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THE EFFECTS OF CONCURRENT TRAINING ORDER ON BODY COMPOSITION AND INSULIN RESISTANCE IN POSTMENOPAUSAL WOMEN: A RANDOMIZED CONTROLLED CLINICAL TRIAL

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ABSTRACT

Postmenopause is a great time for most women, but they are at higher risk for certain health conditions. Therefore, the aim of this study was to investigate the effects of eight weeks ordering of concurrent endurance and resistance training on body composition, Serum insulin levels and blood sugar in postmenopausal women. Thirty-three postmenopausal women (age: 54±4 yrs, BMI: 28±4) were randomly divided in to three groups: concurrent endurance-resistance (CER, n=11), concurrent resistance-endurance (CRE, n=10), control (C, n=12). Training was performed three times per week for eight weeks. Endurance training performed aerobic exercises (intensity: 65–80% MHR) and resistance training included several selected exercises targeting upper and lower body (intensity: overload principle, 8–12 repeat). To measure body composition changes, blood sampling was conducted 48 hours before the start of the course and again 48 hours after the last training session. The results showed that the amounts of weight and body fat percentage (BF %) have significantly decreased in CER group (p<.05). No difference was observed between training sequence orders in reducing BMI, insulin and blood sugar variables (p>.05). CER training affects the body weight and BF % of postmenopausal women. Ordering concurrent training (CT) does not seem to play a role in the positive effect on serum insulin levels and blood sugar in postmenopausal women.

Keywords: *Resistance training, endurance training, postmenopause, insulin, blood glucose.*

1. INTRODUCTION

The menopause refers to that time in every woman's life when her periods stop and her ovaries lose their reproductive function. Usually, this occurs between the ages of 45 and 55 (Gracia, 2019). The menopause transition begins with the onset of menstrual irregularities and ends with the last menstrual period (Davis et al., 2012). Numerous studies have demonstrated that the menopausal transition is associated with hormonal changes and decreased insulin resistance that cause unfavorable changes in body composition, abdominal fat deposition, high and low blood sugar levels , sleep disorders and general health outcome (Friedenreich et al., 2011; Jouyandeh, Nayebzadeh, Qorbani, & Asadi, 2013; Sternfeld et al., 2004). For women aged 50-60 years, weight gain is one of their major health concerns. In general, obesity is characteristically more prevalent in females than in males

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(Davis et al., 2012). Fluctuations in sex hormones at different stages of reproductive life, such as menarche, pregnancy, and menopause transition, may play a role in the adipose tissue expansion (Sternfeld et al., 2004). All of these risk factors can predispose Middle-aged women to metabolic syndrome and has been increasingly implicated in the pathogenesis of metabolic syndrome and cardiovascular disease (Lobo, 2008; Taheri, Irandost, Mirmoezzi, & Ramshini, 2019).

Numerous studies and reviews involving other populations have reported that physical activity and exercise participation may have positive effects on a range of menopause-related symptoms and health outcomes such as cognitive functioning, depression, sleep patterns, fatigue, bone density, energy expenditure, weight maintenance and cardiovascular disease (AJ Daley, Stokes-Lampard, & Macarthur, 2009; Amanda Daley, Stokes-Lampard, Thomas, & MacArthur, 2014; Lobo, 2008). Physical activity by reducing lipid and blood glucose levels, oxidative stress, visceral fat and subsequently reducing the release of proinflammatory cytokines from adipose tissue and increasing the secretion of anti-inflammatory mediators in increasing insulin sensitivity and serum insulin levels and blood sugar, it has a basis (Davidson et al., 2009; Melo et al., 2017). Regular exercise can improve insulin sensitivity, maintaining regular insulin and blood sugar levels even in the absence of substantial weight reduction (Davidson et al., 2009; Mohammadkhani, Irandoust, Taheri, Mirmoezzi, & Baić, 2019).

Resistance training improves muscular strength and insulin action in postmenopausal women. When resistance training is combined with endurance training and weight loss, there is a greater reduction in insulin response to hyperglycemia than with resistance training alone (Ryan, Pratley, Goldberg, & Elahi, 1996). Indeed, the current paradigm is to concurrent endurance and strength training to optimize health and general benefits in postmenopausal women (Annibalini et al., 2017). Among the studies that compared the two types of exercise (resistance and endurance) only Kadaglou et al. demonstrated that endurance training decreased the CRP levels in comparison to those individuals undergoing resistance training (Jorge et al., 2011; Kadoglou et al., 2013; Melo et al., 2017).

