The effect of circuit resistance training with 40, 60 and 80 percent of one-repetition maximum on the levels of IL-10, IL-1β and body fat percent in obese postmenopausal women

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Abstract

Introduction: Adipose tissue plays an important role in increasing systemic inflammation and exercise training result in modulating inflammation by decreasing adipose tissue. The present study aimed to investigate the effect of 12 weeks circuit resistance training with 40, 60 and 80 percent of one-repetition maximum (1RM) on the levels of IL-10, IL-1β and body fat percent in obese postmenopausal women.
Materials and Methods: Forty four postmenopausal women (average age of 56.07 ± 3.18 years old) randomly divided into four group (each group 11 subjects) including the control and circuit resistance training with 40 (RT40), 60 (RT60) and 80 (RT80) percentage of 1RM. Exercise training program was conducted for 12 weeks and three session per week. Blood samples collected before and after the exercise training period. The ELISA method was used to measure the levels of IL-10 and IL-1β and data analysis performed with Graphpad Prism software.
Results: IL-10 levels in trained groups compared to control group indicated significant increase ($P < 0.05$), in which the increase in RT60 ($P = 0.014$) and RT80 ($P < 0.001$) groups were also significant compared to the RT40 group. In addition, significant decrease of IL-1β in RT40 ($P = 0.003$), RT60 ($P < 0.001$) and RT80 ($P < 0.001$) groups compared to control group were observed, as such, IL-1β decrease in RT80 group compared to RT40 ($P < 0.001$) and RT60 ($P = 0.001$) group was also significant. Moreover, different intensity circuit resistance training was associated with decrease in percent body fat ($P < 0.05$), which further decreases reported in the RT60 and RT80 groups.
Conclusion: Despite the anti-inflammatory effects of different intensities of circuit resistance training, the higher intensity of exercise training can be associated with greater effectiveness in reducing inflammation and strengthening the anti-inflammatory pathways.

Keywords: Menopause, Circuit resistance training, Inflammation, Obesity, IL-10, IL-1β

Introduction

Obesity is becoming a worldwide epidemic, which is associated with increasing the health care costs and negative health consequences such as type 2 diabetes, cardiovascular disease, and cancer (1). Obesity itself is not a risk factor for metabolic diseases, but obesity related inflammation plays an important role in development of insulin resistance and diabetes (2). On the other hand, menopause is an aging related phenomenon in women, which significantly increases the risk of various diseases such as obesity, metabolic syndrome, type 2 diabetes and cardiovascular disease (3). Obesity resulting in an increase in adipocyte size and fat mass (4), which in turn increases the production of inflammatory cytokines by macrophages, which results in the development of chronic inflammation (5). Chronic inflammation plays an important role in the pathogenesis of insulin resistance, pancreatic cell death, atherosclerosis, neurodegeneration and tumor growth, and chronic inflammation is one of the main symptoms in rheumatic diseases, which remarkably increases the risk of cardiovascular diseases and rheumatic diseases associated disorders consist of muscle mass loss, anemia, insulin resistance, dyslipidemia and exacerbation of atherosclerosis (6).

Interleukin-1 beta (IL-1β) is an inflammatory cytokine secreted by macrophages and other immune cells, which increased in obesity and cardiovascular disease (7). IL-1β is very important for host defense responses against infection and injury, and is one of the most well-known members of the IL-1 family (8). Inflammatory cytokines including IL-1β and IL-1α are involved in the pathogenesis of chronic inflammatory diseases such as rheumatoid arthritis and type 2 diabetes mellitus, neuropathological diseases such as Alzheimer's, stroke and Parkinson's, and its reported that IL-1β and IL-1α can stimulate several inflammatory mechanisms (9). In contrast, IL-10 as an anti-inflammatory cytokine decreased in obese, diabetic, and cardiovascular patients as well as in inflammatory conditions (10).

