

Effects of Pilates Training on Some Physiological Parameters and Cardiovascular Risk Factors of Middle Aged Sedentary Women

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Abstract

The purpose of this study was to assess the effects of 8 weeks regular Pilates mat work exercises on the physiological parameters and cardiovascular risk factors of sedentary middle aged women.

20 healthy middle aged sedentary women (experimental=10 and control=10) voluntarily participated in this study. Subjects in the exercise group performed three Pilate's beginner mat work sessions per week. Each session lasted 45 minutes with 40-60 % intensity over a period of 8 weeks under the supervision of the same Pilates instructor. All subjects' (exercise and control group), height, weight, resting heart rate (RHR), blood pressure (BP), waist-hip ratio, body mass index (BMI), body fat percentage (BF%), flexibility, hand grip and back strength, sit up and blood lipids were measured using standardized field and laboratory tests. The data evaluated by the use of SPSS 10.0 software. Test of normality for the data has been performed Kolmogorov-Smirnov Test. Because of our data aren't normal, the comparison of the groups made by Wilcoxon test at $p < 0.05$ significance level.

Flexibility, hand-grip, sit-up scores and back strength significantly increased at the end of the Pilates intervention, however BF%, systolic BP and high-density lipoprotein (HDL) decreased ($p < 0, 05$). No other parameters were found to alter.

Key words: Pilates, sedentary women, cardiovascular risk, physiological parameters

Introduction

Pilates is an exercise system started in Germany nearly hundred years ago (Anderson, Spector 2000). Pilates training is a popular form of exercise, which mandates specific movement patterns, unique positions and equipment, specialized instructors, and purports benefits of positive changes in body composition/appearance, flexibility, muscle function, and posture (Otto et al., 2004). The Pilates exercises can be carried in two different ways. Exercises done on a mat on the floor are called "mat work" (Bryan, Hawson, 2003; Kloubec, Banks, 2004). Among the apparatus used in Pilates are trapeze tables, Cadillac, wunda chair, reformer, barrel, spine corrector (Owsley 2005). Pilate's method incorporates six key principles namely centering, concentration, control, precision, breath and flow (Muscolino, Cipriani, 2004).

Although Pilates exercises have lower intensity compared to aerobic and dance exercises, and has very positive effects on health such as decreasing cardiovascular risk, preventing osteoporosis, shaping the body and promoting balance and flexibility (Robinson, Hunter, 2003; Solomon, 2003). Pilates are developed as an alternative to ballistic stretching, static stretching and proprioceptive neuromuscular facilitation (PNF) (Bertolla et al., 2007). Pilates has also many benefits on spine mobility, muscle flexibility, muscular endurance, posture, tennis serve velocity, body awareness, low back pain and general health, bone density, transverses abdomens and pelvic control, rectus

abdomens' and external oblique muscles, low back pain and core stability (Carr, Day, 2004; Cozen, 2000; Schroeder et al., 2002; Otto et al., 2004; Rogers, Gibson, 2006; Segal et al., 2004; Sewright et al., 2004; McMillan et al., 1998; Lange et al., 2000; Gladwell et al., 2006; Betz, 2005; Herrington, Davies, 2005; Esco et al., 2004; Graves et al., 2005; English et al., 2004).

Hypertension, obesity, elevated cholesterol levels, lipoprotein a, diabetes, smoking are some cardiovascular risk factors that are modifiable (Black 1992). Women continue to have a high cardiovascular mortality in the past 20 years and have the highest prevalence of cardiovascular disease which has been associated with changes in body composition, rising Low-Density Lipoprotein Cholesterol (LDL-C) and decreasing High-Density Lipoprotein Cholesterol (HDL-C) (Rosamond et al., 2008). At middle age or above middle age (> 40) periods the physical tolerance levels of the people decrease. At these periods, cardiovascular risk factors such as obesity, diabetes, hypertension, heart diseases show an important rise. There are no studies related to the effect of Pilate's exercises on the cardiovascular risk factors as far as we checked. Studies are mostly focused on strength, body composition, flexibility and muscular endurance.

