1.1	.7	.6
	p	.07	.2	.2	.07	.3	.3	.2	.3	.4	.2	.3	.4

Vit. D: Vitamin D, Cort.: Cortisol, Testo.: Testosteron, WBC: Leukocyte, RBC: Erythrocyte, HGB: Hemoglobin, HCT: Hematocrit, PLT: Thrombocyte, PP: Peak power, AP: Avarage power, MP: Minimum power, PD: Power drop

When we reviewed Table 3, we found out that the cortisol hormone was significantly different between the second and fourth tests; WBC between the second and fourth tests; HCT between the first, second and third tests of the fourth tests; PP and MP between the second test and the third and fourth tests ($p<0.012$).

Tablo 4: Determination of intra-group differences in repeated measurements (group 2)

Variables		**1st test**			**2nd test**			**3rd test**			**4th test**		
		2nd test	**3rd test**	**4th test**	**1st test**	**3nd test**	**2nd test**	**3rd test**	**4th test**	**1st test**	**1nd test**	**2nd test**	**3rd test**
Vit. D	***MD***	**-1.3***	2.7	-2.5	**1.3***	4.0	-1.2	-2.7	-4.0	-5.3	2.5	1.2	5.3
	±SD	**.2**	1.3	.8	**.2**	1.3	.8	1.3	1.3	1.4	.8	.8	1.4
	p	**.02**	.7	.2	**.02**	.2	1.0	.7	.2	.1	.2	1.0	.1
Cort.	***MD***	2.8	.8	-.4	-2.8	-1.9	-3.2	-.8	1.9	-1.2	.4	3.2	1.2
	±SD	2.0	3.7	1.4	2.0	4.1	1.7	3.7	4.1	2.7	1.4	1.7	2.7
	p	1.0	1.0	1.0	1.0	1.0	.8	1.0	1.0	1.0	1.0	.8	1.0
Testo.	***MD***	112.6	-104.1	-126.4	-112.6	-216.7	-239.0	104.1	216.7	-22.3	126.4	239.0	22.3
	±SD	68.1	86.3	70.0	68.1	80.5	75.2	86.3	80.5	21.0	70.0	75.2	21.0
	p	1.0	1.0	.8	1.0	.3	.2	1.0	.3	1.0	.8	.2	1.0
WBC	***MD***	-.4	.1	.2	.4	.6	.7	-.1	-.6	.1	-.2	-.7	-.1
	±SD	.8	.06	.1	.8	.8	.9	.06	.8	.1	.1	.9	.1
	p	1.0	.5	1.0	1.0	1.0	1.0	,524	1.0	1.0	1.0	1.0	1.0
RBC	***MD***	.02	-.01	.2	-.02	-.04	.2	.01	.04	.3	-.2	-.2	-.3
	±SD	.2	.04	.3	.2	.2	.3	.04	.2	.3	.3	.3	.3
	p	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
HGB	***MD***	-.02	-.08	.5	.02	-.06	.5	.08	.06	.5	-.5	-.5	-.5
	±SD	.5	.07	.7	.5	.5	.7	.07	.5	.7	.7	.7	.7
	p	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
HCT	***MD***	-.3	.1	-8.3	.3	.4	-8.0	-.1	-.4	-8.5	8.3	8.0	8.5
	±SD	1.9	.1	3.7	1.9	1.9	3.2	.1	1.9	3.6	3.7	3.2	3.6
	p	1.0	1.0	.5	1.0	1.0	.3	1.0	1.0	.4	.5	.3	.4
PLT	***MD***	29.6	-2.6	52.8	-29.6	-32.2	23.2	2.6	32.2	55.4	-52.8	-23.2	-55.4
	±SD	57.5	8.1	24.7	57.5	60.8	51.3	8.1	60.8	27.8	24.7	51.3	27.8
	p	1.0	1.0	.6	1.0	1.0	1.0	1.0	1.0	.7	.6	1.0	.7
PP	***MD***	-4.8	-10.7	**-9.2***	4.8	**-5.9***	**-4.4***	10.7	**5.9***	1.5	**9.2***	**4.4***	-1.5
	±SD	2.5	2.8	**2.1**	2.5	**1.0**	**.4**	2.8	**1.0**	1.2	**2.1**	**.4**	1.2
	p	.6	.05	**.03**	.6	**.00**	**.00**	.05	**.00**	1.0	**.03**	**.00**	1.0
AP	***MD***	-2.6	-4.4	-3.1	2.6	**-1.7***	-.4	4.4	**1.7***	**1.3***	3.1	.4	**-1.3***
	±SD	1.7	2.1	2.1	1.7	**.3**	.4	2.1	**.3**	**.05**	2.1	.4	**.05**
	p	1.0	.4	1.0	1.0	**.01**	1.0	.4	**.01**	**.00**	1.0	1.0	**.00**
MP	***MD***	-.7	-2.9*	-2.5*	.7	-2.1*	-1.7*	2.9*	2.1*	.3	2.5*	1.7*	-.3
	±SD	.3	.6	.4	.3	.3	.1	.6	.3	.2	.4	.1	.2
	p	.2	.02	.00	.2	.00	.00	.02	.00	.9	.00	.00	.9
PD	***MD***	-2.3	-4.7	-4.0	2.3	**-2.3***	-1.7	4.7	**2.3***	.6	4.0	1.7	-.6
	±SD	1.1	1.4	1.7	1.1	**.2**	.5	1.4	**.2**	.2	1.7	.5	.2
	p	.5	.1	.3	.5	**.00**	.1	.1	**.00**	.3	.3	.1	.3