The main functions of IL-10 have been described as the anti-inflammatory, inhibitory, or self-regulatory role of IL-10, and it has been suggested that IL-10 is a potent negative feedback regulator, which controls and modulate the inflammation through autocrine and paracrine mechanisms (11). The american college of sports medicine (ACSM) has suggested resistance training as a useful method for improving the insulin resistance in diabetics and non-diabetics individuals (12). Among the different types of resistance training, its reported that circuit resistance training increase lipolysis immediately after exercise (13). In addition, circuit resistance training plays an important role in stimulating muscular hypertrophic pathways and increasing muscle strength as well as improving aerobic capacity simultaneously (14), and can improve body composition along with decrease in inflammatory factors in obese individuals (15).

It has been reported that high intensity circuit resistance training result in increased the strength, muscle mass and bone density in the elderly, which is similar to the results of traditional high intensity resistance training (16). In addition, significant decrease of inflammatory cytokines following circuit resistance training have been observed in obese individuals (15). Accordingly, circuit resistance training has been proposed as an effective training method in order to increasing both muscle strength and cardiorespiratory capacity, which can exert metabolic benefits of both resistance and aerobic training in shorter time period (14). However, the effect of different intensities of circuit resistance training on inflammatory mediators is yet remarkably unknown and the optimal intensity in order to maximize the circuit resistance training adaptations needed to investigated. Therefore, in the present study, the effect of 12 weeks different intensities circuit resistance training including the 40, 60 and 80 percent of one-repetition maximum (1RM) on the levels of IL-10, IL-1β and body fat percent in obese postmenopausal women was investigated.

Materials and Methods

Subjects

The present research was performed based on pre-test and post-test design. Present study participants were consist of obese postmenopausal women who were selected among the recruited subjects. All subjects voluntarily participated in the present study and finally 44 postmenopausal women with age ranging the 48-65 years old were chosen as a subject to participate in the present research. Present research inclusion criteria consisting of: at least 12 months have passed after the last menstrual period, non-addiction to drugs or alcohol, don't take part in regular exercise training in last year, no kidney, liver, cardiovascular disease and diabetes, body mass index equal or greater than 30 $kg.m^2$, and the absence of any injuries or physical problems. Exclusion criteria including the absence of regular participation in exercise training sessions, injuries during the exercise training, unwillingness to continue research protocol, medical prohibition to participate in exercise training, and forced to take certain drugs or supplements.

Study Design

Because the present subjects were obese menopausal women and were examined in a 12-week research period, so the present study is semi-experimental. After checkup by a gynecologist and confirming the menopause, subjects were qualified to enter in present study. Menopause was confirmed by menopausal levels of estradiol (<120 pmol/l) and follicle-stimulating hormone (FSH> 30 IU / L). Before conducting the present study, all steps and research methods were explained to subjects and after full knowledge and completion of the medical questionnaire, all of them signed written consent. In the first session, the participants height and weight were measured and in the second session, subjects 1RM determined. The subjects were then matched based on weight, height and body mass index (BMI) and divided into four equal groups including: 1) control (C) (11 person), 2) circuit resistance training with 40 (RT40) (11 person), 3) 60 (RT60) (11 person) and 4) 80 (RT80) (11 person) percent of 1RM. Three training groups completed their research protocol, but the control group was asked to continue daily routine lives and don't take part in regular training.

Circuit Resistance Training Program

The circuit resistance training protocol consisted of eight movements (squat, biceps curl, chest press, knee extension, knee curl, shoulder press with barbell, leg press, underhand cable pulldowns) for upper and lower limb, which conducted as a circuit at different intensities (17, 18). The training group consist of 1) RT80: Three sets with 10 repetitions at 80% 1RM, 2) RT60: Three sets with 13 repetitions at 60% 1RM, 3) RT40) Three sets with 20 repetitions at 40% 1RM. Training volume was calculated based on the Baechle et al (1994) formula (training volume= Weight × number of repetitions × number of sets) (19). The between sets rest considered two minutes and was inactive (20). The subjects 1RM was calculated using Brzycki equation (21) which reported in following:

1-RM = weight (kg) /1.0278 – (number of repetitions to fatigue × 0.0278)

Blood Sample Collection and Analysis

The first fasting blood sample was taken 72 hours before and the second blood sample was taken 72 hours after a 12-week intervention from the subject's forearm vein. Blood samples were transferred to special test tubes for serum and plasma (tubes containing sodium citrate) preparation, and then centrifuged at 3000 rpm for 10 minutes. The obtained serum and plasma samples were stored at -70 °C. Then, the circulating variables were measured using kits and special laboratory methods.