This study was carried out to investigate the effect of 8-weeks Pilates mat work exercises on physiologic parameters and cardiovascular risk factors of middle aged sedentary women.

Material and Methods

This study employed the experimental method using pre and post-test design with control group.

Participants:

20 middle aged sedentary (accustomed to sit or rest a great deal) women live in similar social environment were volunteered to participate in this study. The participants were voluntarily divided into two groups such as experiment (n: 10) and control (n: 10). In experiment group were subjected to 8-week, three days a week 45 minutes Pilates mat work exercises by specialized Pilates instructor. All subjects in experiment group were completed all mat work workouts. The participants in the control group continued their daily activities and they did not participate any physical exercise.

Table 1: Physical features of the participants

	Experimental group (n=10)	Control group (n=10)
Age (years)	38.5 ± 3.894	41.2 ± 8.676
Height (cm)	156.7 ± 5.121	160.8 ± 3.614

Table 2: Exercise program

Week	1	2	3	4	5	6	7	8
Exercise Duration (min)	45	45	45	45	45	45	45	45
Intensity (%)	40	45	45	50	50	55	55	60
Frequency (day/week)	3	3	3	3	3	3	3	3

Procedures

All participants were medically screened in order to participate in study. They also filled in a personal information sheet and signed a consent form. There was no a special diet program applied to any groups throughout the study.

The experiment group carried out for eight weeks three days a week 45 minutes Pilates mat work beginner level exercises at the days which did not follow each other. The intensity of the exercises was 40% of THR (Target Heart Rate) at the beginning and was progressively increased to 60% of THR by the end of the study. THR was calculated using Karvonen Method. Intensity of exercises was measured just end of each work outs. The participants were shown how to measure their hearth rate and calculate the necessary work load. The measurements were carried at the same time by the participants. There was background music with slow rhythm throughout the study in order to motivate the participants.

The physical and physiological tests were carried out in the Gazi University School of Physical Education and Sport Athletic Performance Labs and Ladies Sport Center where the Pilates Exercise Protocol was conducted. All tests were measured by the Gazi University Performance Lab Team. The blood tests were performed in University Biochemistry Lab. All measurements were carried out twice at the beginning (pre-test) and the completion of the study (post-test).

The data obtained were evaluated by the use of SPSS 10.0 software. Test of normality for the data has been performed Kolmogorov–Simirnov Test. The comparison of the groups made by the used of non-parametric Wilcoxon test because of repeated-measures at $p < 0.05$ significance level.

Measures:

Measurement of the height and the body weight: The heights of the participants were measured with a metal measure with accuracy of 0.1 cm at vertical position. The body weights were measured with a scale with accuracy 0.1 kg on bare foot wearing light clothes.

Measurement of the resting heart rate: The resting heart rates were measured for 15 seconds by the palpation method after having the participants lay down at lying supine for 15 minutes and the results were multiplied by four.

Measurement of the blood pressure: The blood pressures of the participants were measured by the use of Erka brand stethoscope in mmHg after having them rest in the sitting position for 5 minutes.

Measurement of the hip and the waist Circumference: Hip and waist circumferences of subjects were measured by using Gullick Tape. Position (or have someone assist) the measuring tape mid-way between the top of subjects' hip bone and the bottom of rib cage. Hip were measured where the gluteal muscles are most prominent.

Body-mass index (BMI): The BMI was calculated by the use of following formula after the determination of their heights and weights:

Body weight (kg) / Height (m²) = BMI

Measurement of the flexibility: The flexibility was measured by Sit and Reach Test. This is the commonly used test for measuring lower back and hamstring flexibility.

Measurement of the body composition: The skin fold thicknesses of the participant were measured in mm with Holtain brand Skinfold Caliper. The measurements were taken from the suprailiac and triceps of the right side of the subjects.

