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The effect of eight-week Pilates exercise on the thyroid function in sedentary women

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Abstract

Introduction: Physical activity and exercise influences energy metabolism in human subjects by increasing activity-induced energy expenditure and resting metabolic rate for several hours after exercise. The effect of Pilates exercise on thyroid function is not well known. Thus the purpose of present study was to examine the effect of eight-week Pilates exercise on triiodothyronine (T3), thyroxine (T4) and thyroid stimulating hormone (TSH) in sedentary women.

Material & Methods: Twenty two sedentary women aged between 25 to 40 years old participated in this study as the subject. The subjects were divided into Pilates group (n=11) or control group (n=11) randomly. The subjects in the Pilates group performed 60 min Pilates exercise, 3 times a week for 8 weeks. Body composition parameters, T3, T4 and TSH concentrations were measured before and after the intervention.

Results: The results showed body fat percent was reduced after Pilates exercise ($P<0.05$), however for T3, T4, TSH concentrations no significant changes were observed.

Conclusions: In summary, the results suggest Pilates exercise utilized in this study had not significant effect on thyroid function in sedentary women.

Keywords: Thyroid function, Triiodothyronine, Thyroxine, Thyroid stimulating hormone, Sedentary women

1. Introduction

It is a well-known fact that exercise affects the activity of many glands and the production of their hormones. One of the glands affected is the thyroid. The thyroid gland is one of the largest endocrine glands in the body, is, that the normal weight adults is 15 to 20 grams, and placed immediately below the larynx, and the sides and front of the trachea. Thyroid gland secretes two separate amino acid-iodine bound thyroid hormones known as 3-5-3' triiodothyronine (T3) and 3-5-3'-5' tetraiodothyronine (T4, thyroxine) both of which are also found in the free form (fT4, fT3), whose importance on the regulation of general metabolism, growth, and tissue differentiation as well as gene expression has been known for a long time (1,2). It is also known that thyroid hormones act in fatty acid oxidation and thermoregulation (3). Thyrotropin-releasing hormone (TRH) secreted from hypothalamus stimulates anterior pituitary to release thyrotropin (TSH, thyroid stimulating hormone) (3). When exercise is repeated at certain intervals, there is a pituitary-thyroid reaction that is properly coordinated by increasing turnover of thyroid hormones (4). When thyroxine turnover and related hormonal action is increased, this would lead to hyperthyroidism (3,5). However, there is no evidence that such a case occurs in trained athletes. For example, in trained athletes the difference between basal metabolic rate and body temperature is rarely abnormal (3). Thus, it appears that an increase in thyroxine turnover, which occurs with physical training, may have a different mechanism (5,6). Training disturbs the athletes' energy homeostasis in an attempt to invoke beneficial adaptations. At the same time, body weight and food intake controlling systems send the signal to save energy. Ignoring this process can result in overtraining and a reduced sensitivity to anabolic hormones and other endocrine signaling (5,7,8). Research on marathon training women brings out very interesting results about thyroid turnover. When a relatively sedentary person starts to train and increases training to 48 km/week – a moderate thyroid disorder develops reflected by increasing T3 and T4 levels (7). Pakarinen et al. (1988) reported that serum total T4 and fT4 decreased following 12 weeks resistance training (9). However, Simsch et al (2002), indicated that TSH and fT3 decreased after high intensity resistance training. For fT4 concentration no significant change was observe (10).

Pilates was created in the 1920s by physical trainer Joseph H. Pilates and has been developed based on the Eastern and Western health preservation methods, such as Yoga and Taichi (11,12). Core stability, strength and flexibility are emphasized in Pilates exercise, as is control of movement, posture, and breathing (12). This exercise is suitable for all the people and may be one of the most attractive fitness trainings (13,14). Pilates exercise was found to be able to correct body posture, relax the waist and neck, solve the problem of shoulder, and reduce fat of arm and abdomen (15-17). Pilates can improve the blood circulation and cardiopulmonary function as the exercise is dominated by the rhythmic breath, particularly the lateral thoracic breathing that can effectively promote the exchange of oxygen. The Pilates has been proven to impact personal autonomy (18), pain control (13,19,20), improved muscle strength (21,22), flexibility (21,23), and motor skills (24). Further studies suggest that Pilates can release the stress of mind, increase brain's oxygen supply, and enhance brain function (25,26), and studies in aged samples also suggest that Pilates is beneficial to quality of life (27,28), mood state (22) and mental state, including sleep quality, emotion, self-confidence and self-esteem (14,29,30). Pilates exercise may affect body metabolism however by our knowledge there has been no study on how a Pilates exercise affects thyroid hormones and thereby body metabolism. Thus the present study was done to examine the effect of eight-week Pilates exercise on T3, T4 and TSH in sedentary women.

2. Material & 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 $\pm$ 3.8 years selected as the subject after screening by inclusion criteria. All the subjects were completely inactive at least 6 month 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.

Biochemical 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 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 T3, T4 and TSH level. The serum TSH level was measured by using immunoradiometric assay (IRMA) and T3 and T4 level was measured by using electrochemiluminescence assay (ECL).

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) (31,32) that modified for our subjects. These exercises were performed in the 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.

