The effect of exercise training program on indexes of adiposity in pre and post- menopausal obese women

Rahimeh Mehdizadeh[1], Reza Andam[2], Ardeshir Zafari[3], Sanaz Mirzayan Shangani[4], Elham Eftekhari[5], Mandana Gholami[6]
[1,2]Assistant professor Shahrood University of Technology, Iran

[3] Department of Physical Education and Sport Sciences, Zanjan Branch, Islamic Azad University, Zanjan, Iran
[4] Department of Exercise Physiology, Faculty of Physical Education and Sport Sciences, Islamshahr Branch, Islamic Azad University, Islamshahr, Tehran, Iran.
[5] Department of Physical Education and Sport Sciences, Najafabad Branch, Islamic Azad University, Najafabad, Iran
[6] Department of Physical Education and Sport Sciences, Tehran Research and Sciences Branch, Islamic Azad University, Tehran, Iran
P.O. Box: 316, Post Code: 3619995161, Shahrood, Iran
Reza Andam (Corresponding author)
Tel:+989113371420; Email: reza.andam@gmail.com

Abstract: The aim of the study was to investigate the effect of resistance exercise training on indexes of overall and central obesity in pre and post-menopausal women. Thirty obese healthy women (BMI ≥30 kg/m^2) were chosen. Depending on hormonal status, subjects were divided into two groups: the postmenopausal (PostM; n=20) group and premenopausal (PreM+EX; n=10) group. At the onset of the experiment, postmenopausal women were randomly divided into two subgroups: postmenopausal+ Exercise (PostM+EX; n=10) and postmenopausal+ Sedentary (PostM+SED; n=10). After fasting for at least 12 h, indexes of overall obesity including body weight (BW), body mass index(BMI), body fat percent (BF%)and body fat mass (BFM) and central obesity including waist circumference(WC) and waist to hip ratio (WHR) were measured. Exercise training program was done for 24 weeks, 3 days a week, 60-75 minutes a day. Result showed that exercise reduced WC, WHR significantly in PostM+EX and PreM+EX groups compared to PostM+SED group ($p<0.01$). BF% decreased in both exercise groups compared to PostM+SED group, but it was significant only in PostM+EX ($p=0.02$). BW, BMI and FM remained unchanged. These results suggest that resistance training decreases central obesity without weight loss in pre and postmenopausal obese women.
[Rahimeh Mehdizadeh, Reza Andam, Ardeshir Zafari, Sanaz Mirzayan Shangani, Elham Eftekhari, Mandana Gholami. **The effect of exercise training program on indexes of adiposity in pre and post- menopausal obese women.** *Life Sci J* 2013;10(2s):127-131] (ISSN: 1097-8135). http://www.lifesciencesite.com.21

Key words: Central obesity, overall obesity, Basal metabolic rate, resistance training

