Central Asian Journal of Medicine

Volume 2021 | Issue 3 Article 1

10-4-2021

VITAMIN 25 (OH) D STATUS OF BUNYODKOR FOOTBALL CLUB PLAYERS WITH DIFFERENT MORPHOPHENOTYPES

Lyubov N. Khegay
Tashkent Medical Academy, Tashkent, 100109, Uzbekistan, Luba0202.55@mail.ru

Larisa A. Skvortsova
Republican Scientific and Practical Center for Sports medicine at the National Olympic Committee of Uzbekistan, Tashkent, 100027, Uzbekistan, Skvor.larisa@mail.ru

Nargiza A. Jumanova
Tashkent Medical Academy, Tashkent, 100109, Uzbekistan

Central Asian Journal of Medicine

VITAMIN 25 (OH) D STATUS OF BUNYODKOR FOOTBALL CLUB PLAYERS WITH DIFFERENT MORPHOPHENOTYPES

Lyubov N. Khegay[1], Larisa A. Skvortsova[2], Nargiza A. Jumanova[3]

1 Candidate of Medical Sciences, Associate Professor, Head of the Department for Coordination of Grants Activities of the Interuniversity Research Laboratory, Tashkent medical academy, Uzbekistan
E-mail: Luba0202.55@mail.ru

2 Basic doctoral student (PhD), Republican Scientific and Practical Center for Sports medicine at the National Olympic Committee of Uzbekistan, Tashkent, Uzbekistan
E-mail: Skvor.larisa@mail.ru

3 Candidate of Medical Sciences, Head of the Branch of the Central Clinical and Diagnostic Laboratory of the Multidisciplinary Clinic of Tashkent Medical Academy, Uzbekistan

ABSTRACT

The article presents the results of studying the sum of concentrations of cholecalciferol isoforms (vit. D3) + ergocalciferol (vit. D2) in the blood serum of Bunyodkor FC players with different morphofunctional phenotypes by seasons of the year. Epidemiological studies of the status of vitamin 25 (OH) D in the blood serum of 53 football players were carried out taking into account the maximum total solar radiation (Qmonth, kilowatt hours /m^2) in the climatic conditions of Tashkent city. A significant prevalence of Vitamin D deficiency in summer, autumn and winter and deficiency in spring was established among young football players.

Key words: sports, football players, cholecalceferol, vitamin D, 25-hydroxyvitamin D, morphofunctional phenotype, deficiency, insufficiency, nutritional and metabolic support

INTRODUCTION

Relevance of the work. In sports medicine, there are special and protective effects of vitamin D. Special effects include direct and indirect ergogenic effects on the characteristics of physiological readiness of athletes, protective effects include increased resistance to diseases of infectious etiology, stabilization of lipid and carbohydrate metabolism, reduction of the risk of developing cardiovascular diseases, obesity, diabetes II and autoimmune diseases [1,2].

Vitamin D is a key participant in the metabolism of bone tissue and affects not only calcium metabolism, but also regulates many processes in the body. According to Kevin D Cashman (2007), the biological effects of 1,25 $(OH)_2D_3$ can be divided into 2 categories: "classical actions", mainly affecting calcium homeostasis; and "non-classical actions", which include functions not related to calcium metabolism, such as regulation of cell differentiation and proliferation, cell growth, regulation of hormone secretion [3].

In the sport of Olympic achievements, heavy physical loads on the musculoskeletal, central, and peripheral nervous and immune systems exceed the physiological capabilities of the body. In the pre-competition and competitive stages, the athletes' body is subjected to enormous physical and emotional influences. In addition, the body of athletes needs the maximum speed of recovery of working capacity after training and performances. As a result, the correction of vitamin D deficiency (Vitamin D) is not a temporary, but a permanent problem in sports, which determines the need to study the clinical and pharmacological aspects of the mechanism of action and use of Vitamin D and its drugs [1]. The production of Vitamin D due to skin synthesis or receipt from a small amount of products rich in vitamin D usually occurs only intermittently [4]. Under the influence of ultraviolet rays of the sun, skin cells synthesize part of the Vitamin D. The availability of endogenous Vitamin D is subject to significant fluctuations throughout the year, reaching a maximum in the summer months and a minimum in winter. Therefore, a "seasonal" correction of insufficiency and deficiency of Vitamin D is justified for athletes. However, the specific timing of the start and duration of "seasonal" prevention, the list of recommended fortified sports nutrition products and the criteria for the effectiveness of the measures taken are not justified [5].