Measurement of the body fat percentage: The body fat percentages (BF%) of the participants were computed by the use of Sloan and Weir formula as follows:

Body density (gm/ml) = 1.0764 – 0.00081 (suprailiac) - 0,00088 (triceps)

Body Percent body fat (%) = (4.57 / Density – 4,142) x 100

Lean body weight (kg) = Body weight – fat weight

Measurement of hand grip strength: Takei digital dynamometer was used to measure hand grip strength.

Measurement of back strength: Back strength was measured with Takei digital back dynamometer.

Measurement of sit-up: Maximum sit ups were taken for strength and endurance of the abdominals during 1 minute. Participants lie on the mat with their knees bent, their hands on their ears and sit up touching the knees with their elbow than return back to the floor.

Measurement of HDL-C, LDL-C, Total Cholesterol (Total-C) and Triglyceride levels: These levels were determined from the fasting blood samples taken at 10.00 am by the analysts using Artax Menarin Brand Analyzer.

Determination of Target Heart Rate (THR):

The Karvonen (Heart Rate Reserve Method) was used to determine subjects' THR.

This method was developed by Karvonen and consists of calculating what is referred to as the heart rate reserve.

HRR = HRmax – HR rest

THR = (HRR x load %) + HR rest

Pilates Mat Work Exercises

Table 3: Pilates Exercises

Pilates mat work exercises	
Warming up	Pilates exercises
1. Breathing	8. The Hundred
	9. The Shoulder Bridge
	10. Single Leg Circle
2. Imprint and release	11. Swimming
	12. One Leg Stretch
	13. Double Leg Stretch
3. Hip rolls	14. Rolling Like A Ball
	15. The Saw
4. Spinal rotation	16. Roll Up
	17. Spine Stretch
5. Cat stretch	18. Leg Pull Down
	19. Leg Pull Up
6. Scapula isolation	20. Push Up
	21. Pelvic Curl
7. Arm circle	22. Side Bend
	23. Side Kick Front
	24. Side Kick Back

Results

Table 4: Pre and Post-Tests results of the experiment and control groups

Parameters	Group	Pre-Test (n=10)	Dif	P	Post- test n=10	Dif	P
Body weight (kg)	Experiment	62.8 \pm 8.76	-4.3	0.444	62.4 \pm 8.47	-6.3	0.386
	Control	67.10 \pm 16.10			68.7 \pm 16.76		
Resting heart rate (beat/min)	Experiment	70.40 \pm 11.95	-0.4	0.857	70.2 \pm 11.94	-1.4	0.681
	Control	70.80 \pm 5.97			71.6 \pm 5.79		
Systolic blood pressure (mmHg)	Experiment	112.0 \pm 12.29	-6	0.196	110.0 \pm 9.42	-8	0.049*
	Control	118.0 \pm 10.32			118.0 \pm 7.88		
Diastolic blood pressure(mmH g)	Experiment	73.0 \pm 8.23	-3	0.453	70.00 \pm 9.42	-7	0.132
	Control	76.0 \pm 6.99			77.00 \pm 6.74		
Waist-Hip ratio	Experiment	0.74 \pm 6.54	-0.03	0.397	0.732 \pm 6.98	-0.06	0.332
	Control	0.77 \pm 9.60			0.799 \pm 9.75		
BMI (kg/m)	Experiment	25.54 \pm 3.05	-0.46	0.799	25.380 \pm 2.91	-1.23	0.508
	Control	26.00 \pm 6.54			26.615 \pm 6.73		
Percent body fat (%)	Experiment	22.65 \pm 2.28	-2.41	0.285	22.045 \pm 2.05	-3.47	0.050*
	Control	25.06 \pm 4.05			25.519 \pm 4.26		
Lean body weight (kg)	Experiment	48.46 \pm 5.93	-1.24	0.721	48.563 \pm 5.96	-1.97	0.646
	Control	49.71 \pm 9.03			50.541 \pm 9.20		