Plasma levels of IL-10 (Biovendor, catalog number: RD194572200R, sensitivity: 1.32

pg.ml) and IL-1β (R&D, catalog number: DLB50, sensitivity: 1.0 pg/ml) were measured by ELISA method. Moreover, Body fat percentage was also measured by BOCA-X1 body composition analyzer made in South Korea. Moreover, insulin resistance was calculated with the previously reported formula (22).

Statistical Analysis

In order to data analysis, graph pad prism statistical software was used and Excel software was used to draw the graphs. Between group differences were analyzed by repeated measures analysis of variance and Bonferroni post hoc test. Intragroup changes were also analyzed by means of dependent t-test. Significance level for all stages of data analysis was considered $P < 0.05$.

Results

The subjects characteristics including age, height, body weight and BMI in different research groups were reported as mean ± standard deviation in Table 1.

Table 1. Subjects physical characteristics including age, height, weight and body mass index (BMI).

Variables	Control	RT40	RT60	RT80
Age (years)	56.7 ± 3.92	54.9 ± 2.68	57.4 ± 2.88	55.3 ± 3.24
Height (cm)	163.9 ± 3.2	164.2 ± 2.7	162.3 ± 2.6	163.2 ± 1.7
Body weight (kg)	89.8 ± 2.1	88.9 ± 2.8	88.4 ± 1.9	89.2 ± 2.2
BMI (kg.m^2)	33.4 ± 1.5	33.0 ± 1.4	33.5 ± 1.3	33.7 ± 0.7

RT40: circuit resistance training with 40% of 1RM. RT60: circuit resistance training with 60% of 1RM. RT80: circuit resistance training with 80% of 1RM.

The results of repeated measures ANOVA test with the between group factor for IL-10 indicated that the effect of time ($P < 0.001$, $F_{1,40}= 232.1$) and group-time interaction ($P < 0.001$, $F_{1,40}= 38.5$) is significant. Therefore, IL-10 levels change between different research groups after 12 weeks of circuit resistance training were significant. Bonferroni post hoc test showed the significant increase of IL-10 levels in RT40 ($P = 0.008$), RT-60 ($P < 0.001$) and RT80 ($P < 0.001$) groups compared to control group. Increased significantly with the control group. In addition, a significant difference was observed between RT40 group with RT60 ($P = 0.014$) and RT80 ($P < 0.001$) groups. Moreover, a significant difference was observed between RT60 and RT80 groups ($P = 0.006$). Investigate the intragroup difference using dependent t-test indicated no significant change for IL-10 levels in control group ($P = 0.58$). However, plasma levels of IL-10 indicated a significant increase in the RT40 ($P = 0.001$), RT60 ($P < 0.001$) and RT80 ($P < 0.001$) groups (Figure 1).

IL-1β data analysis indicated that the effect of time ($P < 0.001$, $F_{1,40}= 146.7$) and time-group interaction ($P < 0.001$, $F_{1,40}= 31.1$) was significant, and there is a significant difference between different groups. The Bonferroni post hoc test indicated that IL-1β levels in the RT40 ($P = 0.003$), RT60 ($P < 0.001$) and RT80 ($P < 0.001$) groups significantly decreased compared to the control group. In addition, a significant decrease of IL-1β levels was observed in the RT80 group compared with the RT40 ($P < 0.001$) and RT60 ($P = 0.001$) groups. Dependent t-test indicated no significant difference for control group ($P = 0.55$), but IL-1β levels significantly decreased in RT40 ($P = 0.001$), RT60 ($P < 0.001$) and RT80 ($P < 0.001$) groups (Figure 2).

