

Effect of serum vitamin D levels on weight loss in obese patients doing aerobic exercises: A retrospective study

Ahmet Karadağ^{1*}, Meryem Otu¹

Abstract

Objective: This study evaluates the effect of serum vitamin D (Vit D) levels on weight loss in obese patients during an aerobic exercise program.

Material and Methods: The study included 88 participants with body mass index (BMI) ≥ 25 kg/m². A serum level of 25(OH)D₃ >30 ng/ml was accepted as normal, 20–29 ng/ml as insufficient and <20 ng/ml as deficient. The obese patients were classified into three groups based on a serum level of 25(OH)D₃. All participants enrolled on an eight-week aerobic exercise program. The BMI, body fat percentage (BF%) and body fat mass (BFM) of the participants were measured before and after aerobic exercise.

Results: No statistically significant differences were identified between the groups in the first and last measured BMI, BF% and BFM values ($p > 0.05$). The differences between the first and last measured weights, BMI, BF% and BFM were statistically significant within the groups ($p < 0.05$).

Conclusion: Aerobic exercise can lead to weight loss in obese patients, although the level of serum Vit D has no effect on weight loss in obese patients engaged in aerobic exercise.

Keywords: Aerobic exercise, obesity, vitamin D

Introduction

Obesity is a serious and growing health problem that is caused by an extreme increase in the amount of fat tissue in the body. A BMI ≥ 25 kg/m² is defined as overweight, while a BMI ≥ 30 kg/m² is defined as obese (1,2).

Vit D is a fat soluble hormone that plays a role in several physiological activities, such as calcium homeostasis and musculoskeletal system health (3,4). Vit D deficiency is today considered a significant global health issue (5). Other than its effect on the musculoskeletal system, Vit D also plays a role in the synthesis and secretion of insulin, and regulates calcium entry into the pancreatic beta-cells. There is evidence that active Vit D modulates intracellular ionized calcium signaling in adipocytes. Besides, Vit D also plays a role in the regulation of glucose transporter 4 (GLUT-4) expression and stimulates the translocation of GLUT-4. In Vit D deficiency, this mechanism is impaired, leading to elevated fasting plasma insulin levels, reduced hepatic and peripheral insulin sensitivity, and significantly decreased peripheral glucose utilization in the obese.

It is thus believed that Vit D plays a role in the pathogenesis of obesity (6,7), although studies analyzing the link between obesity and serum Vit D levels have produced conflicting results. While some studies have reported lower Vit D levels in the obese than those of normal weight, there are other studies reporting similar serum Vit D levels between the obese and those of normal weight (8–10). Literature contains studies assessing Vit D levels in the obese. There are also studies reporting a positive impact of Vit D replacement on weight loss in obese patients (11).

In previous clinical trials investigating the effect of Vit D on weight loss, Vit D replacement was administered to obese individuals with Vit D deficiency. Different from literature, the present study examines the effect of the serum Vit D levels on weight loss in obese and overweight individuals engaged in an aerobic exercise program without Vit D supplement.



Materials and Method

This retrospective study included 88 individuals who applied to the obesity rehabilitation unit of the Physical Medicine and Rehabilitation clinic between June 2016 and June 2019 with a BMI ≥ 25 kg/m², and who completed the rehabilitation program. Those who discontinued the aerobic exercise program, those who joined the aerobic exercise program within the last one year, and those who underwent Vit D replacement therapy within the last 3 months and who started to diet prior to the study were excluded from the study.

Obese patients were divided into three groups based on the serum levels of Vit D. A serum level of 25(OH)D₃ <20 ng/ml was accepted as deficient (Group 1), 20–29 ng/ml as insufficient (Group 2) and >30 ng/ml as normal (Group 3) (12).

Sociodemographic and laboratory data of all participants were recorded. All of the participants were weighed using the same digital scale, and their heights were measured using a stadiometer (F. Bosch Medizintechnik, Germany) while barefoot, head straight and eyes looking forward, before starting and after completing the eight-week aerobic exercise program.

