

Vitamin D3 for Health and Muscle Functions of Athletes

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ABSTRACT

It is well known that vitamin D₃ is important for bone and skeletal health. Research, however, indicates the necessary of vitamin D₃ for muscle and immune function, inflammation and athletic performance. The purpose of the study is to examine the effect Vitamin D₃ supplementation on athletic health and muscle functions. The Researchers used the experimental method of Pre-post assessment of one experimental group due to the suitability of the nature of the Research. The sample comprises (20) young athletes, they ingested a recommended dose of 2000 IU/ Day for two months (1/10/2019 - 30/11/2019). Data were determined pre-post ingestion of vitamin D₃ for 25(OH)D, Insulin growth factor⁽¹⁾ Angiotensin converting Enzyme, nitric oxide, pulse rate blood Pressure and of Growth hormone, 5ml venous blood was drawn from each participant pre-post vit D₃ ingestion. The Results indicated a significant positive change of the study variables after Vit D₃ ingestion. It is concluded that Vit D₃ supplementation may affect muscle function and health of the athlete. It is Recommended that Vit D₃ levels should be checked on annual basis in all athletes for their health

Keywords: Vit D₃ supplementation, muscle functions, Health, performance, athletes, Hormones.

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INTRODUCTION

Vitamin D is considered a vitamin, meaning an Organic Compound found in food and is needed in small amounts for the health and musculoskeletal system, it can also be met through synthesis in the skin by exposure to ultraviolet B (UVB) radiation in sunlight to convert 7-Dehydrocholesterol which is present in the skin to D₃ (cholecalciferol) ⁽¹⁾ ⁽³¹⁾. Vitamin D is converted in the liver to the storage form 25(OH)D, and is found in the diet like salmon, mackerel, Sardine, Tuna, Mushroom, milk, yogurt, fruit juice, Cereals and egg yolk⁽²⁾ ⁽³⁰⁾. young et al. ⁽³⁾ reported the association of Vitamin D₃ to the fast twitch fibers (type 2 muscle) and Vit D supplement showed a significant improvement of the atrophy of type 2 muscle after Vit D treatment.

Erythropoietin (EPO) is a hormone naturally Produced in the body to stimulate the production of red blood cells, which in turn increases the oxygen carrying capacity of the blood to be delivered to exercising muscles, to produce energy that help performance⁽⁴⁾. Kao et al.⁽⁵⁾ added that EPO induced many other functions including combating the fatigue that cause drop in pH levels, and boost Nitric oxide and enhanced nutrient delivery to stimulate muscle growth. Naturally produced EPO in the body stimulates the production of red blood cells from stem cells that originate in bone marrow and there are substances leading to increased EPO such as cobalt, Arachidonic acid and Echinacea.

Insulin growth factor I is the most Studied growth factor inducing muscle growth together with insulin growth factor 2 IGF1 can be found in the cytoplasm and the nucleus and act as angiogenesis, meaning it stimulate capillaries and blood vessels formation, also help wound healing, tissue repair and embryonic development and differentiation of heart, bone and brain ⁽⁶⁾, they also added that IGF1 is up regulated in response to inflammation via

mediators such as TNF and nitric oxide which is a powerful vasodilator, increasing blood supply to the different organs.

Ganong ⁽⁷⁾ stated that growth hormone performs its effect on target tissues through liberation of Somatomedin(c) (IGF₁) and IGF₂. These are secreted from the liver and other tissues like skeletal muscle. He added that there are some vitamins B₁, B₁₂, E, C, A together with Calcium, phosphorus, Zinc and Molybdenum affecting growth.

Angiotensin-converting Enzyme is a zinc metal pole peptidase important for blood pressure control and water and salt metabolism. It cleaves the C-terminal dipeptide from angiotensin 1 to produce angiotensin 11, a potent vasopressor and inactivates bradykinin a potent vasodilator ⁽⁸⁾, they also added that ACE inhibitors are now used clinically to treat hypertension.

