Exercise Physiology and Performance Volume2 Issue1 (2024): 92-105

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Original Article

The effect of 8 weeks of Pilates exercises with and without vitamin D supplementation on body composition and osteoporosis in overweight postmenopausal women

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Submission date: 10-05-2024 Acceptance date: 16-05–2024 Print Date: 15-06–2024

Abstract

Background: Osteoporosis is a fundamental problem that is observed more often from the onset of menopause. Considering that the prevalence of osteoporosis and fractures related to it is higher in postmenopausal women than in old men, it is very important to investigate this issue; the main purpose of this research is to investigate the effect of eight weeks of Pilates exercises with and without vitamin D supplementation on body composition and osteoporosis in overweight postmenopausal women.

Method: The current research method was semi-experimental with a pre-test and post-test design with a control group. The statistical population of this study included postmenopausal women with an age range (50 to 70 years) and a high body mass index (25 to 29 kg/m2) in the city of Masjid Suleiman, Khuzestan province, with 40 women in three experimental groups and one group were controlled. The first group of 10 people only did Pilates, the second group of 10 people only took vitamin D supplements, the third group of 10 people did Pilates with the supplement and the last group was considered as the control group. The subjects participated in the Pilates exercise program, which included 8 weeks of three sessions of one hour per week, and took vitamin D supplements according to the schedule. Finally, the subjects' body mass index, vitamin D level, and osteoporosis level were determined before and after the activity. To check the results, the statistical method of covariance test was used at the significance level of $P \leq 0.05$.

Results: Based on the obtained results, Pilates exercises along with vitamin D supplementation had an effect on the body composition of overweight postmenopausal women and reduced the body mass index of women ($P \leq 0.05$)). Pilates exercises combined with vitamin D supplementation had an effect on osteoporosis in overweight postmenopausal women and the rate of osteoporosis in the subjects was reduced ($P \leq 0.05$). However, supplement consumption and Pilates exercise alone did not affect the amount of body mass index and osteoporosis ($P \leq 0.05$).

Conclusion: According to the results obtained from this research, it is possible to suggest Pilates exercises along with vitamin D supplementation to overweight postmenopausal women to improve body composition and prevent osteoporosis. The main goal of osteoporosis treatment is to prevent fractures. To achieve this goal, bone loss must be stopped or reduced. Although several alternative medical treatments have been recommended to prevent bone loss or increase bone formation, Pilates exercise and vitamin D supplementation are also emphasized in various treatment guidelines as part of osteoporosis management.

Keywords: Pilates exercises, vitamin D, body composition, osteoporosis, Overweight postmenopausal women.

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Introduction

Today, two factors are obesity and vitamin D deficiency which are often observed together, are considered epidemiological problems worldwide (1). Osteoporosis is a progressive skeletal disorder in which bone strength (bone density and quality) is compromised, there by predisposing a person to an increased risk of fracture. Osteoporosis is the most common bone disorder in humans and is an important global public health issue. Fractures caused by osteoporosis are associated with increased mortality (2).

In addition, fractures are associated with increased disability, decreased physical function, and poor quality of life with increased financial burden (3). In this disease, there is low bone mineral density and micro destruction of bone tissue, which leads to bone fragility. With the increasing aging population, osteoporosis and osteoporosis-related fractures are rapidly becoming important public health issues that place a significant economic burden on health care resources (4).

Osteoporosis is a silent disease because it usually has no symptoms and you may not even know you have it until a bone breaks. Osteoporosis is the main cause of bone fractures in postmenopausal women and in elderly men. Fractures can occur in any bone, but most often occur in the bones of the pelvis, vertebrae of the spine, and wrists (2). For many women, it starts a year or two before menopause. Achieving maximum bone mass is important for bone health and plays an important role in preventing osteoporosis and subsequent fractures in later years. It has been reported that hip fractures can be reduced by 30% with a 10% increase in bone mass (6).

Bone mineral densitometry[1] (BMD) is a valuable clinical diagnostic index for osteoporosis and the best tool for predicting osteoporotic fractures. In this method, the amount of bone mineral weight is measured per cubic centimeter, and it represents a relative measure of bone mineral content, and it is measured based on optical accumulation per square centimeter of bone surface in proxy imaging (7). Many factors are effective in measuring bone density, among which age, sex, disease, genetics, and lifestyle can be mentioned (8).