1. Introduction

Obesity, especially central obesity is a common problem after menopause and is a major risk factor for metabolic disorders and the development of cardiovascular diseases (Carr, 2003; Turgeon et al, 2006). Estrogen has great importance in the determination of body fat distribution (Cooke and Naaz, 2004; Turgeon et al, 2006) and estrogen deficiency due to menopause accelerates the selective deposition of abdominal fat and tends to accumulate visceral fat (Brown et al, 2000; Piche et al, 2005). Excess visceral adipose tissue accumulation after menopause is highly associated with decreases in insulin sensitivity, a predisposing factor for cardiovascular disease (Munoz et al, 2002; Okura et al, 2003). On the other hand, studies have indicated that aging is associated with a decrease in physical activity and an increase of risk factors of cardiovascular diseases (Bauman, 2004; Thompson, 2003). A number of studies on the relationship between physical activity and diseases related to lack of physical activity and obesity in postmenopausal women have indicated that the relationship between these two could be justified by the effects on risk factors such as visceral fat. Studies also have shown that physical activity decreases visceral fat and improves body composition (Bauman, 2004; Tsutsumi et al, 2001; Giannopoulou, et al, 2005). Since, there is a strong relationship between obesity, especially abdominal obesity and metabolic disorders, it seems that weight loss and decreases in fat mass could lead to a decrease in visceral fat and a marked improvement in body composition. There are different therapies for the prevention of obesity-related consequences in postmenopausal women such as exercise, diet and hormone replacement therapy. Cross-sectional studies have indicated that exercise training induced a decrease in visceral fat, and this reduction was without weight loss (Thomas et al, 2004; Damirchi et al, 2010). Our previous study indicated that aerobic exercise training failed to change body weight, but significantly decreased visceral fat in ovariectomized (OVX) animals (Damirchi et al, 2010). To our knowledge, the effects of resistance training on body composition in the absence of estrogen have not been fully understood. Since, decrease in muscle strength and muscle mass starts from middle age and continue to old age (Hunter et al, 2004; Bonganha et al, 2011), it seems that resistance training must take a main part in exercise training programs for elders. Strength training not only increases muscle strength and improves physical performance, but also it increases energy expenditure and fat oxidation and leads to a decrease in visceral fat (Bonganha et al, 2011; Orsatti et al, 2012). Therefore, in this research, the effects of 24-week resistance training on body composition of postmenopausal women in the absence of estrogen were studied.

2. Method

Subjects and groups: Subjects of the study were recruited through a recall. We informed the subjects of the purposes of the study and they signed an informed consent form. The study was conducted in accordance with the Helsinki declaration. Thirty-two postmenopausal and twenty- six premenopausal women were volunteered to participate in the study. Twenty postmenopausal and ten premenopausal obese healthy women (BMI $\geq$30 kg/m^2) were chosen. The postmenopausal women were at least 1 and most 6 years away from their last menstruation period and had no history of hormone-therapy. All subjects had no family history of diabetes, heart failure, myocardial heart attack, kidney diseases, eye lattice bleeding, hypertension, and cancer according to the questionnaires. They took part in any exercise training or drug treatment for losing weight from at least a year before the study. Depending on hormonal status, subjects were divided into two groups: the postmenopausal (PostM; n=20) group and premenopausal (PreM+EX; n=10) group. At the onset of the experiment, postmenopausal women were randomly divided into two subgroups: postmenopausal+ Exercise (PostM+EX; n=10) and postmenopausal+ Sedentary (PostM+SED; n=10). In order to keep the life styles the same for three groups, a meeting was held once in every two weeks. Background information on subject characteristics, the time since food was last eaten and the bladder last voided were recorded before testing.

Anthropometric and body composition measures: After fasting for at least 12 h, indexes of overall obesity (BW, BMI, %BF and BFM), central obesity (WC and WHR) and basal metabolic rate(BMR) were measured by Body Composition Analyzer (In Body; 3.0, Biospace Co Ltd, Seoul, Korea) using eight electrodes and four frequencies. These electrodes were in contact with the surface of each hand and foot at the thumb, palm and fingers, forefoot and heel. In this method gender, age and height are entered manually into the system via a digital keyboard, and the subject's BW, %BF, BFM, WHR, BMR and BMI are displayed immediately. These variables were measured with subjects wearing lightweight clothing. WC was measured in triplicate to the nearest 0.1 cm with a non-stretch measuring tape at midway between the lowest rib and the iliac crest (Pigford et al, 2011). All the measurements were done from 800-10:00 AM. BIA measurements were made by one trained experimenter and all anthropometric measures were done by another one. Standing height was measured without shoes. Height was measured to the nearest 0.1cm during a maximal inhalation using a Schorr measuring board.