Shahmora et al. ⁽⁹⁾ and Massidda et al. ⁽¹⁰⁾ reported that ACE gene is one of the most popular gene studied in sport. As for Nitric Oxide, Hussain⁽¹¹⁾ reported that it plays an important role in many Physiological functions, its formation in the vascular endothelium, in response to stimuli, maintains a Vasodilator tone that essentially regulate the blood flow and also blood pressure, so it control muscular tone of the blood vessels of the male genitals, where it may relax blood vessel by pathway that are dependent and / or independent of granulate cyclase. Suboptimal Vit D status is widespread among the general population worldwide, even among athletes in Sunny countries when sun is avoided on skin is shielded ⁽¹²⁾. They added that insufficient sunlight exposure is an important reason together with poor Vit D intake, as studies find that athletes do not reach the recommended Vit D in most countries. They also found that only 5% of college athletes met the RDA from food alone

The purpose of the study is to examine the effect of vitamin D₃ supplementation on athletic health and muscle functions

Research hypothesis

It is hypothesized that Vit D₃ supplementation may affect positively athletic health and muscle functions

Research Procedures

Research Method: The Researchers used the experimental method of pre-post measurement of one group of athletes due to its suitability to the nature of the study

Research Samples: comprises of (20) young athletes.

Table 1. Basic characteristics of the sample m= (20)

variables	A.Mean	Median	SD	skewness
Age (y)	18.64	18.50	0.43	0.08
Height (cm)	181.2	182.0	2.9	0.07
Weight (kg)	78.9	79.1	1.7	-0.93
Pulse rate c/m	84	83.9	12	1.02
Bl.pres.syst	124	124	8	0.48
Diast	80	80	5	0.56

The Table indicated that skewness is (± 3) meaning the homogeneity of the sample

Research Community

Human Community

The research Community include athletes, whose number (20) athletes, aged between (17-19 years).

The different variables studied 25 (OH) D, growth H, IGF (1), Nitric oxide, and ACE were determined in clinical lab at Cairo

also, blood pressure and pulse rate were determined Blood samples (5ml) were collected in special tubes to in ice box in the morning for estimation of different variable a pre-post Vit D₃ administration for two months between 1/10/2019 to 30/11 / 2019.

The Experiment group was reported to administer Tablets containing 2000 IU of Vit D₃ daily for two mouths ⁽¹³⁾, while the players continue their usual training regularly,

5ml blood sample was drawn from the athletes pre-post the Vit D₃ administration for detecting the concentrations of ACE, 25(OH)D, nitric oxide, growth hormone, and IGF(1) using special kits for the variable and quantitative determination of human Immunoassay technique in a specialized lab (Elisa Technique)

Height using Restameter, pulse meter for pulse Rate weight using Medical scale, sphygmomanometer for blood Pressure statistical Analysis of the Data (SPSS):

- Arithmetic Mean, Median
- Standard deviation
- skewness
- "T" test
- P< 0.05

Table 2. pulse rate, Blood Pressure Pre-post vit D₃ ingestion

variables	pre		post		sig
	m	SD	m	SD	
Pulse rate	84	12	78	7	S
Blood Pressistol	124	8	120	6	S
Diast	80	5	78	3	S

Table (2) revealed a significant decreased Pulse Rate and Blood pressure post Vit D₃ administration.

Table 3. pre-post vit D₃ ingestion of 25 (OH)D, IGF, and growth H concentration

variables	pre		post		sig
	m	SD	m	SD	
vit D3 25 (OH)D mg/ml	23.6	1.5	35.3	2.4	S
IGF (pg/ml)	43.2	3.2	87.6	5.1	S
Growth H (pg/ml)	3.8	0.9	6.9	1.1	S

Table (3) indicated a significant increased 25(OH)D, IGF (1), growth H, Post Vit D₃ ingestion

Table 4. Pre-post Vit D₃ ingestion of Nitric oxide and angiotensin converting enzyme

variables	pre		post		sig
	m	SD	m	SD	
Nitric oxide (mm)(nitrite)	32,8	2,2	45,1	3,6	S
ACE (mg/ml)	147,4	1,6	202,7	10,3	S

Table (4) indicated a significant increase of nitrite and decreased ACE post vit D₃ ingestions

DISCUSSION

Table (3) indicated an increased concentration of Vit D₃ (25OH) D of the athletes after Vit D₃ administration (2000 Iu) daily for two months,

The Results : revealed that Vit D₃ of athletes were insufficient pre ingestion of Vit D₃ (23,6 ± 1,5 mg/ml) increased to 35,3 ± 2,4 (mg/ml) This is in agreement with the endocrine society that defines Vit D₃ insufficient as 21 mg/ml and above to 30 mg/ml, whereas Vit D₃ ingestion reached the sufficient level of Vit D₃⁽¹³⁾.

This is in accordance with Maroon *et al.* ⁽¹⁴⁾ that indicated that sufficient Vit D₃ is important for muscle growth that induce better condition for performance and fitness of the athletes.

Data Presented in (Table 3) indicated that Vit D₃ administration led to increased concentration of growth hormone and IGF(1). These results are in accordance with previous studies ^(15, 16).