Waist circumference was measured naked using a standard measuring tape at the level of the iliac bone and umbilicus. BFM and BF% were measured using a bioelectrical impedance analyzer (Tanita TBF 300, Japan) after an 8-hour fasting period. Body mass index was calculated using the formula; BMI = weight (kg)/height (m²).

All of the participants were administered a cardiopulmonary exercise test using an ergospirometry device (CareFusion MasterScreen CPX 7402, Germany). Maximal oxygen consumption (VO₂max) and metabolic equivalent (MET) values were calculated. Exercise programs were created to achieve 70–75% of the maximum heart rate, considering also the age and gender of the individual patients. A treadmill (Profitness 3000, Taiwan) was used for the aerobic exercise. The duration of exercise was planned as 40–50 minutes, including 5 minutes for warm-up and cool-down.

The intensity of exercise was determined according to the heart rate, oxygen saturation (SPO₂) and Borg rating of the perceived exertion values measured during the exercise.

All participants were prescribed a low-calorie diet. During the time of data recording, the same physician, nurse, physiotherapy technician and dietician were on duty in the obesity rehabilitation unit.

The serum levels of vitamin 25(OH)D₃ were measured in the venous blood via an electrochemiluminescent method (Roche Cobas e601, Germany) in the biochemistry laboratory of our hospital.

Approval for the study was obtained from the Clinical Trials Ethics Committee of our university, and the study was conducted in accordance with the Declaration of Helsinki.

Statistical analysis: Data obtained in the study were analyzed statistically using the IBM SPSS Statistics version 22.0 software (IBM Corp., Armonk, NY, USA). Conformity of the data to normal distribution was analyzed using the Kolmogorov-Smirnov test. Student's t test and post hoc ANOVA test were applied when the parametric test assumptions were met. A Mann-Whitney U test and post hoc Kruskal-Wallis test were used when the parametric test assumptions could not be met, and a chi-square test was used to evaluate the categorical data. Data were expressed as number and percentage or as mean/median \pm standard deviation values. A value of $p < 0.05$ was considered statistically significant.

Results

A total of 88 participants were included in the study, comprising 70 (79.5%) females and 18 (20.5%) males. The vitamin D levels and demographic data of the groups are presented in Table 1. No statistically significant difference was noted between the first and last measured BMI, BFM and BF% values between the groups ($p > 0.05$) (Table 2). The difference between the first and last measured BMI, BFM and BF% values was statistically significant within the groups ($p < 0.05$) (Table 3). No statistically significant correlation was found between Vit D levels and waist circumference ($p > 0.05$).

Table 1. Vitamin D levels and demographic data of the groups

	Group 1 (n=19)	Group 2 (n=44)	Group 3 (n=25)	p
Vit D levels (ng/mL)	11.7 \pm 4.2	23.7 \pm 2.3	44.2 \pm 19.4	<0.0001
Age (years)	49 \pm 9.5	51.4 \pm 11.5	50 \pm 8.7	0.73
Gender (Female/Male)	13/6	33/11	24/1	0.42

* $p < 0.05$, Results were given as mean/median \pm standard deviation; n: Number of patients

Table 2. The first and last measured BMI, BF% and BFM values between the groups

	Group 1 (n=19)	Group 2 (n=44)	Group 3 (n=25)		
Weight 1* (kg)	96.46 ± 16.23	90.20 ± 16.29	86.99 ± 16.74	p=0.167	p=0.351 ^a p=0.146 ^b p=0.715 ^c
Weight 2** (kg)	93.21 ± 16.26	86.88 ± 15.65	84.15 ± 15.40	p=0.163	p=0.312 ^a p=0.147 ^b p=0.767 ^c
BMI 1*	36.81 ± 6.51	35.13 ± 7.15	34.65 ± 6.68	p=0.564	p=0.650 ^a p=0.560 ^b p=0.958 ^c
BMI 2**	35.50 ± 6.25	33.72 ± 6.91	33.67 ± 6.31	p=0.580	p=0.593 ^a p=0.637 ^b p=0.999 ^c
BF 1* (%)	41.52 ± 7.00	40.22 ± 7.82	41.67 ± 7.01	p=0.680	p=0.799 ^a p=0.998 ^b p=0.715 ^c
BF 2** (%)	39.17 ± 8.01	38.10 ± 8.09	40.66 ± 7.05	p=0.427	p=0.872 ^a p=0.805 ^b p=0.394 ^c
BFM 1* (kg)	41.03 ± 12.27	37.05 ± 12.92	37.27 ± 11.74	p=0.484	p=0.478 ^a p=0.585 ^b p=0.997 ^c
BFM 2** (kg)	37.25 ± 11.78	33.84 ± 12.24	35.35 ± 11.38	p=0.575	p=0.553 ^a p=0.860 ^b p=0.868 ^c