However, different patterns of CT have received less attention. It also seems that in a CT program, in addition to the intensity and type of exercise protocol, the order of the exercise is also of particular importance. For this reason, it is mandatory to investigate the effect of the CT order (resistance-endurance) and the changes in risk factors during the menopausal transition. We hypothesized that CT order on body composition and Insulin Resistance in postmenopausal women.

2. METHODS AND MATERIALS

2.1 Participants

This was a randomized controlled clinical trial study with three groups: concurrent endurance-resistance (CER; n=11) group, concurrent resistance-endurance (CRT; n=10) group and control (C; n= 12) group. The study population included 60 volunteers' healthy, sedentary and postmenopausal women from Mashhad a city of Iran. Sample size was estimated by G-Power software. The minimum sample size for three groups with respect to effect size was (0.27), Power (0.8) $\alpha=0.05$ was 36 participants. Then, out of 60 volunteers, 33 were selected after screening tests (see Figure 1). Inclusion criteria were menopausal women; Beck depression index of ≤13; Pittsburgh Sleep Quality Index (PSQI) ≤5, physical activity scored into inactive categories according to The General Practice Physical Activity Questionnaire (GPPAQ); Body mass index (BMI) ≤30; age: 50-60 years, functional independence in daily activities, no history of exercise in the last six-month and no smoking, the absence of any disease such as diabetes or heart disease, no musculoskeletal injuries. Exclusion criteria were:

more than one absence in training seasons, use drug and supplements. All participants were explained about the study procedure and signed an informed consent form prior to the study. The study was conducted in accordance with the declaration of Helsinki. This research has been conducted with the ethics code: IRCT20200126046267N1 (Figure 1).

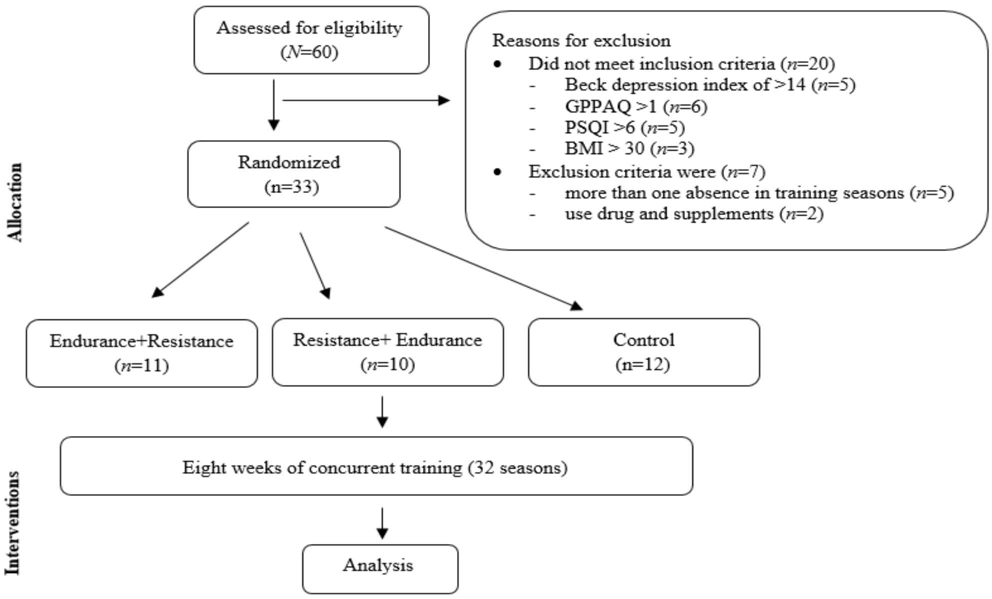


Figure 1: Flowchart of the study design

2.2 Procedures

Testing sessions were performed at the same time of day for each participant under the same environmental condition (~20°C and ~55% humidity). Medical sampler Race industry of China with a precision of 1 cm measured subject's height and the weight was measured with a digital scale (Lumbar, Made in China) with a precision of 0.1 kg. BMI was calculated by dividing body weight by the square of the height (kg/m^2). A polar heart rate monitor was used to control the exercise intensities (Polar S810, Polar Electro, Kempele, Finland). Body Fat (BF) percentage was determined using a caliper device (Lafayette, model 01127, USA) with an accuracy of 1mm. Three skinfolds were measured, namely above the iliac femoral neck and tricpes brachia on the right side. Then BFP was calculated by using Jackson and Pollock formula (Eston & Reilly, 2013).