Recently, it has been proved that Vitamin D is a key protective factor in physical overstrain and fatigue of the athletes ' body. According to International and National classifiers, Vitamin D and its compounds are included in the highest level of evidence and the need for use in sports medicine - category "A". It is determined that Vitamin D and drugs based on it, as "... medical additives-are used for medical indications, including a diagnosed deficiency of this nutrient (pharmaconutrient)". Under the supervision of sports medicine doctors, it is necessary to prescribe personalized doses of the pharmaconutrient Vitamin D. The prohormone is integrated into level A, since all "evidence is based on data from a variety of randomized clinical studies or meta-analyses" [2,6,7].

In the work of A. Y. Khrebtova and A. I. Kuzina (2019), it was noted that among athletes due to excessive physical exertion, an epidemic of insufficiency and deficiency of Vitamin D is characteristic, due to its insufficient intake with food [4]. A. Dmitrieva and A. Kalincheva (2017) believe that these data contributed to "... the uncontrolled use of Vitamin D as a supplement to the sports diet". This explains the close attention of scientists to the problem of ergogenic effects of Vitamin D in sports medicine. There is no consensus among researchers regarding the criteria for the classification of deficiency and the basic

concentration of Vitamin D. It is also not justified to prescribe large doses of vitamin to athletes with its deficiency [1]. The materials of the Research Institute of Sports “Gatorade” (Great Britain) indicate that “... the last decade can be called a "renaissance" of interest in scientific research of vitamin D” [6]. The results of studies published by Graeme L. Close in 2015 confirm that the pharmaconutrient Vitamin D is associated with numerous important biological actions relevant to the athlete, including the regulation of bone health, immune function, cell cycle and skeletal muscle homeostasis [8]. Holick M. F et al. (2011) also found that Vitamin D has a modulating effect on the activity of steroid hormones, controlling metabolic processes [9]. Identification of receptors (VDR–Vitamin D receptors) of the hormonally active form of vitamin 1,25 (OH)2D in body tissues in independent studies by Demay M. B. (2006) and Jong N, Chin A, Paw MJ et al. (1999) proved the fundamental biological role of this prohormone [10,11]. It was found that the endocrine system in the presence of VDR receptors is able to react in a specific way to 1,25-dioxyvitamin D in 38 organs and tissues of the body [4,11,12,13]. Gröber U. et al. (2015) also believe that the extra-bone effects of the active form of D-hormone expand the understanding of its specific role in the body [14].

Object and methods of research. The studies were conducted from 2018 to 2020. In the base of the Republican Scientific and Practical Center of Sports Medicine at the NOC of Uzbekistan, 16 athletes of the Nasaf FC aged 17-25 years (control group) and 53 Bunyodkor FC players of indigenous nationality aged 16.75+3.91 years (observation group) took part. Biochemical studies of Nasaf professionals were carried out within the framework of the UMO on the immunochemical electrochemiluminescent analyzer Cobas e 411 of Roche Diagnostics GmbH (Germany). The studies of the Bunyodkor FC players were carried out on an immunochemical electrochemiluminescent analyzer Raito RT-2100C Microplate Reader (Germany) using a set of 25 (OH)D ELISA on the basis of the TMA Interuniversity Research Laboratory. The sum of concentrations of isoforms of cholecalciferol (vit.D3)+ergocalciferol (vit.D2) in blood serum was studied in 53 Bunyodkor FC players. Both forms of Vitamin D in this study are measured equimolarly. Blood sampling was carried out 2 times a day (in the morning and in the evening). The results of 2 studies were summarized and the average value of the content of 25(OH) D was calculated in the serum. Prior to the start of the research, all the research participants gave their written consent. Along with the determination of the concentration of 25 (OH)D according to the seasons of the year, the morphofunctional phenotype of athletes, growth indicators, chest circumference, caliperometry, vital capacity of the lungs (VCL), carpal dynamometry, body mass index were studied. The data of the variation series are presented as the arithmetic mean (M) ± standard deviation (SD) in the case of a normal distribution and as the median (Md) or quartiles Q or SD for other deviations. The processing of the research results was carried out on a PC-IV using Microsoft Exell office application programs and the Statplus biostatistics program (2009) with the calculation of the arithmetic mean (M), its standard error (m),