The main threat of osteoporosis is the fractures caused by osteoporosis in one place with BMD it occurs below (mostly in the spine, hip, or wrist, sometimes the humerus or ribs are involved) and its incidence increases after a fracture (5). Osteoporotic fractures occur in

1. Bone Mineral Densitometry

the order in which the first symptom is lower extremity fractures starting at age 50, followed by vertebral fractures in the 60s to 75s, and hip fractures in the late 70s. Loss of mobility, reduced quality of life, creates a significant health and economic burden on public health. For example, during the first year after a hip fracture, 20-30% of patients die, which is very costly (9).

Menopause is a natural physiological phenomenon caused by primary ovarian failure secondary to apoptosis. Menopause is accompanied by physical symptoms such as cramping and emotional symptoms such as sleep disturbance, and decreased energy, and affects emotional health. There are many effective treatments for this natural phenomenon, from lifestyle adjustment to hormone therapy (10). Osteoporosis is the most common disease in postmenopausal women and is strongly associated with poor quality of life (11). Osteoporosis after menopause is related to the decrease in estrogen hormone production. In women, estrogen helps slow bone resorption. Therefore, as estrogen levels decrease, bone loss can accelerate. Statistics show that the average age of natural menopause in most countries is around 50 years. As the aging population is expanding rapidly, the proportion of postmenopausal women is increasing. Therefore, the health of postmenopausal women has become a major concern worldwide (12).

Vitamin D one of those key nutrients is vitamin D deficiency it is common in obese people (13). Vitamin D (VD), Calcium and phosphorus minerals are essential for maintaining bone tissue and for homeostasis. severe shortage VD it causes osteomalacia in adults and rickets in children, while a moderate deficiency leads to increased bone turnover and thus a greater risk of bone fracture (14). Some studies have shown that Vitamin D it can also help stabilize emotions and mood, and is widely considered the most important vitamin for menopausal women. One way to take care of your health during menopause is if you are menopausal, by prescribing nutrients that support systems that are vulnerable to changing hormones. The most prominent effects of the Vitamin D on cells is related to bone health. For example, it increases the absorption of calcium and phosphorus from the intestine, and these nutrients help to keep muscles, teeth and bones strong and healthy (15).

Considering that the life process has become inactive with the advancement of technology and modernization, and the level of activity and mobility of people in the society has been greatly reduced and has placed a burden on the society and the health system. For this reason, many countries today have come to the conclusion that by investing in sports

and conducting research, it is possible to improve their physical and mental health while reducing treatment costs and increasing the productivity of people in the society (12). In the meantime, Pilates is one of the sports that can effectively help the physical and mental health of the population, especially the female population, as a suitable and cheap sport due to the lack of different facilities and special places (14).

Pilates is an exercise method designed with simple physical movements that stabilizes the body and increases body strength and balance. The purpose of this exercise is to develop and improve flexibility and strengthen the immune system, strengthen the cardio-respiratory system, improve coordination, strength and mental exercises. In other words, Pilates exercises are an exercise method that seeks to create flexibility, endurance, strength and coordination, without increasing muscle mass. Also, Pilates exercises are an exercise program that encourages the use of thought to control muscles (17).

The current lifestyle of sitting more and moving less is bad for our health and bone density. Strong bone density prevents osteoporosis and arthritis and can affect people of any age. Studies have shown that Pilates is effective in increasing quality of life, relieving pain and increasing bone density (15). The effects of Pilates exercise on aspects such as balance for the general population have been reported by recent systematic reviews. Physical activity of any type and method can have positive and beneficial effects on most different body systems, and Pilates exercises are designed to improve the flexibility and general health of the body, focusing on strengthening the core strength of the body, body posture, and coordination of breathing through movement (13). The Pilates method is a unique approach to mind training. Body awareness and control of body movements and posture and the use of specialized devices provide an opportunity to teach a variety of movement patterns and postures. Pilates as a beneficial exercise has become a target of interest in recent years (17).

Osteoporosis and related fractures are more common in postmenopausal women than in older men because estrogen plays a key role in maintaining bone health. National Osteoporosis Foundation (NOF) estimated that there are 9.1 million women with osteoporosis and another 26 million with low bone mass (12). This number is much higher than the estimated number of men with osteoporosis, 2.8 million, and with low bone mass, 14.4 million (18). Therefore, investigating this issue is very important. By describing the above in this research, the effects of 8 weeks of Pilates exercises with and without vitamin D supplements Body composition and osteoporosis of overweight postmenopausal women

have been investigated.

Material and methods

The current research method was semi-experimental with a pre-test and post-test design with a control group. The statistical population of this study included postmenopausal women with an age range (50-70) and a high body mass index (25-29) in the city of Masjid Suleiman, Khuzestan province. The sampling method was purposeful and available. 40 overweight postmenopausal women were selected voluntarily and then randomly in four groups of Pilates exercises with vitamin D supplements (10 people), Pilates practice without taking vitamin D supplements (10 people) and supplement consuming group (10 people) and 10 people without any variable were examined as the control group.

