Golestan University of Medical Sciences

Jorjani Biomedicine Journal

Online ISSN: 2645-3509

Effects of eight weeks of Pilates exercise on serum 25-Hydroxyvitamin D, Omentin-1, and lipid profile in overweight women

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Abstract

Background: Insufficiency of omentin-1 and 25-hydroxyvitamin D serum levels is associated with obesity, which is known as a threat to health. Therefore, the aim of the present study was to examine the effect of eight weeks of Pilates exercise on the serum levels of 25-hydroxyvitamin D, omentin-1, and lipid profile in overweight women.

Methods: In the present clinical study, 26 young overweight women were divided (Block randomization method) into the Pilates exercise (PT, n= 13) and control group (CG, n= 13). The PT group performed Pilates exercises for eight weeks (Three 60-min sessions per week). The movements started from simple and then increased in intensity and complexity based on the Borg index. The CG group had no training session for eight weeks. Blood samples were taken before the first training session and 48 hours after the last training session. Analysis of covariance was used for between-group comparisons.

Results: Findings showed a significant increase in the serum levels of 25-hydroxyvitamin D (p-value=0.008, SD= 4.78±0.12 ng/ml, effect size= 0.243) and HDL-C (p-value=0.04, SD= 6.44±1.05 mg/dl, effect size= 0.168), but a significant decrease in HOMA-IR (p-value=0.001, SD= 1.54±0.09, effect size=0.199), cholesterol (p-value=0.001, SD= 16.72±3.24 mg/dl, effect size= 0.326), and triglyceride (p-value=0.001, SD= 2.46±0.07 mg/dl, effect size= 0.209), and no significant change in omentin-1 (p-value=0.65, SD= 3.01±0.08 ng/ml) and LDL-C (p-value=0.58, SD= 2.46±0.07 mg/dl) serum levels in the PT group compared to the CG group.

Conclusion: It seems that this type of exercise training may play a critical role in controlling the health parameters and physiological status of the overweight women by having positive effects on serum levels of 25-hydroxyvitamin D and lipid profile, which are affected by body composition, weight, and fat.

Article History

Received: 17 January 2024
Received in revised form: 20 February 2024
Accepted: 27 February 2024
Published online: 6 March 2024
DOI: 10.29252/jorjanibiomedj.12.1.1

Keywords

Exercise movement techniques
Overweight
Insulin resistance
Omentin-1
Lipid profile
25-Hydroxy vitamin D

Article Type: Original Article

Highlights

What is current knowledge?

- Pilates is an exercise that has gained popularity recently. It should be mentioned that some people, particularly those in the overweight segment of society, find it difficult to perform certain exercises, especially aerobic ones. Thus, analysts claim that more recent activities like Pilates have gained popularity.

What is new here?

- A noteworthy discovery of the current study was the beneficial impact of Pilates exercise on the lipid profile and serum levels of 25-hydroxyvitamin D in overweight women.
- It was reported that after eight weeks of Pilates exercise, there was a reduction in insulin resistance.

Introduction

According to the study by Pergola et al. (2019), the prevalence of overweight and obesity is associated with a decline in serum levels of omentin-1 and 25-hydroxyvitamin D (1) due to their impact on insulin sensitivity, which refers to how responsive cells are to insulin (2). In fact, 25-hydroxyvitamin D is a measure of the overall status of vitamin D (3). Iran is among the countries where vitamin D insufficiency is quite prevalent, and it affects females significantly more than males (4). Fortunately, research has shown a correlation between 25-hydroxyvitamin D levels and physical activity (5). In a study, it was shown that the exercise group under dietary control significantly had higher levels of 25-hydroxyvitamin D (6). It is important to note that insufficiency, inflammation, and obesity are indicative of a mild abnormality in vitamin D release, including cardiovascular disorders (7).

Omentin-1, a subgroup of adipokines, or adipocytokines, is a cell-signaling molecule (Cytokine) produced by the adipose tissue that plays functional roles in energy/metabolic status of the body, inflammation, and obesity (8). It is released by visceral adipose tissue and modulates insulin sensitivity, and its level is lower in obese individuals than in thin ones (9). It is related to several cardiovascular risk factors, including inflammation, atherosclerosis, metabolic syndrome, and obesity (10). Reduction in the rate of body fat brought about by the modified body composition has a significant influence on changing the serum omentin-1 concentrations (11). Based on some reports, endurance training reduces cardiovascular risk factors in obese individuals, and this is related to an increase in omentin-1 plasma levels (9,12). Nevertheless, omentin-1 does not appear to be increased in all studies (13). These studies have examined a variety of endurance and resistance protocols that have been used for varying lengths of time and intensities. These inconsistencies highlight the need to discuss omentin-1 and the effects of various exercise activities.