confidence indicators (P) and the Student's criterion For statistically significant changes, the confidence level P<0.05 was taken [15].

The results of our own research.

The pilot studies were conducted in 3 stages.

At the 1st stage, a comparative analysis of the climatic conditions of Uzbekistan with other countries in which the strongest football teams are accredited was carried out.

Based on the above, it is established that the geographical coordinates of Tashkent are latitude:41.3082, longitude:69.2598, 41 18′ 30″ North, 69 15' 35 " East. The height above sea level is 457 m/ur. Mediterranean climate (Köppen Climate Classification: Csa - According to the Köppen climate classification, the climate is "hot dry summer" (classified as Csa) Mediterranean climate [16]. At the 2nd stage of the pilot study, the content of serum 25(OH)was studied according to the seasons of the yearD in 53 young athletes of the Bunyodkor youth football team for four seasons of the year in the pre-competition period, taking into account the maximum total solar radiation (Qmonth, kWh/m^2) [17]. In Uzbekistan, the SanPiN No. 0347-17 "Physiological norms of nutritional and energy needs for gender, age and occupational groups of the population of the Republic of Uzbekistan for maintaining a healthy diet"has been developed. The document takes into account WHO recommendations and regional peculiarities related to the climate and nutrition of the population of Uzbekistan. The average daily consumption of Vitamin D is recommended taking into account the division of the population into groups of labor intensity. Since the SanPiN does not allocate such a target group as athletes, we conditionally assigned the Bunyodkor FC players to the IV group "Workers of heavy physical labor". The standard specifies only the recommended average daily norms of vitamin requirements for various sex and age groups aged 14-17 years, amounting to 5 mcg/l (5 ng / ml), and professional groups of the adult population aged 18-29 years at a dose of 4.5 mcg/l (4.5 ng/ml). Based on this, we used the total serum 25(OH) D indicator as reference values is set according to the criteria recommended for foreign athletes:

pronounced deficiency - at <12 ng/l 25 (OH)D;
deficiency - at >12<30 ng/l 25 (OH)D;
insufficiency - at 30-50 ng/l 25 (OH)D;
adequate level - at > 50 ng/l 25 (OH)D;
optimal - at >100 -250 ng/l 25 (OH) D.

For qualitative analysis, the average monthly values of solar radiation entering the inclined surface of the territory of Tashkent, oriented to the south at various angles of inclination, are calculated. Under average cloud conditions, the maximum is in the values of Qseas. it corresponded to 248.4 kWh/m^2 in the month of July. The average concentration of 25 (OH) D in football players for the months of June, July and August corresponded to 23.74+6.29 ng/l (Fig. 1).

Therefore, in the summer, the players of Bunyodkor FC have a serum concentration of 25 (OH)D at the level of 23.74+6.29 ng/l indicates a deficiency of Vitamin D in comparison with the recommended adequate norms > 50 ng/l.