Protocol for exercise training: Exercise training program was done for 24 weeks, 3 days a week, 60-75 minutes a day by an experienced supervisor. Each exercise session began with 10 minutes of warm up, 45 minutes of resistance training and 5 minutes of cool down. Strength trainings started with high frequency (16 repetitions) and low load (40% of their 1 repetition maximum or 1RM)), and gradually load increased and frequency deceased by the same degree as in last 2 weeks it reached the lowest frequency (8 repetitions) and highest load (80% of their 1RM). The content of strength trainings was the same during these 24 weeks (Bemben et al, 2000). In the first 2 weeks, participants were taught how to work with weights, warm up and cool down. In the first 5 weeks the rate of increasing the load was low in order for the participants to get used to it and to motivate them the amount of load increase was due to their progression. The adding amount was added just when the participants could deal with the weights and pick them up easily. Resistance training program in the study were taken from Hartman et al (2007) which included in elbow flexion, elbow extension, seated overhead press, back extension, bent-leg sit-up, chest press, leg extension, leg curl, and Smith machine squat (Hartman et al, 2007). All exercises performed for 2 sets of 10 repetitions, except bent leg sit-up performed for 15–20 repetitions. The reason to choose these exercises was that subcutaneous fat of these areas are measured for the assessments of fat percentage (one of the fat and body composition indexes) using Calibre. Participants in PostM+SED group avoided any regular physical activity during the study.

Statistical analysis: All data are presented as mean ± standard error. After 24 weeks of training, before statistical analysis, the normal distribution and homogeneity of the variances were tested. Statistical comparisons between groups were performed by the one-way ANOVA test, followed by Tukey's post-hoc test. All the statistical analyses were run according to the object by SPSS18 software and the level of statistical significance was set at P≤0.05.

3. Results

Table 1. Baseline characteristics of the participants. Data are means ± standard error

	PostM+SED (n=8)	PostM+EX (n=10)	PreM+EX(n=8)
Age(y)	54.12±1.38	53.4±0.95	36.62± 3.07
Height(cm)	153±1.12	160± 1.58	157± 4.37
BW (kg)	74.1±4.08	73.4± 4.10	75.04±5.12
%BF	43.07± 1.66	44.12± 1.58	43.35±0.97
BMI (kg/m2)	33.2± 1.84	33.8± 1.75	32.4±0.98
WC(cm)	97.12± 3.73	95.27± 4.01	93.25±1.95
WHR	1.05± 0.025	1.02± 0.048	0.97± 0.058
BFM	32.19± 2.73	32.49± 2.52	31.54± 2.15
BMR	1152.99± 33.49	1148.78± 32.14	1195.84±28.52

PostM + SED, Postmenopausal + Sedentary; PostM + EX, Postmenopausal + Exercise ; PreM + EX, Premenopausal + Exercise; BW, Body Weight; BMI, Body Mass Index; WC, Waist Circumference; WHR, Waist to Hip ratio; %BF, Body Fat percent; BFM, Body Fat Mass; BMR, Basal Metabolic rate

Table 2. Body composition changes after 24-week resistance training program. Data are means ± standard error

	PostM+SED (n=8)	PostM+EX (n=10)	PreM+EX(n=8)
BW (kg)	75.31±3.02	72.32± 3.10	74.04±4.12
%BF	43.27± 1.58	36.2± 1.49*	37.96±1.92
BMI (kg/m2)	33.12± 1.52	28.14± 1.13	30 ± 1.50
WC(cm)	97.52± 3.12	84.4± 2.21**	78.79±1.68**
WHR	1.08± 0.032	0.94± .018**	0.95±0.02**
BFM	32.48± 2.81	26.53± 2.07	28.51±2.47
BMR	1152.71± 33.24	1245.88± 33.54*	1388.92±51.03**

PostM + SED, Postmenopausal + Sedentary; PostM + EX, Postmenopausal + Exercise; PreM + EX, Premenopausal + Exercise; BW, Body Weight; BMI, Body Mass Index; WC, Waist Circumference; WHR, Waist to Hip ratio; %BF, Body Fat percent; BFM, Body Fat Mass; BMR, Basal Metabolic rate
**, P≤0.01
*, P≤0.05

Four participants (two of PostM+SED group and two of PreM+EX group) didn't complete successfully the intervention protocols. Therefore, data of twenty- six subjects were analyzed. Baseline characteristics for the participants are reported in table 1.