Both two experimental groups did the same resistance and endurance training. However, the order of the training was changed. The training interventions were carried out for a period of eight weeks from low to high intensity according to overload principle. Both groups performed their exercises simultaneously after 15 minutes of warm-up. The CRT group first performed resistance training for 45 minutes, then after 10 minutes of rest, they performed endurance training from 20 to 40 minutes. CER group first performed endurance training for 20 to 40 minutes, then rested for 10 minutes and lastly performed resistance training for 45 minutes. Resistance training exercises were Biceps curl, Triceps pushdown, Lat pulldown, Lateral raise, Incline chest press, Leg extension, and Leg curl and calf raise. The participants maintained the overload principle in increasing the amount of weight in such a way that the number of repetitions remained constant between 8-12 repetitions, that is, whenever adjustment with a weight increased the number of repetitions to 14 to 15, the weight increased until the number of repetitions returned to 8-12 (Table 1). Endurance training exercises (Aerobic exercises i.e., lower and upper body exercises) was performed with 65 %

HRmax in the initial training sessions and the exercise intensity reached to 80 % HRmax at the end of the training protocol (Table 1).

Before each blood sampling, the participants were taught to fast for 12 hours (an overnight fast) and abstain from physical activity for the previous 36 hours. Blood samples (5 mL) were obtained from the cubital vein using standard procedures. The initial collection occurred 48 hours before the baseline training session. After clotting occurred, blood samples were centrifuged at 3000 RPM for 10 minutes. Spun serum was removed from the centrifuge and frozen at –70°C for later analysis.

2.3 Data Analysis

The statistical analysis was performed using the SPSS v19.0 software (SPSS Inc., Chicago, IL). Data were checked for normality distribution. One-way ANCOVA was used to compare weight, BMI, BF, insulin and blood sugar in the three study groups. Post-hoc test of Bonferroni was also used for comparing the means. Significant difference was set at p≤0.05.