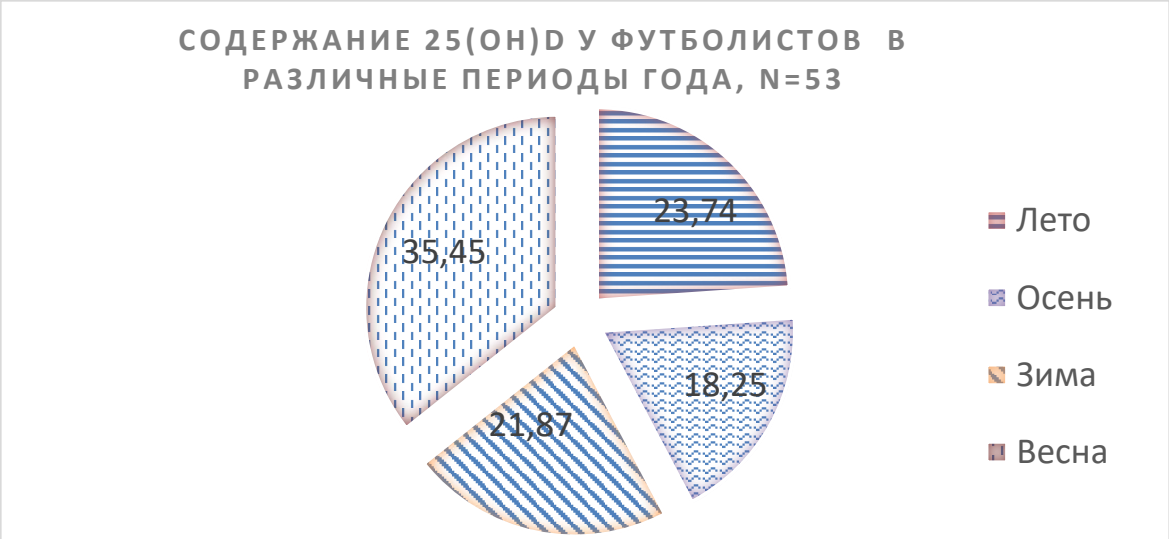

Fig. 1. Distribution of average concentrations of 25 (OH) D by seasons of the year among young Bunyodkor FC players.

In the autumn period of the year with average cloud conditions, the maximum in the values of Qseas. it was observed in September at the level of 189.4 kWh/m^2. The average concentration of 25 (OH) D in the autumn season was set at the level of 18.25+ 5.21 ng/l, which is 1.3 times less than in summer (Fig. 1). The results of the studies allowed us to state that in the autumn, the Bunyodkor FC players had a serum concentration of 25 (OH)D at the level of 18.25+5.21 ng/l indicates a deficiency of Vitamin D in comparison with the recommended adequate norms > 50 ng/l.

In the winter season, the maximum in the values of Qseas. it is observed in the month of November at the level of 103.7 kWh/m^2. The average value of the concentration of 25(OH) D in serum in winter was set at 21.87+5.07 ng/l, which is 1.1 times less than in summer, 1.2 times higher than in the autumn season and 1.6 times lower than in the spring period (Fig. 2). The results obtained indicate a deficiency of the serum concentration of 25 (OH)D in the winter season compared to the recommended adequate standards > 50 ng/l.

In the spring months, the maximum in the values of Qseas. It is observed in the month of May at the level of 209.4 kWh/m^2. The average concentration of 25 (OH) D in March-May was set at 35.45+3.7 ng/l of 25 (OH) D, which is 1.62 times higher than in winter, 1.94 times higher than in autumn and 1.49 times higher than in summer (Fig.1). Content 25(HE)D in the blood serum of athletes at a concentration of 35.45 ng/l indicates an insufficient supply of the athletes ' body with Vitamin D compared to the recommended adequate norms > 50 ng/l. Thus, the results of the conducted studies allowed us to establish that the highest content of serum 25 (OH)D of the Bunyodkor FC athletes, it was revealed in the spring,

slightly lower in the summer and winter, the lowest indicators in the autumn. A comparative analysis of the results obtained allowed us to state that the indicators of the serum concentration of 25 (OH)D among the Bunyodkor FC players indicates a deficit in summer, autumn and winter, and in spring an insufficient level of Vitamin D. The deficit in the summer and autumn seasons of the year is associated with high dustiness of the atmosphere, as a result of which UV rays of type B do not reach the earth's surface, and as a result, the synthesis of Vitamin D in the skin decreases and, as a result, the serum concentration of 25(OH) D decreases in the body. In winter, the synthesis of Vitamin D in the skin practically stops due to the lack of UV radiation from the sun. Because of this, there is a deficiency of Vitamin D in the body. The highest content is 25 (OH)D in the blood serum of athletes in the spring at a concentration of 35.45 ng/l is associated with less dustiness of the atmosphere and insufficient natural insolation due to the prevalence of cloudy days. Comparison with the reference values allowed us to state the insufficient level of security of the athletes ' body in the spring season of the year. Thus, the results of the conducted studies made it possible to establish a deficit in the Bunyodkor FC young athletes in summer, autumn and winter, and in spring an insufficient level of total serum 25(OH)Vitamin D.

