

The effect of an eight-week Pilates exercise regimen on stress management and cortisol levels in sedentary women

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Abstract

Introduction: The aim of the present study is to examine the effect of eight weeks of Pilates exercise on stress management and cortisol levels in sedentary women.

Material & Methods: Twenty-two sedentary women aged between 25 and 40 years old participated in this study. The subjects were randomly divided into the Pilates group (n=11) or the control group (n=11). The subjects in the Pilates group performed 60 minutes of Pilates exercise 3 times a week for 8 weeks. Body composition parameters, resting heart rate (HR), blood pressure (BP), cortisol levels and perceived stress were measured before and after the intervention.

Results: The results showed that body fat percentage, cortisol levels, and perceived stress score were reduced after Pilates exercise ($P < 0.05$); however for resting HR, systolic blood pressure (SBP)

and diastolic blood pressure (DBP) no significant changes were observed.

Conclusions: In summary, the results suggest that the Pilates exercise utilized in this study is a useful strategy for stress management in sedentary women.

Keywords: Stress management, Pilates exercise, Cortisol, Blood pressure, Sedentary women

1. Introduction

Mild stress may be beneficial in cognitive tasks and physical performance while persistently high stress may lead to anxiety and depression (1). Any type of physical or mental stress can lead to greatly enhanced secretion of Adrenocorticotrophic Hormone (ACTH) and consequently cortisol as well. In the case of mental stress, this is believed to result from increased activity in the limbic system, especially in the region of the amygdala and hippocampus, both of which then transmit signals to the posterior medial hypothalamus. Cortisol has direct negative feedback effects on the hypothalamus to decrease the formation of Corticotrophin-releasing hormone and on the anterior pituitary gland to decrease the formation of ACTH. Feedbacks help regulate the plasma concentration of cortisol. However, stress stimuli are prepotent; they can always break through this direct inhibitory feedback of cortisol, causing either periodic exacerbations of cortisol secretion at multiple times during the day or prolonged cortisol secretion at times of chronic stress (2).

Regular physical activity has positive effects on the prevention and treatment of illnesses such as cardiovascular disease, diabetes, pulmonary diseases, osteoporosis and cancer (3,4). Physical activity has been shown to alleviate state and trait anxiety and to improve physical self-perception and mental well-being (5). In addition, physical activity exhibited marked positive associations with a good work capacity and healthy lifestyle (6). Aldana et al. (1996) indicated that employees undertaking physical moderate activity experienced about half the rate of perceived stress compared with more passive individuals (7).

The Pilates method was created in the 1920s by physical trainer Joseph H. Pilates and has been developed based on Eastern and Western health preservation methods, such as Yoga and Tai chi (8,9). Core stability, strength, and flexibility are emphasized in Pilates exercise, as is control of movement, posture, and breathing (9). This form of exercise is suitable for the majority of individuals and may be one of the most attractive forms of fitness training (10,11). Pilates exercise was found to correct body posture, relax the waist and neck, resolve shoulder problems, and reduce fat of the arms and abdomen (12-14). Pilates can improve blood circulation and cardiopulmonary function as the exercise is dominated by rhythmic breathing, particularly lateral thoracic breathing that can effectively promote the exchange of oxygen. Pilates exercise has been proven to impact personal autonomy (15), pain control (10,16,17), improved muscle strength (18,19), flexibility (18,20), and motor skills (21). Further studies suggest that Pilates can release the mental, increase the brain's oxygen supply, and enhance brain function (22,23), while studies of older cohorts also suggest that Pilates is beneficial to quality of life (24,25), mood state (19) and mental state, including sleep quality, emotion, self-confidence and self-esteem among older individuals(11,26).

Karter (2001) emphasizes that Pilates exercise leads to an improvement in the function of the lungs, heart and blood vessels with increased strength and muscular endurance, muscle stretching and balance as well as working to moderate mood, reduce tension, depression, and stress in all aspects of life (27). However, there has been little research on how Pilates exercise affects stress management. Considering the positive effects of regular physical activities and exercise in stress management, in this study researchers studied the effect of an eight-week Pilates exercise regimen on stress management and cortisol levels of sedentary women.

2. Materials and Methods

Subjects

Forty sedentary middle-aged women enrolled and volunteered to participate in this study. All the people were asked to complete a

personal health and medical history questionnaire, which served as a screening tool. Twenty-two sedentary women with a mean (\pm SD) age of 31.4 ± 3.8 years selected as the subject after screening by inclusion criteria. All the subjects were completely inactive at least 6 months before the study and they were nonsmokers and free from unstable chronic condition including dementia, retinal hemorrhage, and detachment; and they had no history of myocardial infarction, stroke, cancer, dialysis, restraining orthopedic or neuromuscular diseases. Thereafter, the subjects were randomly assigned to a control group (n=11) or Pilates group (n=11).