The Pilates training program consisted of 8 weeks of three one-hour sessions per week. Each training session consisted of 5 minutes of warm-up, 50 minutes of training with the desired intensity and 5 minutes of cooling down. Exercise was targeted and controlled with an intensity of 40-80% of the target heart rate and Borg's pressure perception index. At the beginning of the training intensity program, 40% of the target heart rate and Borg's pressure perception index were considered 10, and during 8 weeks, it gradually reached 80% and the Borg's pressure perception index was 16. Due to the non-cyclical nature of Pilates exercises, the minimum intensity of the exercises was 40 and the maximum intensity of the exercises was 80. The number of repetitions of each movement started from 10 repetitions in the first week and increased to 20 repetitions. In order to increase the intensity of the training, in addition to increasing the repetition of movements, the type of movements was also changed. Three phases were considered for gradually changing the training intensity. The first phase included preparation and familiarization with basic principles and movements. The second phase consisted of moderate level movements with moderate repetitions and low speed, and the third phase consisted of moderate movements with a large number and relatively high speed. Resting between sets was done in an active form and doing the opposite movements.

The body composition test included height, weight, body mass index (BMI), waist to hip ratio (WHR), and the ratio of weight to the square of height was used for body mass index. Also, the WHR was the simplest approach to quantify fat distribution, using ratio of waist circumference to hip circumference. To measure bone density by Dexa method[1]

1. Dual-energy X-ray absorptiometry

(DEXA) used. Subjects of the vitamin D supplement user group One capsule of 50,000 international vitamin D units per week (Iran Hakim Pharmaceutical Company) under the supervision of a nutritionist.

Statistical Analysis

The results were analyzed in two parts, descriptive statistics and inferential statistics, and to check the assumptions, the normality test of the data and also the covariance test at the significance level were used $P \leq 0.05$.

Results

Tables 1 and 2 show the mean and standard deviation of the research variables. In general, it can be said that the amount of vitamin D in the post-test of the experimental group has increased compared to the pre-test. The body mass index has decreased and the weight has also decreased in the experimental group compared to the pre-test. This is despite the fact that no difference can be seen in the control group. The bone density index also improved after Pilates exercises and supplement consumption.

Table 1: Average indices of the variables before and after applying the independent variable

Variable	Groups	before and after	Average and standard deviation	Difference of means	Significance level
Weight (kg)	Practice	Before next	65±3.75 63±2.85	2.00	**0.04**
	supplement	Before next	65 ±3.25 65 ±2.26	0.00	**0.12**
	hybrid	Before next	65±3.35 63±2.28	0.00	**0.04**
	Control	Before next	65 ± 3.28 65 ± 3.58	0.00	**0.14**
Indicator body mass (kg/m2)	Practice	Before next	27.4 ±1.8 27.2 ±2.3	0.2	**0.03**
	supplement	Before next	27.4 ±1.8 27.2 ±2.3	2.1	**0.21**
	hybrid	Before next	26.7 ±2.1 24.5 ±1.9	2.2	**0.02**
	Control	Before next	27.7 ±2.3 27.6 ±2.8	0.1	**0.12**
Hip circumference	Practice	Before next	105.1 103.2	1.9	**0.02**

(centimeter)	supplement	Before next	103.5 103.4	0.1	**0.23**
	hybrid	Before next	106.9 104.1	2.8	**0.02**
	Control	Before next	105.9 105.8	0.1	**0.18**
waist size (centimeter)	Practice	Before next	93.8 90.5	3.3	**0.01**
	supplement	Before next	92.9 92.6	0.3	**0.16**
	hybrid	Before next	93.3 91.7	1.6	**0.04**
	Control	Before next	93.6 93.4	0.2	**0.2**

Table 2: Average indices of the variables before and after applying the independent variable

Variable	**Groups**	**before and after**	**Average and standard deviation**	**Difference of means**	**Significance level**
Vitamin D (ng/ml)	Practice	Before next	21.15 22.21	1.06	**0.06**
	supplement	Before next	23.82 35.88	12.06	**0.01**
	hybrid	Before next	21.16 34.25	13.09	**0.01**
	Control	Before next	23.22 23.32	0.1	**0.19**
Density leg bone (BMD) (gr/cm2)	Practice	Before next	0/95±0/11 0/98±0/15	0.03	**0.03**
	supplement	Before next	0/94±0/15 1/06±0/18	0.12	**0.01**
	hybrid	Before next	0/96±0/21 1/09±0/32	0.13	**0.01**
	Control	Before next	0/96±0/12 0/96±0/24	0.00	**0.11**
Density back bone (BMD) (gr/cm2)	Practice	Before next	0/95±0/26 1/11±0/15	0.16	**0.01**
	supplement	Before next	0/94±0/23 1/14±0/18	0.20	**0.01**
	hybrid	Before next	0/94±0/15 1/17±0/31	0.23	**0.01**
	Control	Before next	0/96±0/14 0/96±0/17	0.00	**0.12**