At the end of the experiment, results showed that exercise reduced WC, WHR significantly in PostM+EX and PreM+EX groups compared to PostM+SED group (p<0.01). BF% decreased in both exercise groups compared to PostM+SED group, but it was significant only in PostM+EX (p=0.02). BW, BMI and FM remained unchanged. In addition, BMR was greater in the PreM+EX group by 10% (p=0.04) compared to PostM+EX and by 17% (p=0.002) compared to PostM+SED groups after a 24-week exercise intervention (Table 2).

4. Discussion

It is well documented that menopause and ovariectomy leads to increased body weight and adipose tissue (Ainslie et al, 2001; Anbinder et al, 2006; Babaei et al, 2010). This indicates that the lack of estrogen following menopause influences body weight, partially by increasing visceral fat (Ainslie et al, 2001; Cooke and Naaz, 2004; Turgeon et al, 2006).Results of the present study showed that 24 weeks of resistance training without any changes in BW, BMI and BFM resulted in a significant decreases in WC and WHR in PostM+EX and PreM+EX groups compared to PostM+SED group. Consistent with this results Teixeira et al (2003) and Viljoen et al (2011) found the similar changes in postmenopausal women (Teixeira et al, 2003; Viljoen and Christie, 2011). Whereas, previously Joseph et al (1999) had reported that body composition did not change in postmenopausal women after 12 weeks resistance training (Joseph et al, 1999). One of the findings of this study was that the 24-week exercise training program didn't change body weight, but remarkably decreased the indexes of central obesity such as WC and WHR. Since, these indexes showing intra-abdominal fat, the reduction in WC and WHR with no significant changes in body weight probably reflected an increase in another component of the body (e.g. muscle weight and bone density) after exercise training. Frost (1992) believed that mechanical stimulations can compensate the lack of estrogen in postmenopausal women and prevent the diminution of bone tissues through staying the absorbency of the bone (Frost, 1992). There have been lots of studies on the effects of physical activity as a physical stress on the bones. According to the evidences, exercise training as a therapeutic intervention, plays an important role in bone retrieval, lowering the diminution rate of the bone and increasing muscle mass (Bemben et al, 2000; Bonganha et al, 2011; Orsatti et al, 2012; Westcott, 2012). Bone density and muscle mass has not been assessed in the study, but an increase in bone density and muscle mass due to resistance training could be a justifying reason for lack of weight loss in the exercise groups of this study.

The results of researches in regards to changes in visceral fat, before and after estrogen deficiency due to menopause or ovariectomy are conflict. Cliefton et al (2004) reported that after 12 weeks of weight loss due to low calorie diet, postmenopausal women lose more visceral fat than women who are in the ages before menopause (Cliefton et al, 2004). These findings are in contrast with those of Park and Lee (2003) who showed that after 12 weeks of interventions due to life style changes for weight losing, postmenopausal women lose less visceral fat than the premenopausal women (Park and Lee, 2003). Choi et al (2005) also compared trained ovariectomized and non-ovariectomized rats and concluded that after 8 weeks of training, body weight was lower in ovarectomized group, but the amount of visceral fat was meaningfully higher in ovariectomized (Choi et al, 2005). Because visceral adipose tissue is more sensitive to lipolytic stimulation which is a response to catecholamine hormones, visceral fat decreases more due to training than other interventions (Giannopoulou et al, 2005). Regarding the role of estrogen in visceral fat metabolism, decreases of indexes of central obesity could be attributed to the estrogen biosynthesis after menopause. The main source of estradiol after menopause is transformation of testosterone to estrogen by aromatase enzymes (Misso et al, 2005). The information about how training affects aromatase enzymes is limited. In the present study, exercise also resulted in a significant increase in BMR in pre and post- menopausal women compare to postmenopausal sedentary women. Similar to this result, Singh et al (2010) stated that BMR related to some problems such as blood pressure, anxiety and etc in sedentary people and exercise help in handling them by increasing BMR(Singh et al, 2010).