Understanding the contributing variables to the development of cardiovascular diseases might be crucial to the prevention of illness (14). The elevation of low-density lipoprotein-cholesterol (LDL-C), total cholesterol, triglyceride, and high-density lipoprotein-cholesterol (HDL-C) is one of the most significant risk factors for these disorders (15). There are different study results about the effect of exercise on the lipid profile (16,17). Examining different exercise protocols in the context of obesity is crucial since regular physical exercise and improving physical fitness are two strategies to improve health and well-being. One exercise that has gained popularity recently is Pilates which consists of regulated speed strength and stretching motions done while the joint is in its full range of motion. People with a typical degree of physical fitness can perform Pilates movements without the need for specialized equipment or training (18). Considering potential processes, it has been demonstrated that doing Pilates enhances insulin sensitivity by strengthening the muscles' mitochondrial density, oxidative capacity, and glucose absorption (19). Nevertheless, understanding the direct relationship between exercise participation and serum levels of omentin-1, 25-hydroxyvitamin D, and lipid profiles is essential, as these may vary depending on participants' characteristics and the type of training protocol used. Thus, the current study aimed to investigate the effect of eight weeks of Pilates exercise on the lipid profile, 25-hydroxyvitamin D levels, and omentin-1 levels in overweight women.

Methods

The current study used a pretest-posttest design and was classified as a semi-experimental study. It was recorded under the clinical trial code IRCT20181203037718N1. The participants were overweight women (Body

mass index (BMI)= 25-29.9 kg/m2) and ranged from 25 to 35 years old, who were selected purposefully. The researcher found overweight women who intended to participate in the exercise program to enhance their physiological state and change their weight in the first phase by posting recall announcements. In the first step, by putting up recall notices, overweight people who wanted to do exercises to adjust their weight and improve their physiological conditions were identified by the researcher. In the briefing session, the benefits of the Pilates exercise were explained to the participants. The study population consisted of 26 individuals who fulfilled the research requirements. The health questionnaire included information about cardiovascular, renal, diabetic, physical, or orthopedic injuries. Exclusion criteria included beta-blockers, pre-existing heart conditions, diabetes mellitus, lipid-lowering medication, pregnant or lactating women, smokers, gastrointestinal tract surgery, and major illness (Acute or chronic), including any that would limit the ability to perform the necessary exercises. They completed justifications of the research implementation procedure, as well as the study's potential advantages and disadvantages, were provided at the beginning. Subsequently, by filling out the consent form, these individuals fully and freely indicated that they were willing to take part in this study project. Participants completed baseline measurements over one week before attending an initiation session (BMI, and body fat), then participants were randomly divided (based on the block randomization method) into two groups: the training group (n=13) and the control group (n=13). The experimental group was given general information on Pilates as well as an explanation of the fundamental principles of the exercises. They were instructed to remember and adhere to these principles during all sessions. Study procedures were approved by the corresponding author of this manuscript, and written informed consent was obtained from the participants.

Exercise protocol

The exercise comprised three weekly sessions lasting an hour each, for eight weeks of Pilates. Three stages made up each training session: 1) warm-up; 2) Pilates exercises; and 3) cool-down. The first set of exercises was performed on a mat, while the second set involved utilizing a ball and band. The motions began simply and progressively grew more intricate and intense. The Borg Rating of Perceived Exertion (BRPE) Scale, which is a scale of perception of pressure and difficulty based on the bodily indicators that the subjects themselves experienced-breathing, heart rate, muscular weariness, and sweating, was used to quantify the intensity of the exercise (20). Warming up and cooling down were done using the pressure perception scale (8-10), and the training intensity was progressively increased from the first week to the last week (Pressure Perception Index 10-18) in the main training phase. The exercises were performed in three positions: standing, sitting, and lying down. During this time, the control group participated in none of sports events.

