International Journal of Thin Films Science and Technology

http://dx.doi.org/10.18576/ijtfst/110305

Effect of Pilates Exercises on Cortisol Hormone and Blood Pressure Among Hypertensive Women

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Received: 2 May 2022, Revised: 13 Jun. 2022, Accepted: 12 Jul. 2022
Published online:1 Sep. 2022.

Abstract: ***Background*:** Hypertension is a major risk factor for cardiovascular diseases such as stroke and coronary artery disease as well as causes mortality. The Pilates method is a conditioning program in hypertensive patients of the body and mind that is gaining in popularity and acceptance worldwide. ***Aim of Study***: To determine the response of cortisol hormone level and blood pressure after Pilates exercise in hypertensive post-menopausal women. ***Methods****:* Sixty women participated in this study was selected from Belbies Central employees and outpatient clinic with age mean ± SD values in groups **(A)** and (B) were 52.83 ± 3.89 and 53.37 ± 3.66 years., respectively. All of them suffering from high blood pressure stage 2(systolic 140 or higher and diastolic 90 or higher), they took medications (beta blockers - vasodilator – diuretics) and postmenopausal form 1-5 years ago. The study design was pre-post study. Patients were assigned for 8weeks protocol into two groups: Group (A) received Pilates training exercises (bent knee, shoulder bridge, side kick front, side kick back, and single leg circle), while Group (B) received only anti-hypertensive medications. Group (A) performed 5 types of Pilates exercises per session for /3 sessions/ week/ 8 weeks. The outcome measures were blood pressure (systolic and diastolic), cortisol level, anticoagulant factors (prothrombin time (PT), partial prothrombin time (PTT)) and physical characteristic (weight, body mass index (BMI), and waist hip ratio) were evaluated at the baseline and the end of the study. ***Results*:** Pre- and post-treatment comparisons showed a statistically significant decrease of the measured variables in the group A (cortisol level 17.73%, systolic blood pressure 3.70%, Diastole blood pressure 5.01 %, partial prothrombin time 7.38%, where weight 2.92 %, Body mass index 2.98 %) and significant increase in prothrombin time 0.67 %. In group B cortisol level 10.48%, significant decrease in diastole blood pressure 1.73%, no significant increase in (prothrombin time 0.25%, Partial prothrombin time 0.28%, weight 0.64%, BMI 0.34%, waist hip ration 0.11%) as well as no significant decrease in systolic blood pressure 0.75.

Keywords: Anticoagulant, cortisol factors, hypertension, Pilates exercises.

1 Introduction

The prevalence of most underlying diseases, especially cardiovascular disease, and high blood pressure, is strongly associated with immobilization and decreasing physical activity [1].

Hypertension is blood pressure elevations which are associated with an increased risk of cardiovascular (CV) disease in a linear fashion. Starting at a blood pressure of 115/75 mm Hg, every increase of 20 mm Hg in systolic blood pressure (SBP) and/or increase of 10 mm Hg in diastolic blood pressure (DBP) is associated with a doubling of the risk of death from stroke, heart disease, or other vascular disease. Increases in SBP have the strongest link with CV disease, though other blood pressure components have been linked to CV disease as well, including DBP, 2 pulse pressure, blood pressure variability, and mean arterial blood pressure [2].

The prevalence of hypertension in women increases after the average age of menopause [3]. By 60 to 69 years of age, the prevalence of hypertension is higher in women than in men. There is evidence that changes in estrogen \ androgen ratios favoring increases in androgens, lead to

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activation of the RAS (Renin-angiotensin system), SNA (Sympathetic nervous activity) and ET-1 systems (Endothelin-1), increased vasoconstrictor eicosanoids, anxiety, and depression. All of the aforementioned may be important in the pathogenesis of postmenopausal hypertension [4].

Cortisol, a steroid hormone, is synthesized from cholesterol. It plays important roles during and after exercise, including participating in gluconeogenesis and accelerating the mobilization and use of fats for energy production [5].

The activated partial thromboplastic time (APTT) is used to measure the anticoagulant effect of unfractionated heparin (UFH) and adjust the dose to maintain levels in the target therapeutic range. The APTT reflects the ability of the heparin anti thrombin complex to inhibit thrombin, and other coagulation enzymes in the intrinsic coagulation pathway. There are some advantages of the test including its relative inexpensiveness, wide availability, simple performance, and rapid results [6].