p<0.05; Results were given as mean/median ± standard deviation; BMI: Body Mass Index; BF: Body Fat; BFM: Body Fat Mass; n: Number of patients; a Comparison between Group 1 and Group 2; b Comparison between Group 1 and Group 3; c Comparison between Group 2 and Group 3; 1: Before aerobic exercise; 2**: After aerobic exercise

Table 3. The difference in the first and last measured BMI, BF% and BFM values within the groups

	Group 1 (n=19)	p	Group 2 (n=44)	p	Group 3 (n=25)	p
Weight 1* - Weight 2**	3.25 ± 2.16	<0.001*	3.32 ± 1.89	<0.001*	2.84 ± 2.15	<0.001*
BMI 1* - BMI 2**	1.31 ± 1.31	<0.001*	1.41 ± 1.13	<0.001*	0.98 ± 1.30	0.001*
BF 1* - BF 2**	2.35 ± 1.92	<0.001*	2.11 ± 2.64	<0.001*	1.01 ± 1.76	0.008*
BFM 1* - BFM 2**	3.77 ± 3.17	<0.001*	3.20 ± 2.73	<0.001*	1.91 ± 2.09	<0.001*

p<0.05; Results were given as mean/median ± standard deviation; BMI: Body Mass Index; BF: Body Fat; BFM: Body Fat Mass; n: Number of patients; 1: Before aerobic exercise; 2**: After aerobic exercise

Discussion

This study has evaluated the effect of serum Vit D level on weight loss in obese and overweight patients enrolled in an aerobic exercise program. A significant decrease was noted in weight loss, BMI, BFM and BF% after undertaking aerobic exercise in all three groups. That said, serum Vit D levels were found to make no additional contribution to weight loss, BMI, BFM or BF% in obese patients undertaking aerobic exercise.

Vit D is a fat-soluble steroid hormone, the most important known effect of which is on the calcium metabolism and bone mineralization (13). There have been several studies suggesting a link between Vit D deficiency and many chronic diseases (14). In particular, Vit D deficiency is reported to be a risk factor for cardiovascular disease and diabetes, similar to obesity (15). The prevalence of obesity worldwide is high, and it is considered to be an epidemic by the World Health Organization (16).

There has been a significant increase in the last decade in the number of studies investigating the link between Vit D and obesity (11). The study by Walsh et al. identified lower serum levels of Vit D in the obese than in healthy individuals (17). Likewise, another study reported Vit D deficiency to be more common in the obese than in the healthy population (18). It has also been reported that Vit D level and BMI are negatively correlated (19,20). Although the mechanism underlying the link between Vit D and obesity has yet to be fully clarified, there have been studies identifying Vit D deficiency as a likely cause of obesity (21,22). Additionally, literature contains studies suggesting that obese patients with Vit D deficiency can lose weight when administered with Vit D supplements (23–25). A recent study showed that Vit D supplement given to obese women had a positive effect on weight loss (26). Likewise, a recent study by Perticone et al. demonstrated positive

effects of Vit D supplement on weight loss in obese patients (27). The present study, different from previous research, evaluated the impact of existing serum Vit D levels on weight loss without any intervention in obese patients undergoing aerobic exercises. In the present study, it was demonstrated that serum level of vitamin D had no impact on weight loss in obese patients engaged in aerobic exercises. The findings of the present study seem to be in conflict with those of previous studies evaluating the link between Vit D and obesity; although we believe that aerobic exercise has an important effect on weight loss, and may have masked the impact of Vit D in our study. These conflicting findings may also have resulted from the Vit D measurement method, lifestyle and cultural differences, and geographical condition-related changes.