Blood sample measuring

The participants reported for fasting blood samples at baseline and 48 hours after the last Pilates session. Every participant had their brachial vein taken five milliliters as they sat between 8-10 am. The blood was centrifuged to extract the blood serum at 3000 rpm for 10 minutes, then transferred to specialized microtubes and stored at -70 °C until the index measurement was done. Omentin-1 was also measured using the Omentin-1 kit with a sensitivity of 1.03 ng/L made in China-USA, the product of Hangzhou Stebiopharm Company and by ELISA method. Serum 25-hydroxyvitamin D levels were determined using the IDS kit with a sensitivity of 1.6 ng/mL and the ELISA method. Insulin resistance was determined using the following equation and the Homeostatic Model Assessment of Insulin Resistance (HOMA-IR):

Insulin resistance = fasting insulin × fasting glucose ÷ 22.5

Serum levels of cholesterol, triglyceride, LDL-C, and HDL-C were determined using an enzymatic calorimetric approach and the Pars test kit, which is manufactured in Iran. The Pars Azmun kit was used to assess serum insulin levels using ELISA technique. To this aim, the wells are coated with a capture antibody and blocked. The sample is added to the microplate wells coated with the antibody, then the plate is incubated for some time and washed. Washing removes the unbound antigens.

BMI measuring

The Seca caliper, manufactured in Germany with an accuracy of 0.5 cm, was used to measure heights. The InBody 3 body composition analyzer was used to determine BMI and weight values. A caliper (Poya Caliper, made by Iran Poya Company) with an accuracy of half a millimeter was used to measure the percentage of body fat using the three-point method of the subcutaneous fold (In the regions of the three arms, upper thigh, and thigh) (21).

Statistical analysis

SPSS version 23 was used to analyze research data. The mean and standard deviation (SD) were displayed using descriptive statistics. The Shapiro-Wilk and Levene's tests were used to verify the homogeneity of variances and the normality of the data distribution, respectively. Upon verifying the groups' homogeneity and normality, intergroup changes were examined using the covariance analysis test. P-value ⩽0.05 was considered statistically significant. In this parametric test, considering the pre-test data, we aim to answer the following questions: Does Pilates exercise affect the measured indicators, and is there a significant difference between the two groups?

Results

25-hydroxyvitamin D, omentin-1, insulin resistance index

Covariance analysis findings revealed that blood 25-hydroxyvitamin D levels significantly increased (p-value=0.008) and the insulin resistance index significantly decreased (p-value=0.001) compared to the control group. On the other hand, omentin-1 levels showed no significant difference between the training group and control group (p-value=0.65). Figures 1-3 show the changes in the omentin-1, 25-hydroxyvitamin D levels, and insulin resistance.

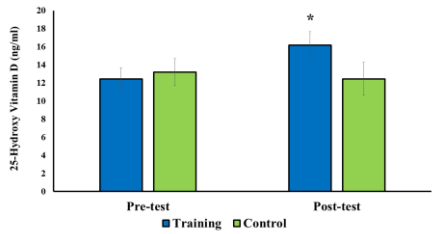

Figure 1. Changes in serum levels of 25-hydroxyvitamin D before and after eight weeks of Pilates exercise in overweight women in both training and control groups. * indicates a significant difference between the groups at the p-value ⩽0.05.

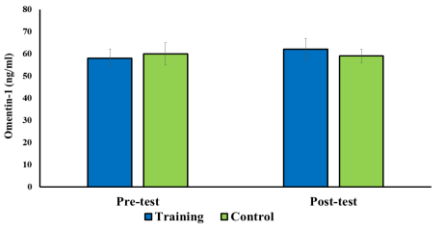

Figure 2. Changes in omentin-1 levels before and after eight weeks of Pilates exercise in overweight young women in the two training and control groups.

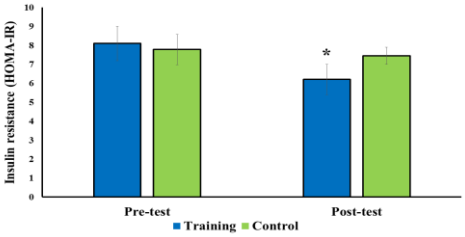

Figure 3. Changes in insulin resistance levels before and after eight weeks of Pilates exercise in overweight women in the two training and control groups. * indicates a significant difference between the groups at the p-value ⩽0.05.