Pilates reduces the risk of heart diseases, prevents osteoporosis, gives the body a good form and develops balance, flexibility and strength [7]. When literature was reviewed about effects of exercise on plasma lipids, lipoproteins, blood pressure and heart rates, results were indicated that moderate and low intensity exercise, if it is performed in adequate time period, causes decrease in body weight and body fat ratio additionally decrease serum total cholesterol level. Though Pilates is an exercise with lower intensity compared to other aerobic and dance exercises, the concentration, control, focus, flowing movement rhythm, certainty of movement, and breathing techniques during positions play a very important role in a healthy body [8].

Together Pilates and aerobic exercises are effective in sedentary women with initially high total cholesterol, triglyceride, and low-density lipoprotein levels. At the end of the cycles of 12 weeks Pilates and aerobic exercises, has a positive effect of waist to hip ratio, blood pressure, and heart beats in sedentary females. So Pilates and aerobic exercises are recommended for decreasing the risk of heart and vascular disease [9].

Pilates exercises are aiming to allow the practitioner to move consciously without pain and fatigue, the method is based on 6 principles [10]: (1) Breathing, (2) Control, (3) Concentration, (4) Centering, (5) Precision, and (6) Fluidity of movement. The exercises should be performed slowly and smoothly, allowing the practitioner to achieve flexibility and strength and requiring a great deal of concentration, thus demanding high levels of body awareness [11].

The previous studies applied to evaluate the effect of Pilates exercise on hypertensive postmenopausal women were limited. So, that this work focused on this relation.

Aim of the study: This study aimed to determine the effect of Pilates exercises on cortisol hormone and blood pressure in hypertensive postmenopausal women.

2 Patient and Methods

The study was performed at Belbies Central Hospital from May 2021 to September 2021.

Ethical consideration:

The study was approved from the Ethical Committee of Faculty of Physical Therapy, Cairo University. All patients were informed about the nature and purpose of the study, what would occur during the treatment sessions with extended opportunity to ask questions then signed an informed consent. Ethical consideration number: P.T.REC/012/003706

A-Inclusion Criteria:

Sixty women were enrolled in this study according to the following criteria:

Their age ranged from 50 to 60 years old. They were post-menopausal p at least for one year after last menses with maximum period 5 years, their body mass index ranged between (25 to 35 kg / m^2). They were hypertensive at stage 2 (systolic 140 or higher and diastolic 90 or higher), and took anti-hypertensive medications (beta blockers - vasodilator - diuretics).

B-Exclusion Criteria:

Women who were under hormonal replacement therapy and unstable cardiovascular conditions (those with a known history of ischemic attacks, stroke, congestive heart failure, or currently on anticoagulant therapy), sever pulmonary disease (with restrictive lung disease or with obstructive lung disease), musculoskeletal disorders (diagnosed sever osteoporosis or sever osteoarthritis) and BMI > 35.

Evaluation Equipment

The evaluation procedures were applied before the beginning of the study and at the end of the 8 weeks for each patient.

Weight and height scale: This scale was used for measuring weight and height of each patient to calculate body mass index (BMI) (Kg/m^2) which was calculated using the following formula: BMI= weight (kg)/ height (m^2) [12].

Sphygmomanometer: To measure systolic and diastolic blood pressure. It was standard (mercury) Sphygmomanometer.

Blood Analyzer to measure the cortisol level Model: Mini Vidas, Bio Mierex, SN: IVD 520482 Made in Italy.

Blood Analyzer to measure (PT) and (APPT) Model: KC1 Delta, REF: G05000, SN: 16 G62926 Made in Germany 2016.

Treatment procedures:

Group (A): consisted of thirty hypertensive postmenopausal women received 5types of Pilates exercises 3 sessions / week for 8 weeks.

The Pilates training included:

- **Mode of exercise**: The Pilates training program **(**The shoulder bridge, Bent-knee, Side kick front, Side kick back, Single leg circle) [13].
- **Duration of exercise**: Each session includes three phases: - **Warming up** (7-10) minutes warm up phase in the form of (breathing, arm circles, hip rolls exercises) - **Pilates phase** 40 minutes that consisted of 5 types of exercises (bent knee, shoulder bridge, side kick front, side kick back, single leg circle) duration of each one from 7-8 minutes. - **Cool down** (7-10) minutes in the form of (neck stretch, knee stretch, breathing exercises) In addition to their antihypertensive medications as in group B.
- **Frequency**: Exercise training was done three times per week for eight weeks.

Group (B): consist of thirty hypertensive postmenopausal women received their medication Beta blockers: Propranolol (Concor), Vasodilator: captopril (Capoten), and Diuretics: Furosemide (Lasix to control their blood pressure).