The effect of time ($P < 0.001$, F1,40= 80.1) and time-group interaction ($P < 0.001$, F1,40= 13.7) was significant for body fat percentage changes, which represented a significant difference between different groups for body fat percentage after 12 weeks different intensities circuit resistance training.

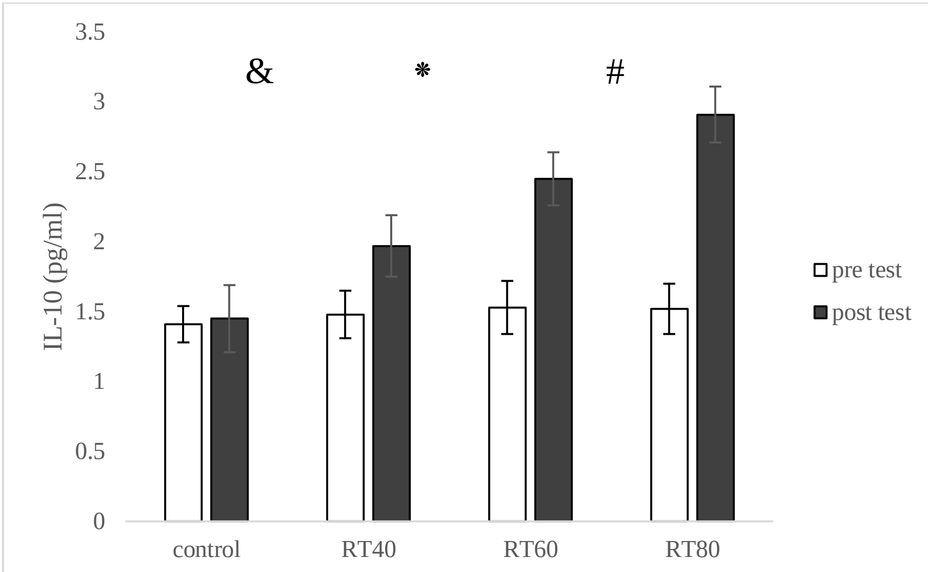

Figure 1. IL-10 levels before and after 12 weeks circuit resistance training. RT40: circuit resistance training with 40% of 1RM. RT60: circuit resistance training with 60% of 1RM. RT80: circuit resistance training with 80% of 1RM. * Significant difference between different measurement times regardless of training intensity ($P < 0.001$). # Significant between groups difference ($P < 0.001$). & Significant intragroup difference in all groups except the control group ($P < 0.001$).