In summary, the results of the present study suggest that 24 weeks of exercise training successfully targets and decreases WC and WHR as index of intra-abdominal fat. Exercise training, as an effective treatment program in preventing metabolic syndrome, acts partially by decreasing abdominal obesity in pre and post-menopausal women. Additional investigation is necessary to evaluate visceral adipose tissue directly in human subjects. Therefore, from a clinical point of view, we conclude that resistance exercise training is a positive strategy to control visceral fat accumulation in pre and postmenopausal women.

Acknowledgment
This work was supported by a grant from Shahrood University of Technology.

References

1. Ainslie, D.A., Morris, M.J., Wittert, G., Turnbull, H., Proietto, J., Thorburn, AW.(2001). Estrogen deficiency causes central leptin insensitivity and increased hypothalamic neuropeptide Y. Int J Obes, 25,1680–1688.
2. Anbinder, A.L., Prado Mde, A., Spalding, M., Balducci, I., Carvalho, Y.R., da Rocha, R.F.(2006). Estrogen deficiency and periodontal condition in rats: a radiographic and macroscopic study. Braz Dent J, 17,201–207.
3. Babaei, P., Mehdizadeh, R., Ansar, M.M., Damirchi, A.(2010). Effects of ovariectomy and estrogen replacement therapy on visceral adipose tissue and serum adiponectin levels in rats. Menopause Int,16(3),100-104.
4. Bauman, A.E. (2004). Updating the evidence that physical activity is good for health: an epidemiological review. 2000-2003. J Sci Med Sport, 7, 6-19.
5. Bemben, D.A., Fetters, N.L., Bemben, M.G., Nabavi, N., Koh, E.T.(2000). Musculoskeletal responses to high- and low-intensity resistance training in early postmenopausal women. Med Sci Sports Exerc, 32(11),1949-1957.
6. Bonganha, V., Modeneze, D.M., Madruga, V.A., Vilarta, R. (2012). Effects of resistance training (RT) on body composition, muscle strength and quality of life (QoL) in postmenopausal life. Arch Gerontol Geriatr, 54(2),361-365.
7. Brown, M.D., Korytkowski, M., Zmuda, J.M., McCole, S.D., Moore, G.E., Hagberg, J.M. (2000). Insulin sensitivity in postmenopausal women: independent and combined associations with hormone replacement, cardiovascular fitness, and body composition. Diabetes Care, 23,1731–1736.
8. Carr, M.C. (2003). The emergence of the metabolic syndrome with menopause. J Clin Endocrinol Metab, 88,2404–2411.
9. Choi, S.B., Jang, J.S., Park, S.(2005). Estrogen and exercise may enhance β-Cell function and mass via insulin receptor substrate 2 induction in ovariectomized diabetic rats. Endocrinology,146(11),4786–4794.
10. Clifton ,P.M., Noakes, M., Keogh, J.B. (2004). Very low-fat (12%) and high monounsaturated fat (35%) diets do not differentially affect abdominal fat loss in overweight, nondiabetic women. J Nutr, 134,1741–1745.
11. Cooke, P.S & Naaz, A. (2004). Role of estrogens in adipocyte development and function. Exp Biol Med (Maywood), 229(11),1127-1135.
12. Damirchi, A., Mehdizadeh, R., Ansar, M.M., Soltani, B., Babaei, P.(2010). Effects of aerobic exercise training on visceral fat and serum adiponectin concentration in ovariectomized rats. Climacteric, 13(2),171-178.
13. Frost, H.M. (1992). The role of changes in mechanical usage set points in the pathogenesis of osteoporosis. J Bone Miner Res, 7, 253-261.