Statistical analysis:

Results are expressed as mean ± standard deviation. Analysis of covariance (ANCOVA) test was used to compare the pre-treatment values of the two groups and on the same time between post-treatment values on controlling the effect of pre-treatment values. Statistical Package for Social Sciences (SPSS) computer program (version 19 windows) was used for data analysis. Descriptive statistics including the mean and standard deviation for physical characteristic (weight, BMI), blood pressure (systolic and diastolic). Paired t-test to compare between pre-treatment and post-treatment within study group for blood pressure (systolic and diastolic). Significant level: All statistical analyses were significant at 0.05 level of probability ($p \leq 0.05$).

3 Results and Discussion

1- Physical characteristic: -

- *Weight*

Represented the weight values in group A. Mean values between pre- and post-weight 91.23 ± 9.41 and 88.57 ± 8.82, respectively, with improvement decrease percentage 2.92 %↓. The statistical analysis by paired t-test revealed that there was significant difference (t=7.220 p=0.001), as shown in table 1.

While in group B mean values between pre- and post-weight 94.28 ± 8.18 and 93.68 ± 8.94 respectively with no significant increase 0.64 ↑. The statistical analysis by paired t-test revealed that there was no significant difference (t=-1.519 p=0.14) as shown in table 2.

- *Body mass index (BMI)*

Group A. mean values between pre- and post-BMI 34.90 ± 3.80 and 33.86 ± 3.67 respectively, with improvement percentage 2.98 %. And significant difference (t=7.139, p=0.001) as shown in table 1.

While BMI values in group B mean values between pre- and post-BMI 35.91 ± 2.21 and 35.79 ± 2.29 respectively with no significant increase 0.34 %↑ and no significant difference (t=-0.749, p=0.46) as shown in table 2.

- *Waist hip ratio*: -

Group A. mean values were 0.919 ± 0.031 and 0.916 ± 0.035 respectively, with improvement percentage 0.33 %↓, but there was no significant difference (t= 0.878 p> 0.05) as shown in table 1.

While waist hip ratio values in group B were mean values 0.928 ± 0.022 and 0.929 ± 0.022 respectively with no significant increase 0.11 ↑ There was no significant difference (t=-0.384 p=0. 70) as shown in table 2.

2- Blood pressure: -

- *Systolic blood pressure:*

Group A. The mean values of pre- and post-systolic blood pressure were 144.0 ± 4.98 and 138.67 ± 5.56, respectively, with improvement percentage 3.70%, and there was significant difference (t= 9.133, p=0.001) as shown in table 1.

While systolic blood pressure values in group B mean values 142.17 ± 6.52 and 141.10 ± 5.85 respectively with no significant decrease 0.75 ↓. There was no significant difference (t= 1.759, p=0. 08) as shown in table 2.

- *Diastolic blood pressure*:

Group A. The mean values of pre- and post-diastolic blood pressure were 96.33 ± 3.20 and 91.50 ± 2.68, respectively, with improvement percentage 5.01%. There was significant difference (t=10.802, p=0.001) as shown in table 1.

While diastolic blood pressure values in group B mean values 94.97 ± 3.14 and 93.33 ± 3.30 respectively with significant decrease 1.73 ↓. And there was significant difference (t= 2.522, p=0.017) as shown in table 2.

3- Cortisol: -

Group A were19.52 ± 3.63 and 16.06 ± 3.75, respectively, with improvement decrease

percentage17.73%↓. There was significant difference (t= 8.752, p=0.001) as shown in table 1.

While cortisol values in group B mean values 19.56 ± 2.88 and 21.61 ± 3.60 respectively with significant increase 10.48 ↑ but there was significant difference (t=-3.870, p=0.001) as shown in table 2.

4- Anticoagulant factors: -

- *Prothrombin time (seconds*)

Group A were 11.99 ± 0.19 and 12.07 ± 0.26, respectively, with improvement percentage 0.67% ↑. There was significant difference (t=-2.424 p=0.022) as shown in table 1.

While Prothrombin time values in in group B mean values 11.96 ± 0.24 and 11.99 ± 0.28 respectively with no significant increase 0.25 ↑. There was non-significant difference (t=-0.728 p=0. 47) as shown in table 2.

- *Partial prothrombin time (seconds)*

Group A were 32.94 ± 2.81 and 30.51 ± 2.59, respectively, with improvement percentage 7.38 %↓. There was significant difference (t=9.790, p=0.001) as shown in table 1.