Measurements

Anthropometric measurements

Height and body mass were measured, and body mass index (BMI) was calculated by dividing body mass (kg) by height (m^2). Waist circumference was determined by obtaining the minimum circumference (narrowest part of the torso, above the umbilicus) and the maximum hip circumference while standing with their heels together. The waist to hip ratio (WHR) was calculated by dividing waist (cm) by hip circumference (cm). Body fat percentage was assessed by skinfold thickness protocol. Skinfold thickness was measured sequentially, in triceps, suprailiac, and thigh by the same investigator using a skinfold caliper (Harpenden, HSK-BI, British Indicators, West Sussex, UK) and a standard technique.

Cortisol assessment

Fasted, resting morning blood samples were taken at the same time before and after 8 weeks intervention. After tourniquet application on the right/left upper arm blood was collected in 5 ml syringe through 16-gauge needle taking all aseptic precautions from the right/left cubital vein. Blood samples were collected between 8:00 – 9:00 am in both the conditions to avoid diurnal variations. 3 ml of blood was transferred to a plain bulb and kept undisturbed for half an hour for the separation of serum from it. The serum collected from this bulb was used to estimate the serum cortisol levels. The serum cortisol levels were measured by using an immunoradiometric assay (IRMA).

Blood pressure and heart rate measurements

The measurement of systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate (HR) were carried out at 8:00 – 9:00 am using an aneroid sphygmomanometer device (Alpk2, Japan). The measurements were taken in the sitting position after a 10- min rest period and the result represented the mean of three measurements completed at intervals of 1 min.

Perceived stress measurement

Perceived stress was measured using the perceived stress scale (PSS-14) (28), which comprised of 14 questions with responses varying from 0 to 4 for each item and ranging from never, almost never, sometimes, fairly often and very often respectively. The PSS had an internal consistency of 0.85 (Cronbach a coefficient) and test-retest reliability during a short retest interval (several days) of 0.85 (28). It assessed the degree to which participants evaluated their lives as being stressful for a month before. PSS-14 scores were obtained by reversing the scores on four positive items, for example, 0 = 4, 1 = 3, 2 = 2, etc. and then summing across all 14 items. Items 4, 5, 6, 7 and 10 were the positively stated items. The scale yielded a single score with high scores indicating higher levels of stress and lower levels indicating lower levels of stress. The PSS-14 had a possible range of scores from 0 to 56. The range of PSS scores was also divided into stratified quartiles. The upper two and lower two quartiles were combined (28 being the operational cut off value for the upper bound) and were labeled as stressed and not stressed respectively.

Pilates exercise protocol

The subjects in the Pilates group were performed 60 min Pilates exercise, 3 times a week for 8 weeks. Pilates exercise protocol of this study was derived from the protocol of Badiei et al. (2017) and Pérez et al. (2014) (29,30) that modified for our subjects. These exercises were performed in a classical way on mattresses, including three parts of warm up with Pilates breathing and stretching exercises followed by the main workout session and finally cooling down. Exercises were divided into two parts; the first week consisted of primary level pre-Pilates exercises (Table 1), and for the next seven weeks included core

interventional exercising. The exercise protocol was further amended by adding new intermediate level exercises that were decided on the basis of individual ability and readiness (Table 2). It was ensured that the participants felt comfortable throughout the period of intervention. The control group was instructed not to change their physical activity.

Table 1. Planning classes in the first weeks: for beginner client

Pre-Pilates Exercise (Lying Down)	Pre-Pilates Exercise (Sitting Up)	Beginner Mat	Wall Series	Series With Weight (1 kg)
Exploring the power house	Towering above the hips	The hundred	Arm circle	Arm forward 90
Pushing the navel toward the spine	Lifting the knee	Rolling up	Rolling down	Arm to the side 90
Pushing the column toward the mat	Raising and lowering the shoulders	Leg circle	Sitting on the chair	Flexion of the forearm standing
Stretching the neck-chain leading toward the chest	Shoulder circles from one side to the other	Single leg stretching		
Rolling down	Looking toward the navel	Double leg stretching		
	Bringing the ear to the shoulder	Spine stretching forward		
	Half circle			

Source: Badiiei et al. (2017) (29) and Pérez et al. (2014) (30)

Table 2. Planning classes in the next seven weeks of intervention: for intermediate client