Lipid profile changes

Figure 4 shows the lipid profile changes. The results of the covariance analysis test showed that there was a significant decrease in cholesterol (p-value=0.001) and triglyceride (p-value=0.001) in the training group compared to the control group. However, there was a significant increase (p-value=0.04) and no significant change in the levels of HDL-C and LDL-C, respectively (p-value=0.58 and p-value=0.63).

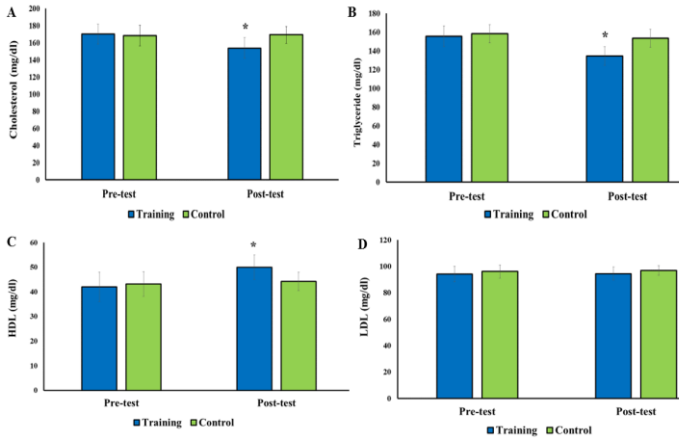

Figure 4. Changes in the cholesterol, triglyceride, HDL-C, and LDL-C levels before and after eight weeks of Pilates exercise in overweight women in the two training and control groups. * indicates a significant difference between the groups at the p-value ⩽0.05.

Weight, BMI, WHR, and body fat percentage

Table 1 presents the findings of the study based on the mean and SD of BMI before and after eight weeks of Pilates exercise. The results of the covariance analysis test showed that there was a significant decrease in the weight (p-value=0.005), BMI (p-value=0.008), waist circumference ratio to hip (p-value=0.001), and fat percentage (p-value=0.001) in the training group compared to the control group.

Table 1. The mean and SD of weight, BMI, and waist circumference before and after eight weeks

Index	Groups	Pre-data	Post-data	Between-group *P-value*
Weight (kg)	Training	74.90 ± 3.48	71.43 ± 9.65	# 0.005
	Control	73.53± 6.59	73.89 ± 7.12	
BMI (kg/cm^2)	Training	28.01 ± 0.81	27.5 ± 2.54	# 0.008
	Control	27.58 ± 0.91	25.93± 3.46	
WHR (cm)	Training	0.95 ± 0.05	0.90 ± 0.07	# 0.001
	Control	0.96 ± 0.02	0.99 ± 0.09	
Body Fat (%)	Training	39.45 ± 3.35	34.85 ± 9.46	# 0.001
	Control	38.36 ± 4.22	37.97 ± 4.52	

# Indicates a significant difference between the groups at the $p \leqslant 0.05$ level.

Discussion

The current study examined the effect of eight weeks of Pilates exercise on 25-hydroxyvitamin D, omentin-1, and lipid profile levels in overweight women. A noteworthy finding of the current study was the beneficial impact of Pilates exercise on the serum levels of 25-hydroxyvitamin D. This led to a significant increase in its levels, which is consistent with the findings of studies conducted by Geirsdottir et al. (2020) (22) and Vahdatpoor et al. (2022) (23). Vahdatpoor et al. (2022) (23) examined the impact of eight weeks of Pilates exercise and sun exposure on vitamin D levels in females diagnosed with multiple sclerosis. The results demonstrated that doing eight weeks of Pilates activities at home in a sunny atmosphere raised its levels, and these patients are advised to do these exercises. Body weight, particularly fat mass, negatively impacts vitamin D status by restricting its availability and conversion to 25-hydroxyvitamin D. However, Pilates exercise decreases the body weight, increases fat lipolysis, mobilizes fat tissue, and as a result, increases the serum level of vitamin D (24). Following eight weeks of Pilates exercise, as this study demonstrated, there was a significant decrease in both body composition and body fat percentage. The impact of Pilates exercise on growing local bone mass is one of the other aspects that merit discussion since exercise reduces calcium release and increases the efficiency of calcium absorption. Elevations in serum calcium also preserve serum vitamin D levels (25). While the current study did not examine serum calcium, variations in calcium levels may contribute to the rise in 25-hydroxyvitamin D. Additionally, according to earlier studies, there is a significant negative relationship between fasting insulin levels and the insulin resistance index and 25-hydroxyvitamin D in overweight and obese individuals (26). As we observed, insulin resistance index decreased and 25-hydroxyvitamin D increased significantly by performing eight weeks of Pilates exercise. The weight loss of the participants in the Pilates exercise group can be ascribed to the rise in vitamin D levels, despite the limitations of the study, which included dietary management, limited sun exposure, and clothing of the individuals. Since vitamin D is soluble in fat and readily absorbed by fat cells, body fat is the primary cause of the decline in vitamin D levels (27). Pilates exercise may lead to an increase in vitamin D levels in overweight conditions from fat tissue by inducing systemic anti-inflammatory effects and reducing pro-inflammatory indicators such as tumor necrosis factor-alpha (TNF-α), as well as reducing glucose, insulin and insulin resistance levels (28). In this way, the levels of 25-hydroxyvitamin D, which is directly related to vitamin D, are affected by Pilates exercise.