At the 3rd stage, the content of serum 25(OH)D was studied according to the seasons of the year taking into account the morphophenotype of 53 Bunyodkor FC young athletes in the pre-competition period. Taking into account the fact of insufficiency and deficiency of the content of total serum 25 (OH)VitD of Bunyodkor FC players, we decided to test the hypothesis of a group of scientists from Great Britain led by G. L. Close (2013). Researchers believe that an increase in the concentration of 25 (OH)D in blood plasma above 40 ng/l in athletes with initial low indicators can generate a positive response of the muscular system and improve anaerobic physiological readiness [18]. The results of this fragment of research would allow us to develop preventive measures aimed at stabilizing the deficiency of Vitamin D, depending on the morphophenotype of the athletes ' body.

L. V. Kapilevich, A.V. Kabachkova (2009) indicate that the morphophenotype of athletes "... is of the greatest importance in sports selection, individualization of the training process, for achieving high sports results, and also allows you to prevent the state of overtraining of the body" [19]. There is no medical and biological knowledge in this field in the practice of sports medicine in Uzbekistan at this stage. The study of morpho-functional phenotypes among athletes of different ages provides huge opportunities for effective professional selection of athletes. However, to date, there are no studies devoted to determining the content of total serum 25 (OH)D in athletes with different morpho-functional phenotypes. This is the first time that such studies are being conducted.

Figure 2 shows the results of studying the morphophenotype of Bunyodkor FC young athletes in the pre-competition period. According to the body type of 53 athletes, normosthenics were 25 people (47.7%), asthenics – 23 (43.4%) and hypersthenics - 5 (9.4%).

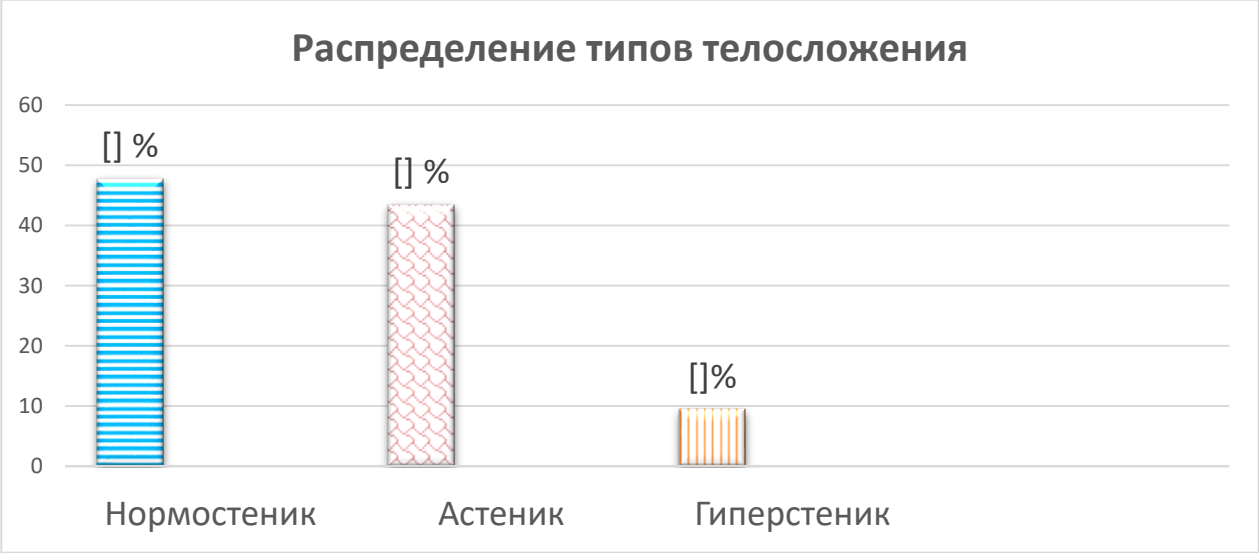

Fig. 2. Distribution of the Bunyodkor FC players by body type

Results of determination of the content of total serum 25 (OH)D among the Bunyodkor FC players, taking into account the morphophenotype of the physique and the season of the year, are summarized in Fig. 3.