Level: Intermediate	Mat Repetition
The hundred	10 sets for 10 repetitions
Rolling up	10-15
Leg circle	5 each way
Rolling like a ball	15-20
Single leg stretching 6	15-20
Double leg stretching	15-20
Single straight leg stretching	5 sets
Double straight leg stretching	10-15
Criss-Crossing	5 sets
Spine stretching forward	10-15
Open leg rocker	15-20

Level: Intermediate	Mat Repetition
Corkscrew	3 sets
Saw	3 sets
Neck circle	1 each way
Single leg kicking	15-20
Double leg kicking	2 sets
Neck pulling	15-20
Side kicking series: front-behind	15-20
Side kicking series: up-down	15-20
Small circle	15-20
Teaser 1	15-20
Sealing	15-20

Source: modified protocol of Badiei et al. (2017) (29) and Pérez et al. (2014) (30)

Ethical approval

The study was approved by the Ethics Committee of the Islamic Azad University, Marvdasht branch, Iran. The purpose of the study was fully explained to the participants and it was ensured that all of them provided written personal consent. The consent form also ensured that the collected data of questionnaires will remain confidential.

Statistical analysis

Results were expressed as the mean \pm SD and Shapiro-Wilk Test was applied to evaluate the normal distribution of variables. ANCOVA was used to assess the impact of the intervention while controlling the co-variant effects of the pre-test. Assumptions of a normal distribution of scores and homogeneity of variance were evaluated. Paired t-test also, was used to assess the inter-group changes. Pearson correlation analysis was performed to calculate a correlation. The significant level of this study was set at $P < 0.05$ and the data were analyzed using SPSS software for Windows (version 17, SPSS, Inc., Chicago, IL).

3. Results

Anthropometric, body composition, physiological, biochemical and stress characteristics of the subjects before and after training are presented in Table 3. No significant differences were observed on the anthropometric parameters of the subjects at baseline. As shown in Table 3, body fat

percent decreased significantly after 8 weeks of Pilates exercise ($P < 0.05$), however for body mass, BMI and WHR no significant changes were observed.

Our data indicated that SBP, DBP and resting HR had a tendency to decrease after the Pilates exercise, but this tendency did not achieve statistical significance.

The results demonstrated that cortisol levels and perceived stress score decreased in the Pilates group compared to the control group ($P < 0.05$). Pearson correlation showed a positive relationship between cortisol levels and perceived stress score. The result indicated that perceived stress score had the tendency to decrease as cortisol levels decreased ($r = 0.42$; $P = 0.04$).

Table 3. Anthropometric, body composition, physiological, biochemical and stress characteristics (mean \pm SD) of the subjects before and after training

	Baseline (mean \pm SD)	After intervention (mean \pm SD)	Paired t- test (Sig)	ANCOVA
Body mass (kg)				
Pilates	64.1 \pm 16.6	63.8 \pm 16.1	0.5	0.9
Control	65.4 \pm 8.3	65.9 \pm 8.3	0.1	
BMI (Kg/m²)				
Pilates	25.2 \pm 6.6	25.0 \pm 6.4	0.5	0.9
Control	24.7 \pm 3.2	24.9 \pm 2.9	0.1	
Body fat (%)				
Pilates	27.3 \pm 7.1	25.4 \pm 6.5	0.01*	0.001*
Control	28.0 \pm 4.0	28.6 \pm 4.4	0.1	
WHR				
Pilates	0.82 \pm 0.04	0.79 \pm 0.06	0.1	0.3
Control	0.81 \pm 0.04	0.82 \pm 0.05	0.3	
SBP (mmHg)				
Pilates	107.2 \pm 10.0	102.7 \pm 7.8	0.1	0.4
Control	110.0 \pm 7.7	107.2 \pm 11.0	0.2	
DBP (mmHg)				
Pilates	77.2 \pm 10.8	73.6 \pm 6.7	0.3	0.1
Control	82.7 \pm 6.4	79.0 \pm 8.3	0.1	

	Baseline (mean \pm SD)	After intervention (mean \pm SD)	Paired t- test (Sig)	ANCOVA
Resting HR (bpm)				
Pilates	71.8 \pm 1.5	69.4 \pm 1.2	0.3	0.2
Control	69.3 \pm 1.3	71.9 \pm 1.3	0.2	
Cortisol (μg/dl)				
Pilates	17.6 \pm 4.7	13.9 \pm 3.5	0.04*	0.04*
Control	13.6 \pm 4.8	14.3 \pm 3.3	0.5	
Stress (Score)				
Pilates	28.4 \pm 2.5	25.4 \pm 2.7	0.01*	0.009*
Control	27.1 \pm 3.8	27.8 \pm 4.2	0.3	

Data are the mean \pm SE of baseline and final values of the anthropometric, body composition, physiological, biochemical and stress changes on each variable in each group. Comparison different significance between groups after 8 weeks Pilates exercise was determined by using the ANCOVA test. *P<0.05.