In the statistical analysis of the results of the effects of Pilates exercises along with the consumption of vitamin D supplements. According to Table 3, the results showed a

significant level of less than five hundredths for the body composition of overweight postmenopausal women. Therefore, it can be said that Pilates exercises with vitamin D supplements. The superior body composition of postmenopausal women has been effective.

Table 3- Checking the effectiveness of Pilates exercises with vitamin supplements Superior body composition of postmenopausal women

Source	sum of squares	Degrees of freedom	F	meaningful
Fixed	0.004	1.00	1.155	0.27
pre-exam	0.294	1.00	32.615	0.07
group	0.071	1.00	46.526	0.01

Based on the information in Table 4, Pilates exercises with vitamin supplementsdIt had an effect on osteoporosis in overweight postmenopausal women, that is, Pilates exercises with vitamin supplementsdIt has had an effect on osteoporosis in postmenopausal women.

Table 4: Checking the effectiveness of Pilates exercises with vitamin D supplements on osteoporosis in postmenopausal women

Source	sum of squares	Degrees of freedom	F	meaningful
Fixed	0.011	1.00	1.220	0.27
pre-exam	0.321	1.00	46.652	0.06
group	0.065	1.00	41.232	0.01

Pilates exercises also had an effect on body mass index, based on the information in Table 5, considering that the significance level is less than five hundredths, it can be said that Pilates training had an effect on body mass index.

Table 5: Checking the effectiveness of Pilates exercises on body mass indices

Source	sum of squares	Degrees of freedom	F	meaningful
Fixed	0.004	1.00	1.311	0.32
pre-exam	0.471	1.00	95.546	0.08
group	0.074	1.00	56.532	0.01

According to the information in Table 6, Pilates exercises had an effect on the indicators of weight, height, and postmenopausal women with osteoporosis, and considering that a significance level of less than five percent was obtained, it can be said that Pilates exercises had an effect on the indicators of weight, height, and postmenopausal women with

osteoporosis. It has been effective.

Table 6: Investigating the effectiveness of Pilates exercises on weight, height, postmenopausal women with osteoporosis

Source	sum of squares	Degrees of freedom	F	meaningful
Fixed	0.003	1.00	1.252	0.32
pre-exam	0.332	1.00	63.415	0.07
group	0.063	1.00	24.523	0.01

Based on the information in Table 7, Pilates exercises on vitamin D levels overweight postmenopausal women were affected. Considering that the results are statistically significant, it can be said that Pilates exercises have an effect on vitamin D levels. Postmenopausal women with excess weight have been affected.

Table 7: Investigating the effectiveness of Pilates exercises on vitamin levels overweight postmenopausal women

Source	sum of squares	Degrees of freedom	F	meaningful
Fixed	0.005	1.00	1.521	0.24
pre-exam	0.451	1.00	82.326	0.06
group	0.062	1.00	51.824	0.01

Discussion

Osteoporosis, a multifactorial systemic skeletal disease, is characterized by low bone mineral density and microarchitectural destruction of bone tissue, leading to bone fragility (1). According to the standards of the World Health Organization, osteoporosis as T-score It is defined as less than or equal to 2.5. The neck of the femur and the lumbar spine are recommended as the target anatomical area. National Osteoporosis Foundation (NOF) It estimates that there are 9 million women with osteoporosis and another 26 million with low bone mass. This number is much higher than the estimated number of men with osteoporosis (20).

Physical activity seems to be one of the most effective ways to lose and control body weight. Currently, the benefits of physical activity cover a wide range that is directly related to weight control (21). According to the results of the research of Pilates exercises along with the consumption of vitamin supplementsdIt has affected the body composition of postmenopausal women. In this regard, studies have shown the effects of Pilates exercises

on the body composition of sedentary, overweight and obese women (19). Pilates exercises can be used to improve body composition. In the present research, Pilates exercises along with vitamin D supplements. It has had an effect on osteoporosis in postmenopausal women. The main goal of treatment in osteoporosis is to prevent fractures, to achieve this goal, bone loss should be stopped or reduced, bone strength should be maintained, and factors contributing to fractures should be eliminated or reduced. Although several medical treatment alternatives have been recommended to prevent bone loss or increase bone formation, exercise has also been emphasized as part of osteoporosis management in various treatment guidelines (22).