3. RESULTS

Table 1: Endurance and resistance training protocols

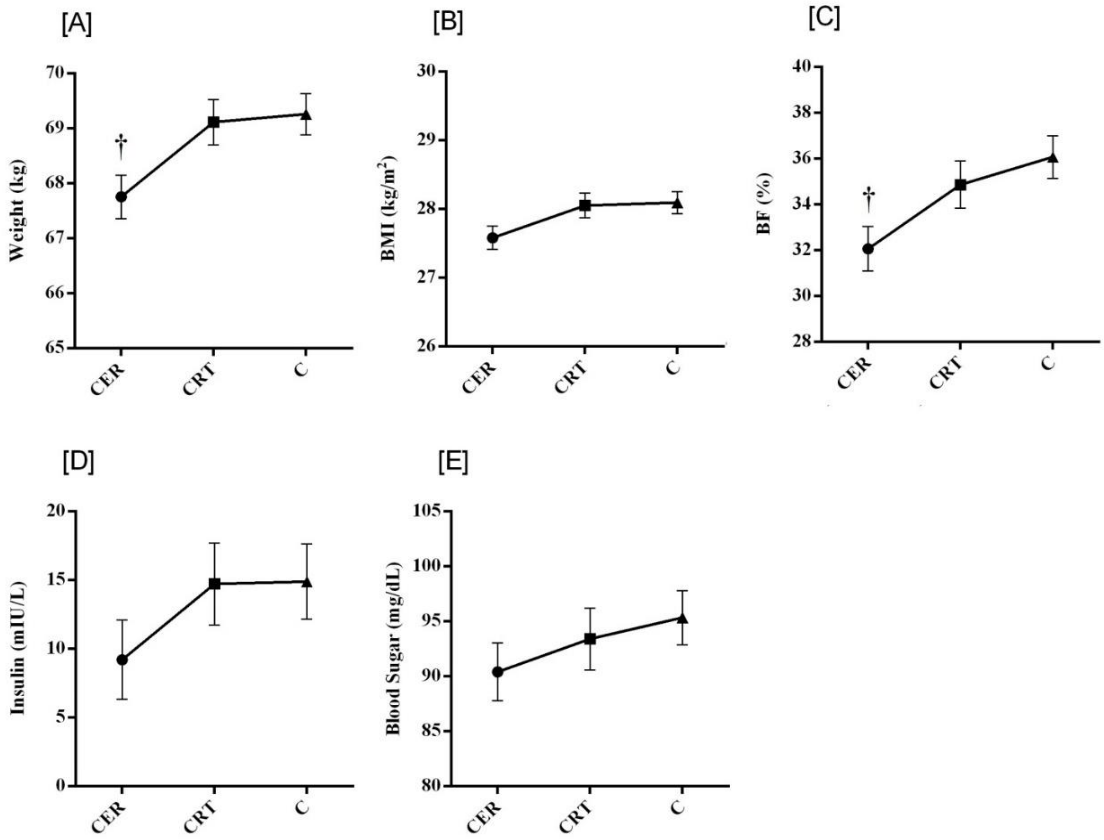
Endurance training	Week	1-2	3-5	6-8
	Intensity (%)	65-70	70-75	75-80
	Set	4×5	4×7	4×10
	Total volume (min)	20	30	40
	Rest intervals (min)	1	1	1
Resistance training	Week	1-2	3-5	6-8
	Set	2	2-3	3
	Station	8	8	8
	Repetition	8-12	8-12	8-12
	Rest between set (min)	1-1.5	1-1.5	1-1.5
	Rest between station (min)	3-4	3-4	3-4
	Number of training sessions per week	3	4	4

Table 2: Characteristics of randomized women, (Mean±SD)

Variable	CER	CRT	C	p-value	Effect size
n	11	10	12		
Age (years)	54.82±3.76	52.6±4.95	54.75±4.00	.407[a]	
Weight (kg)					
baseline	66.6±9.42	70.05± 8.43	70.86± 11.56	< .001[b]	
post intervention	65.39±8.54	69.89± 8.12	70.77±10.48	.022 [c]	.432
BMI (kg/m^2)					
baseline	27.72±4.17	28.29±3.65	28.29±4.38	< .001[b]	
post intervention	27.23±3.93	28.23±3.53	28.27±4.00	.077 [c]	.362
BF (%)					
baseline	34.47± 5.31	37.21± 5.04	35.36± 5.53	< .001[b]	
post intervention	31.31± 4.77	35.88± 3.82	35.90± 5.15	.018 [c]	.441
Insulin (mIU/L)					
baseline	10.80±4.52	18.95±10.36	20.95±37.78	.320 [b]	
post intervention	8.89±2.92	14.81±6.24	15.08±14.07	.301 [c]	.079
Blood Sugar (mg/dL)					
baseline	85.45±10.35	100.60±23.25	90.91±16.30	< .001[b]	
post intervention	84.00±11.21	101.70±21.89	94.25±21.08	.398 [c]	.062

[a] p-value is calculated by Univariate test for between-groups comparison.
[b] p-value is calculated by ANCOVA, baseline as covariate.
[c] p-value is calculated by ANCOVA between-groups comparison.

Table 2 shows the demographic characteristics of the subjects. The results of one-way ANOVA indicated not significantly different in age mean between the groups (Table 2). Given the values obtained, Kurtosis and Skewness for the variables were between -1 and +1, which showed the normal distribution of the data. Hence, parametric methods were used for data analysis. Homogeneity of variance was confirmed and Residuals was normally distributed. So, a one-way ANCOVA was conducted to compare the effectiveness of weight, BMI, BF, insulin and blood sugar in the three study groups whilst controlling for baseline (Table 2). In Table 2 the results of covariance analysis showed a significant difference in mean for weight ($F_{(2,29)}=4.38, p=.022$) and BF ($F_{(2,29)}=4.60, p<.018$). Based on the results of the Bonferroni post hoc test as shown in Figure 2, weight in ET+RT is significantly lower than control (*p<.05, Fig 2 [A]*). BF in ET+RT is significantly lower than control (*p<.05, Fig 2 [C]*).