The present study has a number of strengths. Existing literature contains no studies evaluating the link between serum Vit D levels and weight loss together with aerobic exercise in obese patients. Furthermore, the present study did not intervene in the existing serum levels of Vit D in obese patients.

We are well aware that this study has certain limitations, being limited by its retrospective design and its lack of a separate Vit D supplement group; the low number of patients in the low and normal Vit D groups; the lack of re-assessment of Vit D levels at the end of aerobic exercise; and the lack of a long-term follow-up of the patients after aerobic exercises.

Conclusion

Aerobic exercise has an effect on weight loss in obese patients, while serum Vit D levels make no additional contribution to weight loss in obese patients engaged in aerobic exercise. That said, any deficiencies in this regard should be addressed in individuals with low levels of Vit D, since a relationship has been established between Vit D and numerous diseases. Further, more extensive clinical studies are needed to evaluate the association between obesity and Vit D on a physiological and genetic base.

Acknowledgements: None

Conflict of Interest: The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article

Author's Contributions: AK, MO: Research concept and design, data collection, literature search, preparation of the article, statistical analysis, AK: Manuscript revision

Ethical issues: Author declare, originality and ethical approval of research. The study was conducted under defined rules by the Local Ethics Commission guidelines and audits.

References

- Aydın E, Bulut H. Nursing care in bariatric surgery. *TAF Preventive Medicine Bulletin*. 2014; 13: 77-82.
- Pi-Sunyer X. The medical risks of obesity. *Postgraduate Medicine*. 2009; 12: 6-11
- Reid IR, Bolland MJ, Grey A. Effects of vitamin D supplements on bone mineral density: a systematic review and meta-analysis. *Lancet*. 2014;383:146–155.
- Bouillon R, Carmeliet G, Verlinden L, van Etten E, Verstuyf A, Luderer H.F, et al. Vitamin D and human health: lessons from vitamin D receptor null mice. *Endocr. Rev*. 2008;29:726–776.
- Holick MF, Chen TC. Vitamin D deficiency: A worldwide problem with health consequences. *Am J Clin Nutr* 2008;87:1080S 6S.
- Rosen CJ, Adams JS, Bikle DD, Black DM, Demay MB, Manson JE, et al. The nonskeletal effects of vitamin D: an Endocrine Society scientific statement. *Endocr Rev*. 2012;33:456-92.
- Hyppönen E, Power C. Vitamin D status and glucose homeostasis in the 1958 British birth cohort: the role of obesity. *Diabetes Care* 2002;9:2244–6.
- Need AG, O'Loughlin PD, Horowitz M, Nordin BE. Relationship between fasting serum glucose, age, body mass index and serum 25 hydroxyvitamin D in postmenopausal women. *Clin Endocrinol (Oxf)* 2005;62:738-41.
- McGill AT, Stewart JM, Lithander FE, Strik CM, Poppitt SD. Relationships of low serum vitamin D3 with anthropometry and markers of the metabolic syndrome and diabetes in overweight and obesity. *Nutr J* 2008;7:4
- Moy FM, Bulgiba A. High prevalence of Vitamin D insufficiency and its association with obesity and metabolic syndrome among malay adults in Kuala Lumpur, Malaysia. *BMC Public Health* 2011;11:735
- Perna. Is Vitamin D Supplementation Useful for Weight Loss Programs? A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Medicina (Kaunas)*. 2019;12:55-7
- Holick MF, Binkley NC, Bischoff-Ferrari HA, Gordon MC, Hanley DA, Heaney RP et al. Evaluation, Treatment, and Prevention of Vitamin D Deficiency: an Endocrine Society Clinical Practice Guideline. *J Clin Endocrinol Metab* 2011;96:1911-30
- Bringhurst FR, Demay MB, Krane SM, Kronenberg HM. Bone and Mineral Metabolism in Health and Disease. In: Kasper DL, Braunwald E, Fauci AS, Hauser SL, Longo DL, Jameson JL, editors. *Harrison's Principles of Internal Medicine*. 16th edition. New York:McGraw-Hill Companies; 2005. p. 2238-86
- Wang H, Chen W, Li D, Yin X, Zhang X, Olsen N, Zheng SG. Vitamin D and Chronic Diseases. *Aging Dis*. 2017;8:346-353
- Forsythe LK, Livingstone MB, Barnes MS, Horigan G, McSorley EM, Bonham MP, et al. Effect of adiposity on Vitamin D status and the 25-hydroxycholecalciferol response to supplementation in healthy young and older Irish adults. *Br J Nutr*. 2012;107:126–34.
- Barja-Fernandez S, Leis R, Casanueva FF, Seoane LM. Drug development strategies for the treatment of obesity: How to ensure efficacy, safety, and sustainable weight loss. *Drug Des Devel Ther*. 2014;8:2391–400
- Walsh JS, Evans AL, Bowles S, Naylor KE, Jones KS, Schoenmakers I, et al. Free 25-hydroxyvitamin D is low in obesity, but there are no adverse associations with bone health. *Am J Clin Nutr*. 2016;103:1465-71.
- Samuel, L. Borrell, L.N. The effect of body mass index on optimal vitamin D status in U.S. adults: the National Health and Nutrition Examination Survey 2001–2006. *Ann. Epidemiol*. 2013;23: 409–414
- Baradaran A, Behradmanesh S, Nasri H. Association of body mass index and serum Vitamin D level in healthy Iranian adolescents. *Endokrynol Pol*. 2012;63:29–33.