A current hypothesis to explain these results holds that both growth hormone and IGF(1) affect muscle growth directly as indirectly through the conversion of stem cell of the muscle into muscle fibers. Overall, it seems that growth hormone and IGF(1) can act both in cooperation and independently to stimulate pathways that lead to growth, as growth hormone probably combines with Circulating and locally produced IGF(1) in muscle tissues to produce the growth effect^(17, 18).

Table (4) revealed an increased nitric oxide together with a decreased ACE Concentration post Vit D₃ administration, that indicates that Vit D₃ ingestion may decrease blood pressure of the athletes and may act as ACE inhibitor on Table (2) indicated a decreased blood pressure post Vit D₃ ingestion also the increased nitric oxide as nitrite may help in blood vessel vasodilatation and increased blood flow together with Rbc increased due to dilatation of vessels and may activate erythropoietin as a erythrocyte stimulator.

These results are in accordance with Galal ⁽¹⁹⁾ that noted that ACE is produced by the kidney that convert angiotensin one to angiotensin (2) which in turn increased blood pressure. El Amin ⁽²⁰⁾ Added that Vit D₃ decreased blood pressure through inhibiting ACE that elevate hypertension and dilatation of blood vessel through the action of nitric oxide.

Table (2) denoted a decreased pulse rate indicated that Vit D₃ administration may elevate Fitness of athletes

As for Nitric oxide increased after vit D₃, administration, it diffuses to smooth muscle cells of the blood vessels, where it activates guanylyl cyclase, which in turn mediates the relaxation of vascular smooth muscle ⁽²¹⁾, they also added that nitric oxide is important in brain function and decrease inflammation, but its main function is its involment in vascular remodeling and angiogenesis meaning the increase capillaries which in turn increase blood flow to the tissues and may also be involved in the pathogenesis of atherosclerosis as it increased blood through blood vessels, also Nitric oxide is of great value in curing hypertension and angina of the heart⁽²²⁻²⁵⁾.

Data presented in Table (2,3,4) indicated that Vit D₃ administration led to an increased concentration of 25 (OH)D to a level sufficient to elevate both growth hormone and IGF(1) that act in inducing an elevation of muscle function due to muscle growth, together with increased nitric oxide (nitrite) concentration and decreased ACE concentration helping in reducing hypertension by vasodilatation of blood vessels, and stimulate Rbc increase in the blood which in turn helping in elevation of health Condition by reducing hypertension and increasing blood

O₂ blow to the muscles^(23, 26-29). Also, the decreased pulse rate and blood pressure post Vit D₃ ingestion indicated its effect in health and fitness from the discussion above, this can indicate that the hypothesis has been realized

Conclusion

It may be concluded that long term administration of Vitamin D₃ may affect positively athletic muscle functions and health and elevation of fitness

Recommendation

It is recommended that Vit D₃ levels Should be checked on annual basis as a prophylactic measure for athletes, and to expose to the sun (5-30 minutes) depending on skin pigmentation for fair skin (5 min), and (30 min) for dark skin at close to solar moon several times a week

REFERENCES

1. Holick MF. Vitamin D deficiency. The New England journal of medicine. 2007 Jul 19;357(3):266-81.
2. Heath KM, Elovic EP. Vitamin D deficiency: implications in the rehabilitation setting. American journal of physical medicine & rehabilitation. 2006;85(11):916-23.
3. Young A, Edwards, R, Jones, D Mechanical factors and the skeleton. . England: John Libbey Publishing; 1981.
4. Fisher JW. Erythropoietin: physiology and pharmacology update. Experimental biology and medicine (Maywood, N.J.). 2003 Jan;228(1):1-14.
5. Kao R, Xenocostas A, Rui T, et al. Erythropoietin improves skeletal muscle microcirculation and tissue bioenergetics in a mouse sepsis model. Critical care. 2007;11(3):R58.
6. Menetrey J, Kasemkijwattana C, Day C, et al. Growth factors improve muscle healing in vivo. The Journal of bone and joint surgery. British volume. 2000;82(1):131-7.
7. Ganong WF. Review of Medical Physiology; 2000.
8. Barrett KE, Barman SM, Boitano S, Brooks HL. Ganong's review of medical physiology. McGraw-Hill Education New York; 2016.
9. Shahmoradi S, Ahmadelipour A, Salehi M. Evaluation of ACE gene I/D polymorphism in Iranian elite athletes. Advanced Biomedical Research. 2014 January 1, 2014;3(1):207-.
10. Massidda M, Vona G, Calò CM. Lack of association between ACE gene insertion/deletion polymorphism and elite artistic gymnastic performance of Italian gymnasts. European Journal of Sport Science. 2011 2011/05/01;11(3):149-53.
11. Hussain NE-SA-E. Effect of Ginseng on Male Fertility in Rabbit [PhD]: zagazig; 2005.
12. Hamilton B, Grantham J, Racinais S, Chalabi H. Vitamin D deficiency is endemic in Middle Eastern sportsmen. Public health nutrition. 2010 Oct;13(10):1528-34.
13. Larson-Meyer D. The importance of vitamin D for athletes. Sports Sci. Exch. 2015;28:1-8.
14. Maroon JC, Mathyssek CM, Bost JW, et al. Vitamin D profile in National Football League players. The American journal of sports medicine. 2015 May;43(5):1241-5.
15. Owens DJ, Tang JC, Bradley WJ, et al. Efficacy of High-Dose Vitamin D Supplements for Elite Athletes. Medicine and science in sports and exercise. 2017 Feb;49(2):349-56.