CER: concurrent endurance-resistance group, CTE: concurrent resistance-endurance group, C: control group, weight [A], body mass index [B], body fat [C], insulin [D], blood sugar [E].
† p≤0.05 significant difference with control.

Figure 2: Bonferroni post-hoc results to compare the groups with the adjusted mean

4. DISCUSSION

Ageing is often accompanied by a reduction in lean body mass and an increase in fat mass, especially in the visceral depot, worsening insulin resistance and glucose tolerance, dyslipidemia and hypertension. In women these changes occur particularly rapidly after menopause (Sillanpää et al., 2009).

The results of the current research indicated a significant decrease in body weight, BF% among CER group, and no difference was observed between training sequence orders in reducing BMI, insulin and blood sugar variables. Although the results showed that there was no significant difference between groups CER and CRE, but with a significant difference between CER and C, it seems that the training order affects the body composition. These findings were similar other study by Sheikholeslami-Vatani et al. (Sheikholeslami-Vatani, Siahkouhian, Hakimi, & Ali-Mohammadi, 2015), Rigi et al. (Rigi, Banitalebi, Kazemi, & Azimian, 2017), Sillanpaa et al. (Sillanpää et al., 2009) and Rossi et al. (Rossi et al., 2017). But, the findings of present research were different from those of Campos et al. (Campos et al., 2013) and Cadore et al. (Cadore et al., 2010). This discrepancy can be attributed to the differences among the studied groups, training period, intensity, duration and type of training.

CER training enhances more the increasing the basal metabolic rate and therefore, can help reduce body weight and fat mass. The literature provides evidence of a relationship between energy expenditure from physical exercise training and lean body mass (Rossi et al., 2017). The researchers noted that CER was more efficient to decrease the body weight and BF % when compared to isolated training (Campos et al., 2013; Faramarzi, Bagheri, & Banitalebi, 2018). Endurance training helps to improve body composition by reducing body fat mass and resistance training by increasing lean body mass (Rigi et al., 2017).The results showed that exclusive the order of CER training is effective in improving body composition. It may be argued that the CER group that first performed the aerobic exercise was able to maintain the time spent at maximum oxygen consumption without fatigue due to previous resistance training, resulting in a further reduction in fat loss and body weight. No acute alteration in their BMIs was detected but we had a BMI decrease in the CER group, also the difference with the control group was not significant. In this regard, seems to have had the number of low-intensity training sessions and dividing body weight by the square of the height in BMI may not had determine the effects of exercise on BMI. It is unlikely that BMI in middle-aged women has changed due to muscle hypertrophy (Rigi et al., 2017).

Moreover, the current results demonstrated both concurrent of endurance and resistance training order (CER and CRE) for 8 weeks had no significant difference on Serum insulin levels and blood sugar in postmenopausal women. These findings were similar other study by Rigi et al. (Rigi et al., 2017), Kazemi et al. (Kazemi & Mizani, 2015) and Banitalebi et al. (Banitalebi, Faramarzi, & Salehi, 2015). But, the findings of present research were different from those of Sheikholeslami-Vatani et al. (Sheikholeslami-Vatani et al., 2015) and Jones et al. (Jones, Howatson, Russell, & French, 2017). This contradictioncan be related with differences in the training intensity and participants. Aftermore, CT (CER and CRE) had no significant difference on Serum insulin levels and blood sugar in postmenopausal women. In this regard, it can be said that the level of insulin and blood sugar of healthy, non-diabetic and obese women was in the normal range, and it is likely that CT have helped to stabilize it (Gill, Herd, Tsetsonis, & Hardman, 2002; Medeiros et al., 2015).

5. CONCLUSIONS

The current research indicates concurrent endurance-resistance training affects the body weight and body fat percentage of postmenopausal women. Consequently, this protocol may be effective in body composition and promoting health of postmenopausal middle-aged women elderly women. Also, concurrent training order does not seem to play a role in the positive effect on serum insulin levels and blood sugar in postmenopausal women.

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