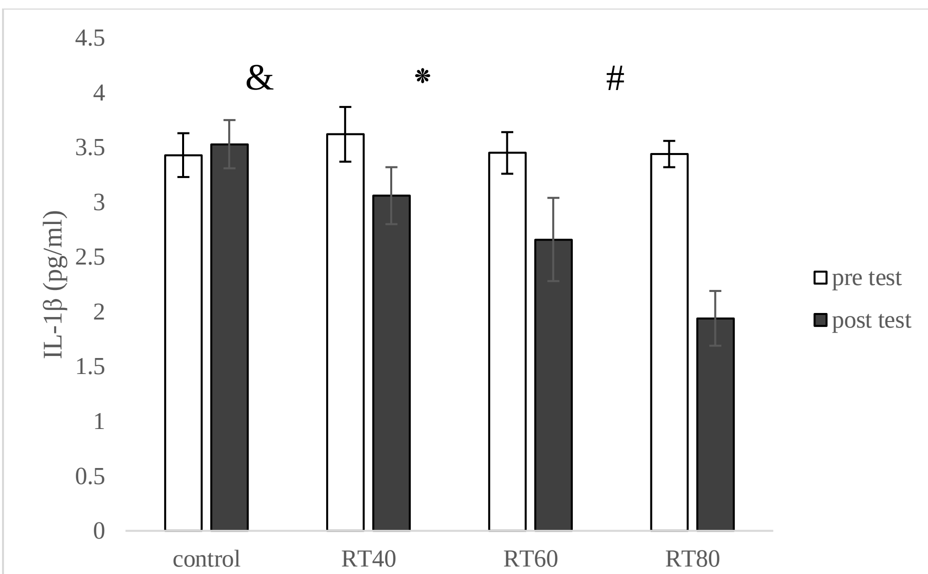

Figure 2. IL-1β levels before and after 12 weeks circuit resistance training. RT40: circuit resistance training with 40% of 1RM. RT60: circuit resistance training with 60% of 1RM. RT80: circuit resistance training with 80% of 1RM. * Significant difference between different measurement times regardless of training intensity ($P < 0.001$). # Significant between groups difference ($P < 0.05$). & Significant intragroup difference in all groups except the control group ($P < 0.001$).

Bonferroni post hoc test showed a significant decrease of body fat percentage in the RT60 and RT80 groups compared to the control group ($P < 0.001$). In addition, there was a significant difference between RT40 with RT60 ($P = 0.008$) and RT80 ($P < 0.001$) groups. While the difference between RT60 and RT80 groups was not significant ($P = 0.091$), the intragroup changes analysis by dependent t-test represented the significant decrease of body fat percentage in RT40 ($P = 0.004$), RT60 ($P = 0.001$) and RT80 ($P < 0.001$) groups, but no significant changes was observed for the control group ($P = 0.98$) (Figure 3).

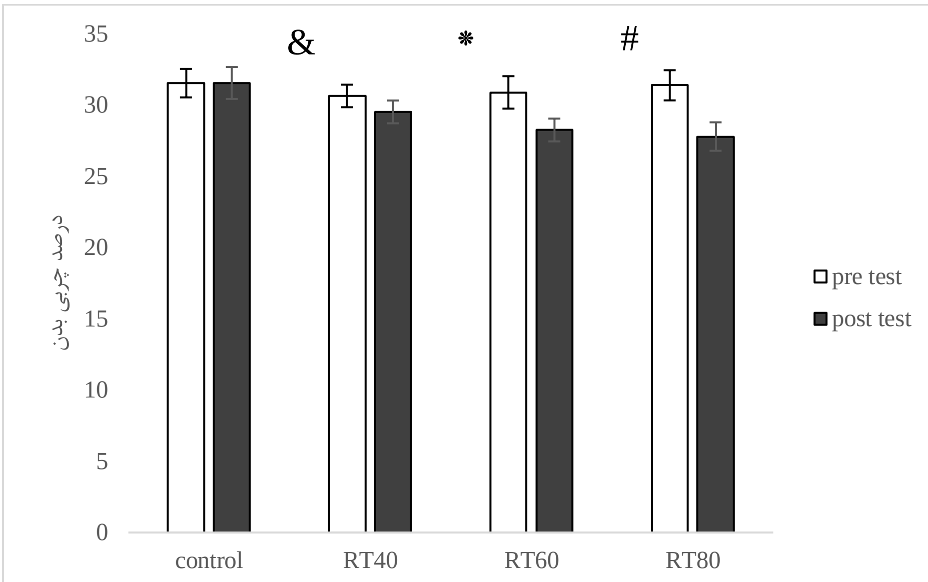

Figure 3. Body fat percentage before and after 12 weeks circuit resistance training. RT40: circuit resistance training with 40% of 1RM. RT60: circuit resistance training with 60% of 1RM. RT80: circuit resistance training with 80% of 1RM. * Significant difference between different measurement times regardless of training intensity ($P < 0.001$). # Significant between groups difference ($P < 0.05$). & Significant intragroup difference in all groups except the control group ($P < 0.05$).