4. Discussion

The aim of the present study was to examine the effects of eight-week Pilates exercise on stress management and cortisol levels in sedentary women. Our data indicated that eight-week Pilates exercise improved body fat percent of the subjects. Several studies have proven that the Pilates exercise has a beneficial effect on body composition (31-33). However, Segal et al. (2004) reported that body fat percent had no significant changes after a period of Pilates exercise (20). These discrepant results may be attributed to differences in subject populations, Pilates exercise and/or body composition measurement.

Our data in line with the previous studies (34,35) showed that no significant changes occurred in SBP, DBP and resting HR after the intervention. For example, Jago et al. (2006) found non-significant changes in SBP and DBP, following four-week Pilates training in girls (34). Pilates exercise increases the rated capacity to extract more oxygen from the blood that allows the reduction of blood flow rate to active muscles and thus decreases HR (36). Sahinci Gokgul and Hazar (2017) indicated that eight-week Pilates exercise had positively affected the reduction of the pulse and blood pressure rates at rest (37). Pilates exercise program leads to lower blood pressure at rest and after the

effort because of the positive changes associated with regular training for a long time to the heart muscle and the efficiency of blood vessels and improves blood components. Hassan and Amin (2011) noted that Pilates exercise activates venous blood circulation and increases blood return to the heart. On the other hand, these exercises increase the number of opened capillaries in the tissue cells, make blood flow easily inside the arteries and capillaries during contraction of the heart and thus lower SBP. The increasing expansion of capillaries blooming during Pilates exercise may lead to a decline in peripheral resistance to blood flow in the arteries leading to lower DBP (36).

Another influential mechanism in the decrease in blood pressure could be due to total body relaxation and mental calmness as a result of correct breathing during the Pilates exercise (35,36,38). Mental or emotional stress activates nervous and endocrine responses, such as an increase in epinephrine and norepinephrine stimulation that results in an increase in blood pressure, while preparing the body for physical activity (39). Pilates exercise program includes a set of stretching and muscle strength exercises and relaxation accompanied by music and the organization of breath during the performance, leading to a sense of fun, less stress and strain. These exercises help to reduce HR and blood pressure (36).

The results of the present study showed that cortisol levels decreased in the Pilates group compared to the control group ($P < 0.05$). Corazza et al. (2014) noted that chronic exercise modulates serum cortisol levels, but it is dependent on the type of exercise and variables of the training process (volume, intensity, duration, periodization) (40). The studies indicated that the decrease of cortisol levels following the regular exercise may be related to the inhibition of protein catabolism and the promotion of protein aggregation by virtue of reducing its degradation (40).

In the end, according to our results, perceived stress score was reduced after eight- week Pilates exercise and a positive relationship between cortisol levels and perceived stress score were observed in the present study ($P < 0.05$). The result indicated that perceived stress score had the tendency to decrease as cortisol levels decreased. Muller et al. (2016) also, mentioned that Pilates exercise reduces stress and anxiety during

pregnancy (41). Karter (2001) reported that Pilates exercise leads to a moderation of mood and reduces tension and anxiety suffered by the individual during daily life (27). Large amounts of cortisol are associated with mental disorders and a decrease in perceived stress score may be attributed to a decrease of cortisol levels caused by Pilates exercise. HPA axis dysregulation and cortisol hypersecretion have been implicated in mental health and some studies have shown lower stress-induced cortisol responses in physically trained individuals compared to the untrained ones (42) suggesting that physical activity may act as a buffer against exaggerated or sustained stress responses. Pilates exercise is a useful strategy for promoting health status, wellness, depression, anxiety and quality of life improvements in both nonclinical and clinical populations (43,44). Furthermore, Pilates exercise leads to increase in body awareness and conscious use of breath and these exercises increases confidence, ability to concentrate and improves intuition of injury prevention, stress management, and relaxation (45). We had some limitations in this study. First, we did not measure ACTH in the present study. If we could measure ACTH, we could carefully explain the mechanisms responsible for Pilates exercise that reduces cortisol levels. Secondly, every questionnaire study has subjective questions that can lead to a loss in accuracy and reliability.

5. Conclusion

Our results indicated that Pilates exercise is a useful strategy for body composition improvement, stress management and reducing cortisol levels in sedentary women. Generally, studies on the effects of Pilates exercise on psychological stress and cortisol levels are scarce and additional studies are needed to elucidate the effect of these exercises on stress management.

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