Vit. D: Vitamin D, Cort.: Cortisol, Testo.: Testosteron, WBC: Leukocyte, RBC: Erythrocyte, HGB: Hemoglobin, HCT: Hematocrit, PLT: Thrombocyte, PP: Peak power, AP: Avarage power, MP: Minimum power, PD: Power drop

When we reviewed Table 4, we found out that vitamin D was significantly different between the first and second tests; PP between the first and fourth tests, between the second test and the third and fourth tests, between the fourth test and the first and second tests; AP between the second and third tests, between the third test and the second and fourth tests, between the fourth and third tests; PD between the second and third tests ($p<0.012$).

Tablo 5: Determination of differences between groups in repeated measurements

	Vit. D	Cort.	Testo.	WBC	RBC	HGB	HCT	PLT	PP	AP	MP	PD
MS	33.7	4.3	121953.9	.2	.00	.01	.5	1974.0	126.2	121.0	7013.2	7949.4
F	.6	.3	4.9	.3	.05	.00	.05	.6	.00	.00	.07	.09
p	.4	.5	**.05**	.5	.8	.9	.8	.4	.9	.9	.7	.7

Vit. D: Vitamin D, Cort.: Cortisol, Testo.: Testosteron, WBC: Leukocyte, RBC: Erythrocyte, HGB: Hemoglobin, HCT: Hematocrit, PLT: Thrombocyte, PP: Peak power, AP: Avarage power, MP: Minimum power, PD: Power drop, MS: Mean square

When we reviewed Table 5, we found out that there was only a significant difference in the testosterone hormone (p<0,012-p<0,05).

DISCUSSION

Research on the parameters studied in the study was discussed, reported and interpreted.

Topal et al. (2018) determined in the study they carried out that the children in the province of Erzincan had vitamin D deficiency at a rate of 42,3 percent and inadequacy at a rate of 27,2 percent. They reported that only 30,5% of the children was above the reference values accepted for vitamin D. In the seasonal review carried out in the same study, they observed that there was a reduction in the vitamin D levels of both boys and girls (in all age groups) during the winter and spring months (Topal et al., 2018).

In a study carried out in the province of Samsun, while the serum 25-OH D level of a total of 13.395 people was determined as 14,71 ± 10,21 ng/mL during the winter months, the serum 25-OH D level of a total of 10.378 people was determined as 19,13 ± 11,09 ng/mL during the summer months. While the higher level in the summer months is considered to be possible, it attracts attention the averages are of significant deficiency level (<20 ng/ml) in both seasons (Çubukçu, Acı & Müderrisoğlu, 2019).