14. Giannopoulou I, Ploutz-Snyder LL, Carhart R, Weinstock RS, Fernhall B, Goulopoulou. S., Kanaley, J.A. (2005). Exercise is required for visceral fat loss in postmenopausal women with type 2 diabetes. J of Clin Endocrinol & Metab, 90,1511–1518.
15. Hartman, M.J., Fields, D.A., Byrne, N.M., Hunter, G.R. (2007). Resistance training improves metabolic economy during functional tasks in older adults. J Strength Cond Res, 21(1),91-95.
16. Hunter, G.R., McCarthy, J.P., Bamman, M.M. (2004). Effects of resistance training on older adults. Sports Med, 34(5),329-348.
17. Joseph, L.J., Davey, S.L., Evans, W.J., Campbell, W.W.(1999). Differential effect of resistance training on the body composition and lipoprotein-lipid profile in older men and women. Metabolism, 48,1474-1480.
18. Misso, M.L., Jang, C., Adams, J., Tran, J., Murata, Y., Bell, R., Boon, W.C., Simpson, E.R., Davis, S.R. (2005). Adipose aromatase gene expression is greater in older women and is unaffected by postmenopausal estrogen therapy. Menopause, 12,210–215.
19. Munoz, J., Derstine, A., Gower, B.A. (2002). Fat distribution and insulin sensitivity in postmenopausal women: influence of hormone replacement. Obes Res, 10,424–431.
20. Okura, T., Koda, M., Ando, F., Niino, N., Ohta, S., Shimokata, H.(2003). Association of polymorphisms in the estrogen receptor a gene with body fat distribution. Int J Obes, 27, 1020–1027.
21. Orsatti, F.L., Nahas, E.A., Orsatti, C.L., de Oliveira, E.P., Nahas-Neto, J., da Mota, G.R., Burini, R.C. (1012). Muscle mass gain after resistance training is inversely correlated with trunk adiposity gain in postmenopausal women. J Strength Cond Res, 26(8),2130-2139.
22. Piche, M.E., Weisnagel, S.J., Corneau, L., Nadeau, A., Bergeron, J., Lemieux, S.(2005). Contribution of abdominal visceral obesity and insulin resistance to the cardiovascular risk profile of postmenopausal women. Diabetes, 5,770–777.
23. Pigford, A.A.E., Sanou, D., Ball, G.D.C., Fehderau, D.D., Willows, N.D. (2011). Abdominal adiposity and physical activity in cree first nations children living on-reserve in an alberta community. Can J of Diabetes, 35, 328- 333.
24. Singh, M., Dureha, D.K., Yaduvanshi, S., Mishra, P.(2010). Effect of aerobic and anaerobic exercise on basal metabolic. Br J Sports Med, 44, 26.
25. Teixeira, P.J., Going, S.B., Houtkooper, L.B., Metcalfe, L.L., Blew, R.M., Flint-Wagner, H.G., Cussler, E.C., Sardinha, L.B., Lohman, T.G. (2003). Resistance training in postmenopausal women with and without hormone therapy. Med Sci Sports Exerc, 35(4),555-562.
26. Thomas, E.L., Brynes , A.E., McCarthy, J., Goldstone, A.P., Hajnal, J.V., Saeed, N., Frost, G., Bell, J.D. (2000). Preferential loss of visceral fat following aerobic exercise, measured by magnetic resonance imaging. Lipids, 35,769–776.
27. Thompson, P.D. (2003). Exercise and physical activity in the prevention and treatment of atherosclerotic cardiovascular disease. Arterioscler Thromb Vasc Biol, 23,1319-1321.
28. Tsutsumi, K., Kusunoki, M., Hara, T., Okada, K., Sakamoto, S., Ohnaka, M., Nakay, Y. (2001). Exercise improved accumulation of visceral fat and simultaneously impaired endothelium-dependent relaxation in old rats. Biol Pharm Bull, 24, 88-91.
29. Turgeon, J.L., Carr, M.C., Maki, P.M., Mendelsohn, M.E., Wise, P.M.(2006). Complex actions of sex steroids in adipose tissue, the cardiovascular system, and brain: Insights from Basic Science and Clinical Studies. Endocrine Rev, 27,575–605.
30 Viljoen, J.E & Christie, C.J.A. (2011). Resistance training and changes to plasma lipoproteins in postmenopausal women. SAJSM, 23(2), 40-44.
30. Westcott, W.L. (2012). Resistance training is medicine: effects of strength training on health. Curr Sports Med Rep,11(4),209-216.

1/8/2013