Thus, the content of 25(OH)D in the peripheral blood of the examined persons, depending on the type of physique, was distributed according to the seasons of the year as follows: in the summer period of the year, the average content of Vitamin D in normosthenics was 23.15 ng/l; asthenics-24.27 ng / l; hypersthenics-24.04 ng/l. Consequently, in the summer, of Bunyodkor FC players, regardless of their body type, had a deficit of 25(OH)D content almost at the same level and averaged 23.92 ng/l (Fig.3).

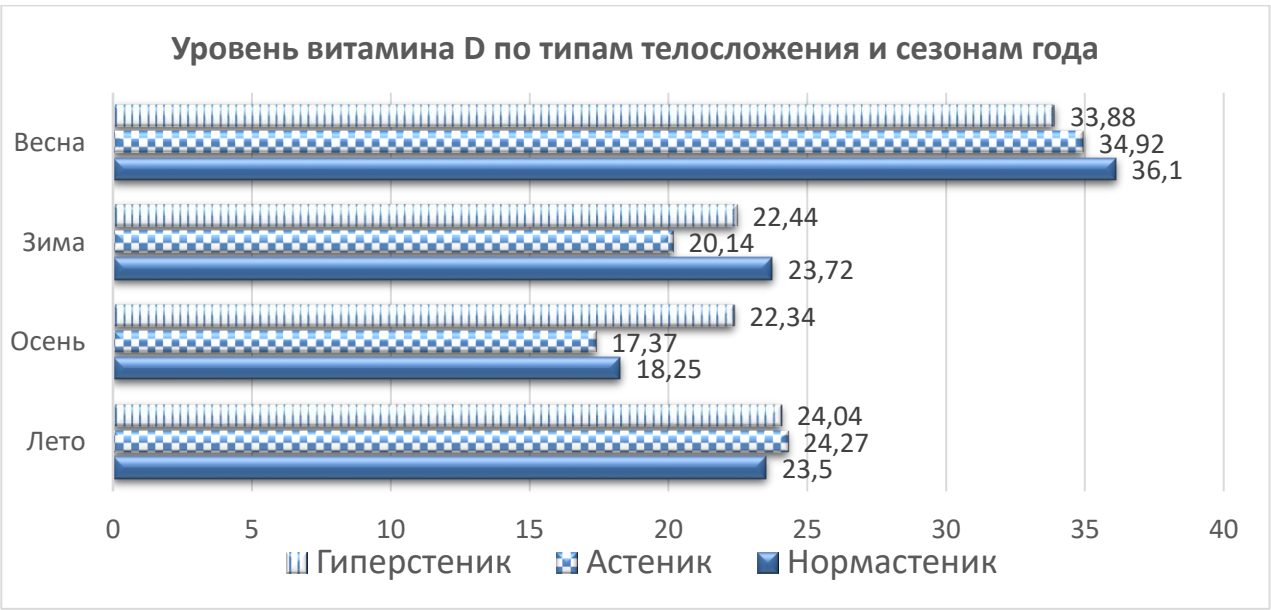

Fig. 3. The content of total serum 25 (OH)VitD among the Bunyodkor FC players, depending on the season of the year and morphophonetype.

In the autumn period of the year, there is a significant variability in the values of the studied indicator. Thus, the average content of Vitamin D was 17.37 ng/l in asthenics, 18.25 ng/l in normosthenics, and 22.34 ng/l in hypersthenics. The results obtained indicate a deficiency of Vitamin D in young football players, regardless of the morphophenotype. However, ectomorphs (asthenics) have the lowest level of prohormone content compared to the mesoform and endomorphic constitutional type. In the winter season, the serum concentration indicators are 25 (OH)D in normosthenics corresponded to 23.72 ng/l, in asthenics 20.14 ng/l and in hypersthenics 22.44 ng/l. A comparative analysis of the research results allowed us to state that Bunyodkor FC young players, regardless of the phenotype, have a deficiency of serum concentration of 25(OH)D in winter.