When it is compared with the result of our study, the lower vitamin D level is similar in general. However, the seasonal analysis results appear to be different. In our study, the results proving to be higher in the winter months have been considered to be the extension of the summer months. At the same time, the period when active skiing takes place is rather the winter months. Due to the altitude of the environment, the athletes are exposed to direct and more intense sun rays in this period.

Öğüş et al. (2015) found the mean vitamin D levels of the patients as 22,80±13,27 ng/mL in the January-December period. In 47,00% of the patients (50% in women and 38& in men), the vitamin D level was below the deficiency limit (<20 ng/mL), in 28,00 within the deficiency limits (20-30 ng/mL) and in 25,00% most of these was at the optimal level (>30 ng/mL) (Öğüş et al., 2015).

Compared to the result of our study, the low vitamin D level is the same in general. We see that the results that are closest to those of the relevant study are obtained in our study (in November and January).

Seo et al. (2019) caused 47 teenager taekwondo athletes (age 16,7±0,84 years, height 175,2±5,97 cm, body mass 66,2±10,46 kg and training experience 53,4±10,60 months) to have training for at least 3 hours a day and 5 days a week in a study. They determined that approximately 75% of the participants had vitamin D deficiency at the end of the study (Seo et al., 2019).

In some studies carried out on football players and gymnasts, it was reported that the frequency of observing vitamin D deficiency or inadequacy varied between 59% and 94% (Owens, Allison & Close, 2018; Lovell, 2008; Willis, Peterson & Larson-Meyer, 2008). Abate and Salini (2022) studied the seasonal variances in vitamin D, cortisol and testosterone secretion in a study which they carried out on football players in the Italian Serie B (38 of Caucasian and 12 of African origin, making a total of 50 football players). They found out that all athletes who participated in the study had high testosterone levels in the summer months. They linked the reason for this to their unlimited life style and sexual excitement. They found cortisol at high levels in the winter months and put forward the weather conditions, event and training intensities as the reason therefor. They found vitamin D at high levels in the summer months and stated as a reason therefor that the skin which was exposed to ultraviolet B radiation synthesised better. It was reported that the results of the study were similar to those available in the literatüre (Abate & Salini, 2022).

In a study which Lombardi et al. (2017) carried out on 167 professional football players playing in the Italian league, they studied the seasonal variances in vitamin D, testosterone and cortisol secretion. They found out as a result of the study that the vitamin D and testosterone levels increased in the summer months but the cortisol level was higher in the winter months (Lombardi et al., 2017). This study supports the results of our study in terms of the testosterone and cortisol hormones. However, in our study, vitamin D started to increase in the summer months and reached the maximum level in autumn. The results vary at this point. As a reason therefore, we think that it arises from th different structures and characteristics of the sample groups.

In a study which Michalczyk et al. (2020) carried out during the season, they studied the effects of the winter sun and the summer sun on vitamin D. As a result of the study, they found out that the winter sun increased the vitamin D level more than normal and that the summer sun further increased the vitamin D level as compared to the winter sun (Michalczyk et al., 2020).

Conclusion

In the Group 1 (n:7), the maximum level was reached in the cortisol hormone in January (winter/test 1). The maximum level was reached in testosterone, PP, AP, MP and PD values in June (summer/test 3); and the maximum level was reached in WBC, RBC, HGB and PLT in April (spring/test 2) (table 1).

In the intra-group studies, we found a significant variance in the cortisol, WBC, HCT, PP and MP parameters ($p<0,012$) (table 3).

In the Group 2 (n:7), the maximum level was reached in vitamin D, testosterone and HCT values in November (autumn/test 4). The maximum level was reached in the cortisol hormone in January (winter/test 1). The maximum level was reached in WBC in April (spring/test 2); the maximum level was reached in HGB in April and June (spring/test 2 and summer/test 3). The maximum level was reached in RBC, PLT, PP, AP, MP and PD values in June (summer/test 3) (table 2).