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-chin 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: Badiei et al. (2017) (31) and Pérez et al. (2014) (32)

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 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
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) (31) and Pérez et al. (2014) (32)

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 ± 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 normal distribution of scores and homogeneity of variance were evaluated. Paired t-test also, was used to assess the inter-group changes. 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 and biochemical 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 the Table 3, body fat percent decreased significantly after 8 weeks Pilates exercise ($P<0.05$), however for body mass, BMI and WHR no significant changes were observed.

Our data indicated that T3 and T4 had tendency to increase and TSH had tendency to decrease after the Pilates exercise, but these tendency did not achieve statistical significance.

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

	Baseline (mean ± SD)	**After intervention (mean ± SD)**	**Paired t-test (Sig)**	**ANCOVA**
Body mass (kg)				
Pilates	64.1 ± 16.6	63.8 ± 16.1	0.5	0.9
Control	65.4 ± 8.3	65.9 ± 8.3	0.1	
BMI (Kg/m^2)				
Pilates	25.2 ± 6.6	25.0 ± 6.4	0.5	0.9
Control	24.7 ± 3.2	24.9 ± 2.9	0.1	

	Baseline (mean ± SD)	After intervention (mean ± SD)	Paired t-test (Sig)	ANCOVA
Body fat (%)				
Pilates	27.3 ± 7.1	25.4 ± 6.5	0.01*	0.001*
Control	28.0 ± 4.0	28.6 ± 4.4	0.1	
WHR				
Pilates	0.82 ± 0.04	0.79 ± 0.06	0.1	0.3
Control	0.81 ± 0.04	0.82 ± 0.05	0.3	
T3 (ng/ml)				
Pilates	133.8 ± 9.0	138.8 ± 10.6	0.1	0.7
Control	134.9 ± 12.6	137.7 ± 16.3	0.5	
T4 (μg/ml)				
Pilates	8.5 ± 0.9	8.7 ± 1.3	0.5	0.1
Control	8.2 ± 0.7	8.8 ± 0.8	0.001*	
TSH (μU/ml)				
Pilates	2.3 ± 1.4	2.1 ± 1.4	0.4	0.9
Control	3.8 ± 2.2	3.0 ± 1.4	0.6	

Data are the mean ± SE of baseline and final values of the anthropometric, body composition and biochemical 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 thyroid function 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 (33-35). However, Segal et al. (2004) reported that body fat percent had no significant changes after a period of Pilates exercise (23). These discrepant results may be attributed to differences in subject populations, Pilates exercise and/or body composition measurement method.

Peripheral metabolism of thyroid hormones can be changed significantly by a number of physiological and pathological conditions, which can alter the deiodination pathway and lead to a change in the circulating level of thyroid hormones. The biological effects of short-term changes in the thyroid hormone levels are not currently completely understood but are potentially important in the body's adjustment to stressful or catabolic states (36). Compelling evidence also suggests that, if exercise-related energy expenditure exceeds calories consumed, a low T3 syndrome may be induced.

In female athletes, four days of low energy availability reduced T3, fT3, increased rT3, and slightly increased T4. Since an adequate amount of the prohormone T4 was available throughout the study, an alteration in the peripheral metabolism of T4 was likely. The increase in rT3 and decrease in T3 are consistent with a decreased activity of hepatic 5'-deiodinase activity, since this enzyme is responsible for the production of T3 and the clearance of rT3. These alterations in thyroid hormones could be prevented solely by increasing dietary caloric consumption without any alteration in the quantity or intensity of exercise (37). While the role of a hypo caloric diet in producing alterations in thyroid hormones has been demonstrated in several studies, the role of exercise in thyroid hormone metabolism is not very clear. A connection is established between increasing training to 80 km/week and elevated hormone levels (5). In another study looking at men with six months of endurance training, while T4 and free T4 concentrations reduced a little, no change in thyrotropin was observed (38). Koistinen et al.'s study on unacclimatized top class skiers showed that training at moderate altitude for 12 days resulted in a significant decrease in serum total T3 levels and an increase in fT3 levels with no significant change in TSH, T4, fT4 and reverse T3 (rT3) (6). Another study done by Deligiannis et al. (1993) looking at the thyroid hormone response to swimming for 30 minutes at varying water temperatures showed that TSH and fT4 levels were significantly increased at 20°C as compared to 32°C but no significant effect was seen on T3 (39). The confounding results of thyroid hormone levels seen following exercise might be mediated by elevated cortisol levels however; additional research is required to establish this connection.

Exercising increases metabolic activity, which helps burn more calories and helps keep weight down. Research results showed that mediumintensity aerobic exercise, which the study classified as 70% of a person's maximum heart rate, produced the best results for improving TSH (40). Some improvement in thyroid function might be attributed to decreasing in body mass after the exercise. Exercise can by itself also improve thyroid function may be through better perfusion of gland. However this needs to be investigated further. Even gentle exercise such as walking, swimming, or yoga stimulates thyroid gland secretion and increases tissue sensitivity to thyroid hormones (40).

5. Conclusion

The results indicated that Pilates exercise is a useful strategy for body composition improvement; however these exercise had not significant effect on thyroid function.

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