The results of studies to determine the average concentration of Vitamin D in the spring season established the content of serum 25 (OH)D, in normosthenics, corresponding to 36.10 ng/l, in asthenics 34.92 ng/l and in hypersthenics 33.88 ng/l. The analysis of the obtained data allowed us to establish that the "Bunyodkor FC " young players, regardless of the morphofunctional features of the body structure, in the spring period of the year, there is an insufficient level of provision of the body with Vitamin D. The results of the studies indicate a deficiency in athletes in summer, autumn and winter, as well as a lack of Vitamin D in spring, regardless of body type (Fig.3).

Thus, a comparative assessment of the status of Vitamin D in the body of the Bunyodkor FC athletes with the recommended adequate level > 50 ng/l and optimal reference values >100-250 ng/l proved that young football players had a deficiency in summer, autumn and winter, and in spring an insufficient content of total serum 25 (OH)D. Based on the conducted studies, a high frequency of the prevalence of total serum 25(OH)D deficiency was confirmed among young athletes in the summer season with the maximum value of total solar radiation in the month of July 239.0 kWh/m^2. Consequently, the results of the conducted studies allow us to state that in the summer, autumn and winter seasons, of Bunyodkor FC young players have a deficiency, and in the spring period - a deficiency of vitamin D in the body.

Conclusion. The prevalence of vitamin D deficiency among "Bunyodkor FC" players is 81.13%. Insufficient provision of Vitamin D was detected in only 18.87% of athletes. This circumstance requires immediate correction. Deficiency and insufficiency 25 (OH)D in the blood serum of Bunyodkor FC players require a total appointment of nutritional and metabolic support to all athletes up to the target indicator-achieving an optimal concentration of 25 (OH)D >100 -250 ng/l 4 times a year.

There is no screening of the content of 25(OH) D blood serum of professional athletes in Uzbekistan. The issue of the need to use substances and biologically active additives to food with Vitamin D and the issue of including athletes in the risk group for vitamin D deficiency and deficiency remains unresolved. The consequence of such a position among athletes due to excessive physical exertion is characterized by an epidemic of insufficiency and deficiency of Vitamin D, due

to its insufficient intake with food and contributing to "...the uncontrolled use of Vitamin D as a supplement to the sports diet". This explains the close attention of scientists to the problem of ergogenic effects of Vitamin D in sports medicine in Uzbekistan.

In countries that attach primary importance to nutritional and metabolic assistance (NMP) to elite athletes, constant monitoring of insufficient and deficient levels of Vitamin D concentrations, the use of biological additives to food are issued in the form of a separate state program of NMP. In the leading sports teams of the world, the course preventive appointment of Vitamin D_3 is practiced. At the initial concentrations of vitamin D in the blood serum at the level of < 75 nmol/l, a dose of 5000 IU is prescribed. With a pronounced deficiency corresponding to < 30 nmol/l and <12.5 nmol/l), a dose of vitamin D of 10000 IU/day is prescribed for 4 months, followed by a transition to a dose of 5000 IU/day.

It is recommended to evaluate the level of total serum 25 (OH)D among the "Bunyodkor" FC players according to the approximate criteria:

pronounced deficiency - at <12 ng/l 25 (OH)D;
deficiency - at >12<30 ng/l 25 (OH)D;
insufficiency - at 30-50 ng/l 25 (OH)D;
adequate level - at > 50 ng/l 25 (OH)D;
optimal - at >100 -250 ng/l 25 (OH) D.

REFERANCES

1. Dmitriyev A., Kalinchev A. Vitamin D:rol' v sporte i sportivnoy meditsine (obzor literatury) /A. Dmitriyev, A. Kalinchev/ //Nauka v olimpiyskom sporte.- 2017.- № 1.-S.56-74.

2. Wacker M, Holick M. Vitamin D-Effects on Skeletal and Extraskeletal Health and the Need for Supplementation. Nutrients. 2013;5(1):111-148.