While Partial prothrombin time values in in group B mean values 32.24 ± 3.13 and 32.33 ± 3.10 respectively with no significant increase 0.28 ↑. There was non-significant difference (t=-1.140; p=0.26), shown in table 2.

Table (1) Pre and Post treatment outcome variables in group A:

Variables	(mean ±SD) Pre-treatment post-treatment	MD	Improvement %	p-value
Weight	91.23±9.41 88.57±8.82	2.66	2.92%↓	0.001(S)
Body mass index	34.90±3.80 33.86±3.67	1.04	2.98%↓	0.001(S)
Waist hip ratio	0.919±0.03 1 0.916±0.03 5	0.003	0.33 %↓	0.387(NS)
Systolic blood pressure	144.0±4.98 138.67±5.5 6	5.33	3.70%↓	0.001(S)
Diastolic blood pressure	96.33±3.20 91.50±2.68	4.83	5.01%↓	0.001(S)
Cortisol	19.52±3.63 16.06±3.75	3.46	17.73%↓	0.001(S)
Prothrombin time	11.99±0.19 12.07±0.26	0.08	0.67%↑	0.022(S)
Partial prothrombin time	32.94±2.81 30.51±2.59	2.43	7.38%↓	0.001(S)

Data are expressed as mean ±standard deviation **(SD), MD**: Mean difference, **p-value**: probability value, **(S):** significant (p<0.05), **(NS):** non-significant (p>0.05)

Table (2) Pre and Post treatment of all: outcome's variables in group B:

Variables	(mean ±SD) Pre-treatment post-treatment	MD	Improvement %	p-value
Weight	93.68 ± 8.94 94.28 ± 8.18	-0.60	0.64 ↑	0.14 (NS)
Body mass index	35.79 ± 2.29 35.91 ± 2.21	-0.12	0.34 ↑	0.46 (NS)
Waist hip ratio	0.928 ± 0.022 0.929 ± 0.022	0.001	0.11 ↑	0.704(NS)
Systolic blood pressure	142.17 ± 6.52 141.10 ± 5.85	1.07	0.75 ↓	0.089(NS)
Diastolic blood pressure	94.97 ± 3.14 93.33 ± 3.30	1.64	1.73 ↓	0.017 (S)
Cortisol	19.56 ± 2.88 21.61 ± 3.60	-2.05	10.48 ↑	0.001 (S)
Prothrombin time	11.96 ± 0.24 11.99 ± 0.28	0.03	0.25 ↑	0.472(NS)
Partial prothrombin time	32.24 ± 3.13 32.33 ± 3.10	0.09	0.28 ↑	0.264(NS)

Data are expressed as mean ±standard deviation **(SD), MD**: Mean difference, **p-value**: probability value, **(S):** significant (p<0.05), **(NS):** non-significant (p>0.05)

Table 3: Comparisons between all outcome's variables in both group:

Variable	Item	Groups (Mean± SD)		F value	P-value
		Group A n= 30	Group B n=30		
Systolic Blood pressure	Pre treatment	144.0 ± 4.98	142.17 ± 6.52	1.496	0.226 (NS)
	Post treatment	138.67 ± 5.56	141.10 ± 5.85	23.307	0.001 (S)
	Mean difference	5.33	1.07		
	% Improvement	3.70 ↓↓	0.75 ↓↓		
	t value	9.133	1.759		
	p- Value	0.001 (S)	0.089 (NS)		
Diastolic blood pressure	Pre treatment	96.33 ± 3.20	94.97 ± 3.14	2.794	0.100 (NS)
	Post treatment	91.50 ± 2.68	93.33 ± 3.30	13.193	0.001 (S)
	Mean difference	4.83	1.64		
	% Improvement	5.01 ↓↓	1.73 ↓↓		
	t value	10.802	2.522		
	p-Value	0.001 (S)	0.017 (S)		
Cortisol	Pre treatment	19.52 ± 3.63	19.56 ± 2.88	0.002	0.964 (NS)
	Post-treatment	16.06 ± 3.75	21.61 ± 3.60	72.254	0.001 (S)
	Mean difference	3.46	-2.05		
	% Improvement	17.73 ↓↓	10.48 ↑↑		
	t value	8.752	-3.870		
	P Value	0.001 (S)	0.001 (S)		
PT	Pre treatment	11.99 ± 0.19	11.96 ± 0.24	0.174	0.678 (NS)
	Post-treatment	12.07 ± 0.26	11.99 ± 0.28	1.616	0.209 (NS)
	Mean difference	0.08	0.03		
	% Improvement	0.67 ↑↑	0.25 ↑↑		
	t value	-2.424	-0.728		
	P Value	0.022 (S)	0.472 (NS)		
PTT	Pre treatment	32.94 ± 2.81	32.24 ± 3.13	0.826	0.367 (NS)
	Post-treatment	30.51 ± 2.59	32.33 ± 3.10	93.432	0.001 (S)
	Mean difference	2.43	0.09		
	% Improvement	7.38 ↓↓	0.28 ↑↑		
	t value	9.790	-1.140		
	P Value	0.001 (S)	0.264 (NS)		