Omantin-1 was one of the other variables examined in this study and there was no significant change in its value following eight weeks of Pilates exercise. This finding is consistent with investigations conducted in 2015 by Daryanosh et al. (2015) (29). According to their study, no significant change was observed in omentin-1 after exercise, which examined the impact of resistance training on omentin-1 in women with diabetes. Faramarizi et al. investigated the impact of balanced aerobic exercise on omentin-1 in obese women. The current study found that although insulin resistance, fat percentage, and BMI decreased with the implementation of eight weeks of Pilates exercise, levels of omentin-1 did not change significantly. It is proposed that various factors, including the initial levels of omentin-1 and the intensity, type, and duration of exercise, contribute to changes in omentin-1 levels in the blood (30). It should be mentioned that several studies have demonstrated an inverse relationship between insulin resistance and plasma levels of omentin-1, which can be used to predict obesity-related metabolic consequences. Thus, further controlled research is needed to determine the precise process underlying increases in omentin-1 levels after exercise, as other variables may also be implicated in these changes. Ommentin-1 may also be regulated by inflammation. As obesity is associated with lower levels of chronic inflammation, it may contribute to the regulation of omentin's role in humans (31). Inflammation levels were not measured in the present study, it is suggested to be examined in future studies. Few researches have been conducted on the effect of different and regular exercises on the levels of ommentin-1 in obese and overweight people. Correspondingly, the mechanisms of regulation of the circulating level of omentin-1 have not yet been properly determined. It is possible that the reduction of fat cell size, due to the change in body composition, is an effective factor in changing the plasma concentration of omentin-1.

Lipid profile was one of the indicators evaluated in this research. The findings of the current study demonstrated that lipid profile can be improved after eight weeks of Pilates exercise. Subsequently, the concentrations of triglyceride, cholesterol, and HDL-C dramatically changed in the exercise group compared to the control group; however, the level of LDL-C did not change much, despite a drop in its level. It should be mentioned that the initial levels at the start of training are key influencing factors when discussing how sports training affects these indicators. In other words, those with greater baseline triglyceride and LDL-C or lower HDL-C had a different lipid profile after receiving additional training (32). Following eight weeks of Pilates exercise, the training group showed a significant reduction in total levels of cholesterol and triglyceride compared to the control group. This finding is consistent with studies by Yamaner et al. (2024) (33) and Huldani et al. (2024) (34). HDL-C levels were one of the other characteristics that were evaluated, and it significantly increased compared to the control group. The beneficial effects of physical exercise on HDL-C are well acknowledged in the study literature. Even in a one-time training session, this variable has shown positive improvements. These results are inconsistent with the findings of Lee et al.'s study (2021) (35) and consistent with Franczyk et al. (2023) (36) and Shlool et al. (2023) (37). Lee et al. (2021) investigated the effects of combined exercise and low carbohydrate ketogenic diet interventions (CELCKD) for overweight and obese individuals. Results showed HDL-C was not statistically different after the interventions. Studies have demonstrated that women typically exhibit a smaller shift in lipoprotein levels following exercise training than males. This difference may be partially attributed to women's lower total cholesterol levels than those of men. The study's limitations included a lack of control over food consumption, nutritional status, and participant exposure to sunlight. Exposure to sunlight produces the active form of vitamin D, which can affect serum levels of 25-hydroxyvitamin D (38). Future research is advised to concentrate on aspects such as individual caloric intake, nutritional status, and the amount of sunlight exposure.