Flexibility (cm)	Experiment	29.20±5.51	-1.6	0.545	36.30±3.86	6.6	0.011*
	Control	30.80±5.09			29.70±5.18		
Grip strength (Right hand)	Experiment	26,53±9,42	0,53	0,610	30,93±6,76	4,71	0,017*
	Control	26,00±2,29			26,22±3,90		
Grip strength (Left hand)	Experiment	25,54±7,98	0,88	0,575	30,64±6,85	6,95	0,013*
	Control	24,66±3,61			23,69±4,17		
Back strength	Experiment	66,00±24,7	13,9	0,139	84,13±20,8	33,3	0,005*
	Control	52,08±9,42			50,83±7,06		
Sit up (num/1min)	Experiment	10,40±1,57	-0,2	0,905	12,60±2,01	2,5	0,028*
	Control	10,60±2,17			10,10±1,66		

* p<0.05

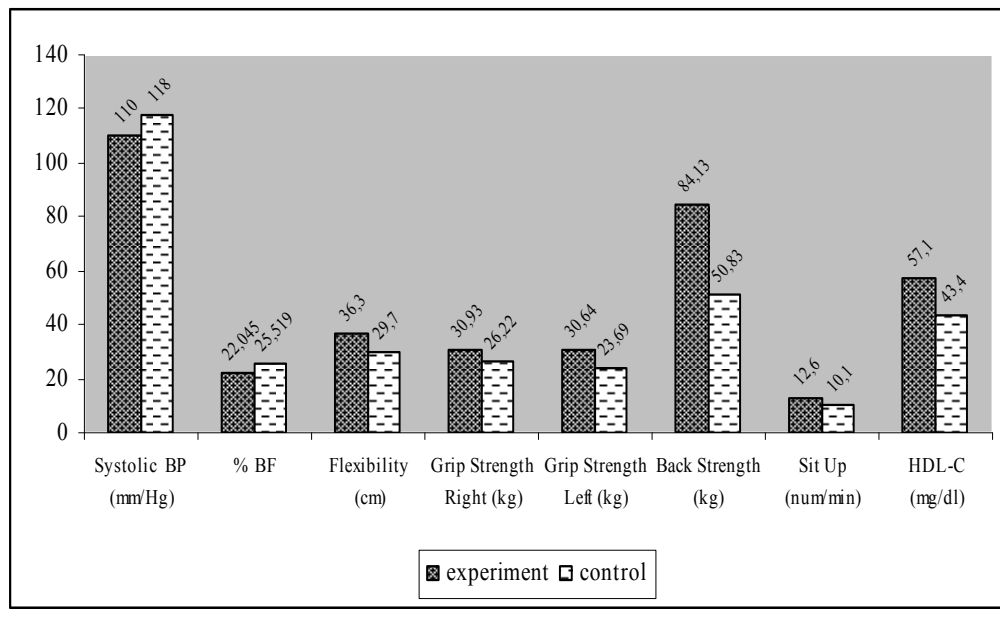
Table 4 shows that there are no significant differences between the pre-test results of both groups. However, table reveals that there are statistically important difference in the systolic blood, body fat percentage, flexibility, strength of hand (right and left) and back strength and sit up values in the favor of experimental group in the post test results (p<0.05).

Table 5: The pre-posttests blood parameters of the experiment and control groups

Parameters	Group	Pre- test (n=10)	Dif	P	Post-test (n=10)	Dif	P
Total-C (mg/dl)	Experiment	186.20±34.64	7.3	0.445	172.70±24.73	-0.4	0.838
	Control	178.90 ±41.11			173.10±51.17		
HDL-C (mg/dl)	Experiment	60.20±19.85	12	0.092	57.10±15.20	13.7	0.036 *
	Control	48.20±6.32			43.40±6.04		
LDL-C (mg/dl)	Experiment	112.30±25.38	12.9	0.241	101.20±22.03	7.2	0.333
	Control	99.40±23.54			94.00±26.33		
Triglyceride (mg/dl)	Experiment	66.90±16.99	-	0.610	73.70±21.50	-21.9	0.674
	Control	94.70±58.97			95.60±51.42		

* p<0.05

As seen from Table 5 there is no statistically significant differences between the pre-test blood parameters of the experimental and the control groups. The post test blood parameters show that there is a statistical significance between HDL-C values of the both groups (p<0.05).