3. Kevin D Cashman. Vitamin D in childhood and adolescence //Postgrad Med J. 2007 Apr;83(978):230-5. doi: 10.1136/pgmj. 2006.052787.

4. Michael F Holick. High prevalence of vitamin D inadequacy and implications for health // Mayo Clin Proc. 2006 Mar;81(3):353-73.doi: 10.4065/81.3.353.

5. Saygitov R.T. Differentsirovannyy («sezonnyy») podkhod pri profilaktike nedostatochnosti vitamina D3 u detey //Voprosy sovremennoy pediatrii /2009/ Tom 8/ № 5.-S.70-79.

6. Khrebtova A.YU., Kuzin A.I. Potentsial'nyye ergogennyye effekty vitamina D v sportivnoy meditsine //Nauchno-sportivnyy vestnik Urala i Sibiri.- 2019.- № 1(21).-S.12-21.

7. Richard B Kreider, Colin D Wilborn, Lem Taylor, Bill Campbell, Anthony L Almada et al. ISSN exercise & sport nutrition review: research and recommendations //J. of the International Society of Sports Nutrition, Article number: 7 (2010), P.7-50.

8. Graeme L. Close. Vitamin D Measurement and supplementation: what, when, why and how? Research Institute for Sports and Exercise Sciences (Liverpool John Moores University, United Kingdom), Sports Science Exchange - 2015. - Vol. 28, 147.-P.1-4.

9. Holick MF, Binkley NC, Bischoff-Ferrari HA, Gordon CM, Hanley DA, Heaney RP, Murad MH, Weaver CM; Endocrine Society. Evaluation, treatment, and prevention of vitamin D deficiency: an Endocrine Society clinical practice guideline. J Clin Endocrinol Metab. 2011 Jul;96(7):1911-30. doi: 10.1210/jc.2011-0385. Epub 2011 Jun 63.

10. Demay M.B. Mechanism of vitamin D receptor action //Ann. N. Y. Acad. Sci., 2006,1068:204-213.

11. Jong N, Chin A, Paw MJ et al. Functional biochemical and nutrient indices in frail elderly people are partly affected by dietary supplements but not by exercise //J Nutr. 1999;129(11):2028-2036.

12. Blaney G.P., Albert P.J., Proal A.D. Vitamin D metabolites as clinical markers in autoimmune and chronic disease //Ann N.Y. Acad. Sci. 2009. Vol. 1173 P. 384-90.

13. Peter B Tomlinson, Corey Joseph, Manuela Angioi. Effects of vitamin D suplemenation on upper and lower body muscle strength levels in healthy individuals A systematic review with meta-analysis. //P. B. Tomlinson. J. Sci. Med. Sport, №18(5). 2014. P. 575-80.

14. Gröber, U., Michael F. Vitamin D Die Heilkraft des Sonnenvitamins // U. Gröber. Wissenschaftliche Verlagsgesellschaft Stuttgart. 2015. – 340 p.

15. Zaytsev V.M., Liflyandskiy V.G., Marinkin V.I. Prikladnaya meditsinskaya statistika /Uchebnoye posobiye.-SPb.- OOO «Izdatel'stvo Foliant».- 2003.- 432 s. Http://www.twirpx.com. kingmed.info› knigi book.

16. https://ru.qaz.wiki/wiki/Mediterranean_climate.

17. Khegay L.N., Skvortsova L.A., Makhmudov D.E., Usmanov D.R., Muslimov O.YA., Adylkhodzhayev A.A. Soderzhaniye 25-OH-vitamina D u futbolistov v usloviyakh solnechnoy radiatsii Uzbekistana /International Scientific Conference «Actual Questions and Innovations in Science II» Balikesir, Turkey, October 9, 2019.- R.154-155

18. Close G.L., Russell J., Cobley J.N. et al. 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.

19. L.V. Kapilevich, A.V. Kabachkova. Sportivnaya meditsina: Praktikum. Chast' 1.- Izd-vo: Natsional'nyy issledovatel'skiy Tomskiy gosudarstvennyy universitet.- Tomsk.- 2009.- 86 s.