Conclusion

The results of this study indicate that eight weeks of Pilates exercise may promote the lipid profile and serum levels of 25-hydroxyvitamin D in overweight women. As a result, Pilates exercises are a good non-drug option for people with low blood levels of 25-hydroxyvitamin D or overweight people suffering from obesity-related disorders.

Acknowledgement

The authors sincerely thank all persons who helped in the implementation of this research.

Funding sources

Not applicable.

Ethical statement

The Ethics Committee of the University of Mohaghegh Ardabili approved this study's protocol (IR.ARUMS.REC.1398.114).

Conflicts of interest

There is no conflict of interest.

Author contributions

Mojdeh Khajehlandi contributed to data collection, statistical analysis, and laboratory experiments. Ali Eyvazi Nasirlu, Hamed Kheirollahi Meidani, Rasoul Ershadifard, Farnaz Seifi, and Roghayyeh Fekri conceived and supervised the study. All authors read and approved the final manuscript.

References

1. De Pergola G, Martino T, Zupo R, Caccavo D, Pecorella C, Paradiso S, et al. 25 Hydroxyvitamin D levels are negatively and independently associated with fat mass in a cohort of healthy overweight and obese subjects. 2019;19(6):838-44. [View at Publisher] [DOI] [PMID] [Google Scholar]
2. Nettore IC, Albano L, Ungaro P, Colao A, Macchia PE. Sunshine vitamin and thyroid. Rev Endocr Metab Disord. 2017;18(3):347-54. [View at Publisher] [DOI] [PMID] [Google Scholar]
3. De Pergola G, Nitti A, Bartolomeo N, Gesuita A, Giagulli VA, Triggiani V, et al. Possible role of hyperinsulinemia and insulin resistance in lower vitamin D levels in overweight and obese patients. Biomed Res Int. 2013:2013:921348. [View at Publisher] [DOI] [PMID] [Google Scholar]