In the intra-group studies, we found a significant variance in the vitamin D, PP, AP and PD parameters ($p<0,012$) (table 4).

As a result of the inter-group comparison, we found out that there was only a significant variance in the testosterone hormone ($p<0,012$-$p<0,05$) (table 5).

We found out that the results of the study are usually analogous to those of the literature. We think that the increase in testosterone in the summer months is associated with the weather temperature. We think that cortisol which reaches its maximum level in the winter months arises from such intensities as training, competition and camp period, etc.

We thought that vitamin D's starting to increase in the summer months and reaching the maximum level in the autumn months was an extension of the summer. At the same time, active skiing period is usually the autumn-winter months. Considering that the athletes are exposed to direct and more intense winter sun at higher altitudes, we think that the results are possible.

In consideration of the gender and age of the participants, height of the altitude where workout takes place, training environment and training level, we think that possible results have been obtained.

Suggestion;

There is a need for multi-subject and multi-repetitive studies examining different age groups.

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Author Contributions: In this study, the contribution rate of the first author was 35%, the contribution rate of the second author was 25%, the contribution rate of the third author was 25%, and the contribution rate of the fourth author was 15%.

Conceptualization, B.C. and T.D.S.; methodology, B.C. and T.D.S.; software, T.D.S.; validation, B.C., U.İ., T.D.S. and M.C.; formal analysis, T.D.S.; investigation, B.C., U.İ. and M.C.; resources, B.C. and U.İ.; data curation, B.C. and T.D.S.; writing—original draft preparation, T.D.S., U.İ. and B.C.; writing—review and editing, M.C.; visualization, T.D.S.; supervision, M.C.; project administration, B.C All authors have read and agreed to the published version of the manuscript.

Ethics Text

The approval for this study was obtained from Clinical Research Ethics Board of Erzincan Binali Yıldırım University (Approval number: 08/02 Date: 09.07.2019).

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GENİŞLETİLMİŞ ÖZET

Çalışmanın Amacı: Bu çalışmanın amacı, erkek kayakçılarda mevsimsel döngülere göre d vitamini, kortizol ve testosteron değerlerinin incelenmesidir.

Araştırmanın Soruları: Mevsimlere göre d vitamini, kortizol ve testosteron düzeyinde belirgin değişim yaşanır mı? Erkek kayakçılarda, d vitamini, kortizol ve testosteron düzeyinde artış, yaz aylarında mı yoksa kış aylarında mı gözlenir?

Literatür Araştırması: Literatür incelemesinde, dönemsel olarak ilgili hormonlardaki değişimi inceleyen birçok çalışmaya rastlanmaktadır. Bir araştırmada, Ocak-Aralık döneminde hastaların ortalama D vitamini düzeyleri 22,80±13,27 ng/mL olarak belirlenmiştir. Hastaların %47'sinde (kadınlarda %50, erkeklerde %38) D vitamini düzeyi eksiklik sınırının (<20 ng/mL) altında, %28'inde eksiklik sınırları içinde (20-30 ng/mL), %25'inde bunların çoğunun optimal düzeyde (>30 ng/mL) olduğu belirlenmiştir (Öğüş ve ark., 2015). İtalya liginde oynayan 167 profesyonel futbolcu üzerinde yapılan bir çalışmada, D vitamini, testosteron ve kortizol salgılanmasındaki mevsimsel değişimleri incelenmiştir. Çalışma sonucunda yaz aylarında D vitamini ve testosteron düzeylerinin arttığı, kış aylarında ise kortizol düzeylerinin daha yüksek olduğu belirlenmiştir (Lombardi ve ark., 2017). Mevsim boyunca yapılan bir başka çalışmada, kış güneşi ve yaz güneşinin D vitamini üzerindeki etkileri incelenmiştir. Çalışma sonucunda, kış güneşinin D vitamini düzeyini normalden daha fazla artırdığı, yaz güneşinin ise kış güneşine göre D vitamini düzeyini daha fazla artırdığı belirlenmiştir (Michalczyk ve ark., 2020).