20. Muscogiuri G, Sorice GP, Prioleta A, Policola C, Della Casa S, Pontecorvi A, et al. 25-hydroxyvitamin D concentration correlates with insulin-sensitivity and BMI in obesity. *Obesity* 2010;18:1906–10.
21. Costa P.R.F, Assis A.M.O, Santos C.A.S.T, Santos D.B, Pereira-Santos M, Pereira-Santos M, et al. Obesity and vitamin D deficiency: A systematic review and meta-analysis. *Obes. Rev.* 2015;16:341–349.
22. Wood R.J. Vitamin D and adipogenesis: New molecular insights. *Nutr. Rev.* 2008;66:40–46
23. Wamberg L, Kampmann U, Stødkilde-Jørgensen H, Rejnmark L, Pedersen S.B, Richelsen B. Effects of vitamin D supplementation on body fat accumulation, inflammation, and metabolic risk factors in obese adults with low vitamin D levels—Results from a randomized trial. *Eur. J. Intern. Med.* 2013;24:644–649.
24. Kampmann U, Mosekilde L, Juhl C, Moller N, Christensen, Rejnmark L, et al. Effects of 12weeks high dose vitamin D3 treatment on insulin sensitivity, beta cell function, and metabolic markers in patients with type 2 diabetes and vitamin D insufficiency—A double-blind, randomized, placebo-controlled trial. *Metabolism.* 2014;63:1115–1124.
25. Mason C, Xiao L, Imayama I, Duggan C, Wang C.-Y, Korde L, et al. Vitamin D3 supplementation during weight loss: A double-blind randomized controlled trial. *Am. J. Clin. Nutr.* 2014;99:1015–1025
26. Khosravi ZS, Kafeshani M, Tavasoli P, Zadeh AH, Entezari MH. Effect of Vitamin D Supplementation on Weight Loss, Glycemic Indices, and Lipid Profile in Obese and Overweight Women: A Clinical Trial Study. *Int J Prev Med.* 2018;20:9:63
27. Perticone M, Maio R, Sciacqua A, Suraci E, Pinto A, Pujia R, et al. Ketogenic Diet-Induced Weight Loss is Associated with an Increase in Vitamin D Levels in Obese Adults. *Molecules.* 2019;9:24