4. Looker AC. Do body fat and exercise modulate vitamin D status? 2007;65(suppl_2):S124-6. [View at Publisher] [DOI] [PMID] [Google Scholar]
5. Bunout D, Barrera G, Leiva L, Gattas V, de la Maza MP, Avendaño M, et al. Effects of vitamin D supplementation and exercise training on physical performance in Chilean vitamin D deficient elderly subjects. Exp Gerontol. 2006;41(8):746-52. [View at Publisher] [DOI] [PMID] [Google Scholar]
6. Groenendijk I, Chan R, Woo J, Ong S, Parikh P, Bragt MC, et al. A combined nutrition and exercise intervention influences serum vitamin B-12 and 25-hydroxyvitamin D and bone turnover of healthy Chinese middle-aged and older adults. J Nutr. 2020;150(8):2112-9. [View at Publisher] [DOI] [PMID] [Google Scholar]
7. Mallard SR, Howe AS, Houghton LA. Vitamin D status and weight loss: a systematic review and meta-analysis of randomized and nonrandomized controlled weight-loss trials. Am J Clin Nutr. 2016;104(4):1151-9. [View at Publisher] [DOI] [PMID] [Google Scholar]
8. Patel VB, editor. Molecular nutrition: carbohydrates. Academic Press; 2019. [View at Publisher] [Google Scholar]
9. Seifi F, Khajehlandi M. Effect of 12-Weeks Pilates Exercise Training on Serum Levels of Apelin and Omentin-1 in Inactive Overweight Women. J Ardabil Univ Med Sci. 2019;19(3):311-22 [View at Publisher] [DOI] [Google Scholar]
10. Narumi T, Watanabe T, Kadowaki S, Kinoshita D, Yokoyama M, Honda Y, et al. Impact of serum omentin-1 levels on cardiac prognosis in patients with heart failure. Cardiovasc Diabetol. 2014;13(1):84. [View at Publisher] [DOI] [PMID] [Google Scholar]
11. Shibata R, Ouchi N, Takahashi R, Terakura Y, Ohashi K, Ikeda N, et al. Omentin as a novel biomarker of metabolic risk factors. Diabetol Metab Syndr . 2012;4(1):37. [View at Publisher] [DOI] [PMID] [Google Scholar]
12. Mogharnasi M, Galdavi R. The Effect of Circuit Resistance Training and Detraining on Plasma levels of Omentin-1 and Body Composition in Overweight and Obese Female Students. 2015;3(8):75-88. [View at Publisher] [DOI] [Google Scholar]
13. Li S, Xue J, Hong P. Relationships between serum omentin-1 concentration, body composition and physical activity levels in older women. Medicine (Baltimore). 2021;100(10):e25020. [View at Publisher] [DOI] [PMID] [Google Scholar]
14. Gotto Jr AM. High-density lipoprotein cholesterol and triglycerides as therapeutic targets for preventing and treating coronary artery disease. Am Heart J. 2002;144(6Suppl):S33-42. [View at Publisher] [DOI] [PMID] [Google Scholar]
15. Sadowska-Krępa E, Gdańska A, Rozpara M, Pilch W, Přidalová M, Bańkowski S. Effect of 12-week interventions involving Nordic walking exercise and a modified diet on the anthropometric parameters and blood lipid profiles in overweight and obese Ex-Coal miners. Obes Facts. 2020;13(2):201-12. [View at Publisher] [DOI] [PMID] [Google Scholar]
16. Arslanoğlu E, Şenel Ö. Effects of pilates training on some physiological parametres and cardiovascular risk factors of middle aged sedantary women. International Journal of Sport Studies. 2013;3(2):122-9. [View at Publisher] [Google Scholar]
17. Cruz-Ferreira AIC, Pereira CLN, Fernandes JA. Sports Si, Exercise. Effects Of Three Months Of Pilates-based Exercise in Women on Body Composition: 1447. Medicine & Science in Sports & Exercise. 2009;41(5):16-7. [View at Publisher] [DOI] [Google Scholar]
18. Ebrahimi F, Mahdavinejad R, Jalily HR. The effects of selected Pilates exercises on muscle strength, balance and HbA1c in female patients with diabetes type 2. 2015;7(2):251-65. [View at Publisher] [DOI] [Google Scholar]
19. Atashak S. The effect of eight weeks of pilates training on C-reactive protein, insulin resistance, and body composition in middle-aged obese women. J Rafsanjan Univ Med Sci. 2018;17(5):421-34. [View at Publisher] [DOI] [Google Scholar]
20. Borg G, Hassmén P, Lagerström M. Perceived exertion related to heart rate and blood lactate during arm and leg exercise. Eur J Appl Physiol Occup Physiol. 1987;56(6):679-85. [View at Publisher] [DOI] [PMID] [Google Scholar]
21. Jackson AS, Pollock ML. Generalized equations for predicting body density of men. Br J Nutr. 1978;40(3):497-504. [View at Publisher] [DOI] [PMID] [Google Scholar]
22. Geirsdottir OG, Chang M, Jonsson P, Thorsdottir I, Ramel A. Associations of physical activity with vitamin D status depends on obesity status in old adults. Clin Nutr ESPEN. 2020;39:222-6. [View at Publisher] [DOI] [PMID] [Google Scholar]