Data are expressed as mean ±standard deviation **(SD), MD**: Mean difference, **p-value**: probability value, **(S):** significant ($p<0.05$), **(NS):** non-significant ($p>0.05$)

Table (3), showed a statistically significant difference between the two groups in all the measured variables (systolic blood pressure, diastolic blood pressure, cortisol hormone, prothrombin time, Partial prothrombin time) $p<0.05$ in favor of group A (study group) in post treatment comparisons.

So, it could be concluded that Pilates exercises have a statistically significant effect on blood pressure in hypertensive post-menopausal women.

The findings of this study agreed with, Wang et al [14], their study indicated that Pilates lead to a remarkable decrease in body weight, BMI in adults with overweight or obesity.

On another hand this study disagreed with de Souza Cavina et al., [15] Who showed that the mat Pilates method was not more effective than the traditional exercise or control condition models for the analyzed variables (body mass index, lean mass, body fat percentage, and abdominal circumference). Moreover, in the exploratory analysis with older people, adults, and overweight/obese individuals, the mat Pilates method was also not superior for the analyzed outcomes.

The present study is consistent with Seraj et al [16] in examining the effect of Pilates exercises on body composition and flexibility of non-athlete women, they concluded that Pilates exercises had a significant positive effect on flexibility, and BMI but no significant effect on waist hip ratio (WHR).

The results of this study coincided with Ebrahim et al., [17] who concluded that Pilates exercise program could have a positive effect on reducing blood pressure in hypertensive patients,

Same observation was noted with Abd El-Monim, et al [18] who found that Pilates exercises were effective for managing cardio metabolic risk factors in patients with type 2 diabetes. As there were highly significant differences, lipid profile, blood pressure (systole and diastole) and waist-hip ratio after treatment.

The study results matched with a study by Rocha et al. [19] that was designed to investigate the blood pressure (BP) and heart rate variability (HRV) responses to a single session of Pilates among adults with hypertension. It was concluding that a single session of Pilates reduced BP by 5-8mm Hg in adults with hypertension during the first 60 minutes of post-exercise recovery. Acute BP reduction was concomitant to lowered cardiac parasympathetic activity. Those findings were promising for the use of Pilates as an alternative exercise modality to lower BP.

In contrast to the results of this study, Batista, et al [20] reported that Systolic blood pressure, diastolic blood pressure, and mean blood pressure area under the curve were significantly lower after both aerobic and resistance exercises sessions but not after the Pilates session when compared with the control session. Nitrite concentrations in saliva were higher 60 min after the end of all exercise

sessions. Heart rate variability was higher after the resistance exercise. Aerobic and resistance exercises were capable of decreasing arterial blood pressure after acute exercise.

The results are also coincided with Corazza et al [21], who noted that chronic exercise modulates serum cortisol level, but it is dependent on the type of exercise and variables of the training process (volume, intensity, duration, periodization). The study 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. The same was noted in the current study results.

This study agrees with the findings of Khademi et al [22], who showed that after 8 weeks of concurrent training (a combination of both aerobic: moderate-intensity continuous and resistance methods: Progressive Resistance Exercise. with a free weight and machine weight) prothrombin time (PT) significantly increased. These changes can be attributed to the type, intensity, and duration of concurrent training.

The results of this study in line with Sobhani et al. [23]. They found that after exercise, the number of platelets and fibrinogen level in the concurrent exercise decreased significantly and prothrombin time (PT) in the high intensity exercise the same intensity of Pilates (8-week trainings, 3 times a week) in both exercises increased significantly.

The results of this study were consistent with the findings of Khademi et al [23], who showed the reduction of PTT after 8weeks of training in their research. Their findings can be attributed to intensity (60- 85% Max HR), duration, and the resistive type of training. This decrease can indicate faster blood clotting time, which is very important in patients with cardiovascular disease (CVD).

Conclusion: -

It can be concluded that Pilates exercise program had a positive effect on reducing blood pressure, cortisol hormone and anticoagulant factors in hypertensive postmenopausal women.

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