Yöntem: Çalışmaya 12-18 yaş aralığında 14 erkek kayakçı katıldı. Katılımcılar yaş aralıklarına göre iki grupta incelendi. 1. grupta; yaş ortalaması 13.0±0.8 (yıl), boy ortalaması 153.2±8.0 (cm) ve ortalama vücut ağırlığı 45.7±2.7 (kg) olan 7 erkek yer aldı. 2. grupta; yaş ortalaması 16.8±1.3 (yıl), boy ortalaması 166.0±4.0 (cm) ve ortalama vücut ağırlığı 64.2±6.6 (kg) olan 7 erkek yer aldı. Katılımcıların yaş, boy ve vücut kütlesi bilgileri standart yöntemlerle belirlendi. Anaerobik güç seviyesini belirlemek için Wingate anaerobik güç testi (WAnT) yapıldı. Antekübital venden, oturur pozisyonda, kan örnekleri alındı. Tüm testler; 2.000m rakımda, Ocak, Nisan, Haziran ve Kasım aylarında birer kez yapıldı.

Sonuç ve Değerlendirme: 1. grupta (n:7), kortizol hormonunda maksimum düzeye Ocak ayında ulaşıldı (kış/test 1). Testosteron, PP, AP, MP ve PD değerlerinde maksimum seviyeye Haziran ayında ulaşıldı (yaz/test 3); WBC, RBC, HGB ve PLT'de maksimum seviyeye Nisan'da ulaşıldı (ilkbahar/test 2) (tablo 1). Grup içi karşılaştırmalarda kortizol, WBC, HCT, PP ve MP parametrelerinde anlamlı farklılık saptandı (p<0,012) (tablo 3).

2. grupta (n:7), D vitamini, testosteron ve HCT değerlerinde en yüksek seviyeye Kasım ayında (sonbahar/test 4) ulaşıldı. Kortizol hormonunda maksimum seviyeye Ocak ayında ulaşıldı (kış/test 1). WBC'de maksimum seviyeye Nisan'da ulaşıldı (ilkbahar/test 2); HGB'de maksimum seviyeye Nisan ve Haziran aylarında ulaşıldı (ilkbahar/test 2 ve yaz/test 3). RBC, PLT, PP, AP, MP ve PD değerlerinde maksimum seviyeye Haziran ayında ulaşıldı (yaz/test 3) (tablo 2). Grup içi karşılaştırmalarda vitamin D, PP, AP ve PD parametrelerinde anlamlı farklılık saptandı (p<0,012) (tablo 4). Gruplar arası karşılaştırma sonucunda, sadece testesteron hormonunda anlamlı farklılık olduğu saptandı (p<0,012-p<0,05) (tablo 5). Çalışma sonuçlarının literatürdeki sonuçlarla genellikle benzer olduğu görüldü. Yaz aylarında testosteron artışının hava sıcaklığı ile ilişkili olduğu düşünüldü. Kış aylarında maksimum düzeyine ulaşan kortizolün antrenman, müsabaka, kamp dönemi gibi yoğunluklardan kaynaklandığı düşünüldü. Yaz aylarında artmaya başlayan ve sonbahar aylarında maksimum seviyeye ulaşan D vitamininin yazın bir uzantısı olduğu düşünüldü. Aynı zamanda aktif kayak dönemi genellikle sonbahar-kış aylarıdır. Sporcuların daha yüksek irtifalarda doğrudan ve daha yoğun kış güneşine maruz kaldıkları göz önüne alındığında sonuca önemli etkisi olduğu düşünülmektedir. Katılımcıların cinsiyeti ve yaşı, antrenman yapılan rakımın yüksekliği, antrenman ortamı ve antrenman seviyesi dikkate alındığında olası sonuçların elde edildiği düşünülmektedir. Yine de farklı yaş gruplarını inceleyen çok denekli ve çok tekrarlı çalışmalara ihtiyaç vardır.