Graph 1: Comparison of Post- Test for two groups

Discussion and conclusion

There are some conflicted study results on effects of Pilate's exercises on blood pressure in literature. Although Jago et al., (2006) found no effect of the 4-week Pilates exercises upon the systolic and diastolic blood pressures of young women, there was a significant decrease in the BMI. Ali et al. (2010) examined the effects of Pilates exercise on blood pressure in sedentary overweight females. They did not find any effects on blood pressure of participants. However in another study carried out on hypertensive patients the application of 4 week Pilates exercises resulted a decrease in the blood pressures of the participants (Collier et al. 2008). In parallel, we found significant decrease in systolic blood pressure but there was no effect on diastolic blood pressures of Pilates mat exercises.

Sekendiz et al., (2007) reported that there was no change in BMI and percent body fat of the sedentary women as a result of 5-week Pilates exercises. They concluded that there was a positive effect of Modern Pilates mat exercises on abdominal and lower back muscular strength. The findings of our study suggest that Pilates may be one of the good exercises to improve abdominal and hand grip muscular strength. There were no changes in body mass index BMI in our study.

Segal et al. (2004) reported that Pilates exercises had effect on increasing flexibility but no effect on the lean body weight, body weight and other body composition parameters in their study. Flexibility show similarities with our study, but in contrast to this study we found significant differences in percent body fat in Pilates exercise group. Irez et al., (2011) claimed that, Pilates exercises are effective in improving dynamic balance, flexibility, reaction time and muscle strength as well as decreasing the propensity to fall in older women.

Christopher et al. (2006) investigated the effects of Pilates exercise on core strength in females. They measured maximum isometric strength of the hip abductors, abdominals, and back extensors, before and after ten weeks. They found no strength differences between experimental and control groups. In our study, we measured hand grip and back strength with dynamometer. Our results show that Pilates exercise increase strength of hand grip and back strength.

In another study, Irez (2009) found significant differences in some physical parameters of 65+ years old women. She concluded that, Pilates exercise can be efficient for increasing muscle strength and dynamic balance, flexibility, reaction time and decreasing anxiety while increasing quality of life. In the long term, Pilates exercise also may have very positive effects on bone mineral density.

Ali et al. (2010) examined the effects of Pilates exercise on selective physical fitness components in sedentary overweight females. Participants consisted of 15 women and in the exercise group and 15 women in the control group. They concluded that, significant decrease in fat percentage, fat body mass and waist circumference in the experimental group after 8 weeks Pilates exercise by 7.3%, 8.5% and 4.6%, respectively. Aerobic power, abdominal muscular endurance and hand grip in experimental group compared to control group significantly increased by 12.3%, 9.8% and 23%. However they could not find any significant differences between experimental and control groups in total body weight, body mass index and lean body mass.

In a study carried out to determine the effect of 8 weeks mat work Pilates exercises upon the fitness characteristic of the adults, there were significant improvements in body composition, muscle endurance and flexibility of the participants (Rogers, Gibson, 2006). Similar to our study, they found positive differences in all selected physical fitness parameters. Our data also support this review.

Ramezankhany et al., (2011) determined the comparing effects of aerobics, Pilates exercises and low calorie diet on leptin levels and lipid profiles in sedentary women. They stated that a combination of diet and exercise may be closely related to significant decreases in lipid profiles. In our study we found significant changes in HDL-C.

This study revealed that 8-week Pilates exercises had a positive effect on the systolic blood pressure, flexibility, percent body fat, hand grip-back strength and abdominal muscle strength of the middle aged sedentary women.

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