16. Wyon MA, Wolman R, Nevill AM, et al. Acute effects of vitamin D3 supplementation on muscle strength in judoka athletes: A randomized placebo-controlled, double-blind trial. *Clinical journal of sport medicine*. 2016;26(4):279-84.
17. Ward KA, Das G, Berry JL, et al. Vitamin D status and muscle function in post-menarchal adolescent girls. *The Journal of clinical endocrinology and metabolism*. 2009 Feb;94(2):559-63.
18. Mougios V. *Exercise Biochemistry*. . first ed. USA: Human Kinetics; 2006.
19. Galal A. Diversity of ACE, ACTN3 and its relation to biological and digital variables in athletic selection: Assuit; 2017.
20. El Amin M. Study the Association of FokI Polymorphism of Vitamin D Receptor (VDR) Gene and Hypertension Predisposition in Sudanese Patients. Sudan: El Nilen Univ; 2017.
21. Ahluwalia A, MacAllister RJ, Hobbs AJ. Vascular actions of natriuretic peptides. *Basic research in cardiology*. 2004;99(2):83-9.
22. Sakoury MMA, Shalaby MN, Elmaghraby AM, Omar IM, Tahoun MMA. The effectiveness of a water sports program on the level of poly unsaturated fatty acids and the severity of the disease in children with Autism spectrum disorder. *Med. Sci*. 2020;24(101):143-64.
23. Shalaby MN. The Determinants of Leadership: Genetic, Hormonal, Personality Traits Among Sport Administrators. *International Journal of Pharmaceutical and Phytopharmacological Research*. 2017;7(5):9-14.
24. Shalaby MN. The Effect of Whey Protein (Natural Nanoparticle) on Muscle Strength, GH, IGF, T. Protein and body composition. *International Journal of Pharmaceutical Research & Allied Sciences*. 2018;7(1).
25. Shalaby MN, Alghamdi A, Sakoury M, Al-Dossary R, Alzayani A. The effects of Exercise Program and Dietary Supplement on the Efficiency of the Dynamic System in Old Females. *Wulfenia*. 2020 06/11;27:11-26.
26. Shalaby M, Sakoury M, Rabei M, Alzayani A. Covid-19 Pandemic Era. *Aegaeum*. 2020 06/22;8:1083-93.
27. Shalaby MN, Liu JY, Kassem MM, Saad M. Circulating Hematopoietic Stem Cell and Some Physiological Parameters in Different Training Programs. *Life Science Journal*. 2012;9(1):965-71.
28. Shalaby MN, Saad M, Akar S, Reda MAA, Shalgham A. The Role of Aerobic and Anaerobic Training Programs on CD34+ Stem Cells and Chosen Physiological Variables. *Journal of Human Kinetics*. 2012;35(1):69-79.
29. Shalaby MN, Saad MM. Advanced Material Engineering and Nanotechnology for Improving Sports Performance and Equipment. *International Journal of Psychosocial Rehabilitation*. 2020;24(10).
30. Elmaghraby, A. M., Rafataboseta, M., & Shalaby, M. N. (2019). Some Biochemical Variables and its Relation to Muscular Fatigue in 800 m Freestyle Swimmers. *International Journal of Psychosocial Rehabilitation*, 23.
31. Shalaby, M. N. & Fadl, . M. A. (2020) Relative Indicators and Predicative Ability of Some Biological Variables on Cardiac Neural Activity for Volleyball Players. *Systematic Reviews in Pharmacy*, 11 (9), 834-840. doi:10.31838/srp.2020.9.119