23. Vahdatpoor H, Askari R, Shakarian S, Marefati H, Kashani K. The Effect of Eight Weeks of Exposure to Sunlight and Home-Based Pilates Training on Vitamin D Levels, Resiliency and Sleep Quality in Women with Multiple Sclerosis. Journal of Isfahan Medical School. 2022;40(685):667-77. [View at Publisher] [DOI] [Google Scholar]
24. Moosavi SJ, Habibian M, Farzanegi P. The effect of regular aerobic exercise on plasma levels of 25-hydroxy Vitamin D and insulin resistance in hypertensive postmenopausal women with type 2 diabetes. Razi Journal of Medical Sciences. 2016;22(141):80-90. [View at Publisher] [Google Scholar]
25. Lu L, Yu Z, Pan A, Hu FB, Franco OH, Li H, et al. Plasma 25-hydroxyvitamin D concentration and metabolic syndrome among middle-aged and elderly Chinese individuals. Diabetes Care. 2009;32(7):1278-83. [View at Publisher] [DOI] [PMID] [Google Scholar]
26. Specker BL. Evidence for an interaction between calcium intake and physical activity on changes in bone mineral density. J Bone Miner Res. 1996;11(10):1539-44. [View at Publisher] [DOI] [PMID] [Google Scholar]
27. Al-Othman A, Al-Musharaf S, Al-Daghri NM, Krishnaswamy S, Yusuf DS, Alkharfy KM, et al. Effect of physical activity and sun exposure on vitamin D status of Saudi children and adolescents. BMC Pediatr. 2012;12(1):92. [View at Publisher] [DOI] [PMID] [Google Scholar]
28. Eslami VF, Habibian M, Moosavi SJ. The effectiveness of vitamin D supplementation with Pilates Training on vitamin D status and insulin resistance in overweight men. A clinical trial study. Pathobiology Research (Modares Journal of Medical Sciences). 2021;23(5):17-28. [View at Publisher] [Google Scholar]
29. Daryanoosh F, Aminilari Z. The effect of 12 weeks of resistance training on the Apelin, Omentin-1 levels and insulin resistance in the elderly overweight women with type 2 diabetes. J Adv Med Biomed Res. 2015;23(98 and 3):29-40. [View at Publisher] [Google Scholar]
30. Faramarzi M, Banitalebi E, Nori S, Farzin S, Taghavian Z. Effects of rhythmic aerobic exercise plus core stability training on serum omentin, chemerin and vaspin levels and insulin resistance of overweight women. J Sports Med Phys Fitness. 2016;56(4):476-82. [View at Publisher] [PMID] [Google Scholar]
31. Kazama K, Usui T, Okada M, Hara Y, Yamawaki H. Omentin plays an anti-inflammatory role through inhibition of TNF-α-induced superoxide production in vascular smooth muscle cells. Eur J Pharmacol. 2012;686(1-3):116-23. [View at Publisher] [DOI] [PMID] [Google Scholar]
32. Lalonde L, Gray-Donald K, Lowensteyn I, Marchand S, Dorais M, Michaels G, et al. Comparing the benefits of diet and exercise in the treatment of dyslipidemia. Prev Med. 2002;35(1):16-24. [View at Publisher] [DOI] [PMID] [Google Scholar]
33. Yamaner E, Demirkıran B, Özcan E. Effects of a Six-Week Aerobic Exercise Training Program on Lipid Profiles in Sedentary Women. International Journal of Disabilities Sports and Health Sciences. 2024;7(3):564-9. [View at Publisher] [DOI] [Google Scholar]
34. Huldani H, Biworo A, Noor F, Ahdiya W, Ridhoni MH, Amaliea NR, et al. Differences in total cholesterol and triglyceride levels between the trained and untrained groups after 30 minutes of running. Revista Latinoamericana de Hipertension. 2024;19(4):139. [View at Publisher] [DOI] [Google Scholar]
35. Lee HS, Lee J. Effects of combined exercise and low carbohydrate ketogenic diet interventions on waist circumference and triglycerides in overweight and obese individuals: a systematic review and meta-analysis. Int J Environ Res Public Health. 2021;18(2):828. [View at Publisher] [DOI] [PMID] [Google Scholar]
36. Franczyk B, Gluba-Brzózka A, Ciałkowska-Rysz A, Ławiński J, Rysz J. The impact of aerobic exercise on HDL quantity and quality: a narrative review. Int J Mol Sci. 2023;24(5):4653. [View at Publisher] [DOI] [PMID] [Google Scholar]
37. Shlool HA, Qandeel NN. Intensity Level of Endurance Exercise and its Effect on Males with Elevated Blood LDL-C Levels. J Hum Sport Exerc. 2023. [View at Publisher] [DOI]
38. Keyfi F, Hashemniya V, Hosseinzade F, Tajik H, Varasteh AR, Sharifi N. Effects of Vitamin D on Human Body and the Measurement Methods: A Systematic Review. Govaresh. 2020;25(3):208-15. [View at Publisher] [Google Scholar]

How to Cite:

Khajehlandi M, Eyvazi Nasirlu A, Kheirollahi Meidani H, Seifi-Skishahr F, Fekri R, Ershadifard R. Effects of eight weeks of Pilates exercise on serum 25-Hydroxyvitamin D, Omentin-1, and lipid profile in overweight women. *Jorjani Biomedicine Journal.* 2024;12(1): 1-4.