Weight bearing exercises and strength training have been reported to have positive effects on bone loss. It has been suggested that high-intensity exercise may have additional beneficial effects on bones. However, it has also been reported that people with osteoporosis may benefit from even mild-intensity exercise. In addition to its positive effects on bone mass, exercise is well known to have beneficial effects on pain, functional decline, balance, and quality of life (20). Therefore, exercise programs to improve trunk and lower limb muscle strength, as well as general strength and postural stability are needed to prevent falls. A specialized Pilates program targets muscle and bone strength and directly helps prevent further bone loss and even reverse the effects of osteoporosis. Pilates focuses on weight bearing exercises while simultaneously strengthening the core, spine, and legs (23).

Also, in this study, Pilates exercises had an effect on body mass index. In this context, Pilates is considered as a method that helps to reduce overall body weight, body fat percentage, body mass index and visceral fat level (21). In a study that was conducted to evaluate the scientific evidence for the effectiveness of Pilates in improving body weight and body composition in overweight women, the results showed that Pilates led to a significant reduction in body weight, BMI, it becomes overweight. Weight loss appears to be more pronounced in studies with obese participants, and Pilates appears to be effective for improving body weight and BMI be more evident in the longer intervention period (24). These findings can have significant implications for promoting exercise interventions for overweight and obesity management. Several studies have shown that Pilates is effective on body weight and body composition in overweight or obese adults (22). In some systematic reviews to determine the effects of Pilates on body composition in different populations, it was shown that there is not enough evidence that Pilates has a positive effect on body weight

and body composition (25). This finding is different from the results of our research and the main reason that may explain this is the poor methodological quality of the included studies (26 , 27). In another systematic review, there was evidence that Pilates can reduce body fat and increase lean mass (28). Although this is partially consistent with our findings, another study found no evidence of the effectiveness of Pilates in improving body weight and body composition in the general population, including overweight and obese individuals, which was inconsistent with the results of the present study, and insufficient exercise intensity and Lack of diet control can be the main reason for these results (29).

Some studies have shown that exercise can improve the function of several body systems, thereby improving body weight, body composition, and emotional health status, so exercise is widely considered to reduce weight use. It has been reported that 30–45 min of Pilates exercise can provide sufficient stimuli to induce positive changes in energy expenditure and thereby reduce body weight (25), which is in line with our results. In addition, since Pilates exercise involves the application of various types of resistance (26), it can increase the muscle strength of the upper body, lower body, and abdomen (27), and as a result, it can improve the composition. The body helps (28-30), which in turn may improve overweight or obesity (31).

In this study, Pilates exercises on vitamin D levels Postmenopausal women with excess weight have been affected. Vitamin D it has many physiological functions, including the regulation involved in the absorption of intestinal calcium and phosphate, the mobility of bone reabsorption, the renal reabsorption of calcium, and also acts on a variety of pleiotropic functions (32). It is believed that many hormonal effects of Vitamin D involving a 1,25-dihydroxyvitamin receptor-mediated transcriptional mechanism D_3 which involves binding to cellular chromatin and regulating hundreds of genes in many tissues. In a trial, the results showed that after eight weeks in the exercise group, compared to the control, serum vitamin D levels significantly increased and at the end they concluded that vitamin D deficiency it can be significantly improved through exercise and the use of nutritional supplements (15).

Conclusion

In explaining the results, it can be said that the factors measured in the current study are changes in body parameters such as body weight, BMI, WHR and vitamin D amounts and the osteoporosis index of the body was that all these changes were significantly improved

after 8 weeks of Pilates training and supplement consumption compared to the control group. Studies have shown that deep breathing during exercise increases energy expenditure through fat burning (). The reason is that in addition to the active muscles, the respiratory muscles involved also consume energy. Since deep and diaphragmatic breathing is one of the most important principles of Pilates exercises, Pilates exercises are expected to have significant effects on body fat mass, fat percentage and weight (28). The results of this study showed the positive effect of Pilates practice on abdominal obesity. Other studies have shown similar results. For example, 12 weeks of Pilates exercises have been shown to improve visceral fat levels. These results are consistent with some findings (32), but not consistent with the results of some other studies (33). The major difference between those studies and the present study was the characteristics of the subjects and the exercise protocols. For example, it seems that eight weeks of training is not enough to improve some indicators (34).

Declaration

Competing interests

There is no competing interest to disclose.

Acknowledgments

Thanks to all coworkers.

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