Discussion

The present study aimed to investigate the effect of 12 weeks circuit resistance training with different intensities (40, 60 and 80% of 1RM) on the levels of IL-10, IL-1β and body fat percentage in obese postmenopausal women. According to present findings, different intensities of circuit resistance training lead to a significant decrease of IL-1β and significant increase in IL-10 levels. Interestingly, higher intensity circuit resistance training was more effective in decreasing IL-1β and increasing IL-10 levels. IL-10 is an anti-inflammatory cytokine that play an important role in inhibiting the systemic inflammation and TNF-α (23). Consistent with the present study, its reported that eight weeks resistance training in elderly women leads to a significant decrease of inflammatory mediators' including TNF-α and IL-6, which the researchers attributed the effect of resistance training to anti-inflammatory mediators release such as IL-6 from skeletal muscle during exercise, which acts as a TNF-α antagonist during exercise (24).

Abd El-Kader et al (2019) in accordance with present findings suggested that long-term endurance training in elderly men and women, decrease the levels of inflammatory (IL-6 and TNF-α) and simultaneously increases anti-inflammatory (IL-10) cytokines. Therefore, researchers concluded that aerobic exercise training in elderly subjects is an effective non-pharmacological method to decreasing inflammation (25). Exercise training anti-inflammatory effects exert through different mechanisms, including a reduction in visceral fat mass (26), decrease the number of circulating proinflammatory monocytes (27), and increase the number of regulatory T cells (28). Despite these findings, some researchers have suggested that exercise training can decrease the inflammatory mediators, independent of changes in the body weight (29). In addition, the anti-inflammatory effects of exercise training partly exerted by decrease in mitochondrial stress and decrease of ROS production by mitochondria (30).

It seems that the length of circuit resistance training period plays an important role in the observed adaptations following exercise training. In this regard, Alizadeh et al (2019) reported that six weeks high-intensity circuit resistance training, despite the increase in IL-10 levels, don't have a significant effect (31). In addition to intense circuit resistance training, researchers have suggested that high intensity interval training has a greater effect in modulating the inflammatory pathway compared to moderate-intensity continuous training, which was associated with further decrease in visceral adipose tissue (32). In support of this hypothesis, present study results indicated that 12 weeks circuit resistance training with different intensities result in decrease of body fat mass, which highest reduction was observed in the high intensity circuit resistance training group, which was associated with a further increase in IL-10 levels and a further decrease of IL-1β in high intensity circuit resistance training group. In this regard, it has been shown that anti-inflammatory effects of exercise training are largely depend to intensity and duration of exercise training, fitness, type of exercise and nutritional status of individuals (33).

Although, the effect of circuit resistance training with different intensities on the levels of IL-1β is remarkably unknown, it has been reported that 12 weeks aerobic training in postmenopausal women significantly decreased the IL-1β levels, which was associated with a significant decrease in body fat percentage (29). In another study, Farinha et al (2015) in accordance with the present findings reported that 12 weeks aerobic training in women with metabolic syndrome are associated with significant decreased of IL-1β, IL-6 and TNF-α levels, which modulating inflammatory factors were associated with a significant increase in IL-10 levels as an anti-inflammatory cytokine, and consistent with the present findings, decreased levels of inflammatory agents (IL-6 and TNF-α) were associated with decrease of body fat percentage (34). However, contrary to the present findings, Salamat et al (2016) reported that eight weeks aerobic and combined training (resistance-aerobic) in overweight men result in decrease the levels of IL-1β, but there is no significant change in IL-1β levels for resistance training group (35). Contradiction with the present findings is probably related to the shorter duration of resistance training (eight weeks) period compared to the present study and also the different subjects' characteristics. Despite these findings, due to present study limitations such as the low number of subjects in each group, different nutritional states, as well as the difference in motivation and subjects' goals, accurate conclusion about the effect of different intensities circuit resistance training on inflammation, requires further investigations.

Conclusion

The present study findings indicate a greater effect of high intensity circuit resistance training in modulating the inflammatory mediators (such as IL-1β) and increasing the anti-inflammatory factors (such as IL-10) compared to lower intensities. Based on the present evidence, it appears that greater effect of high intensity circuit resistance training on the inflammatory and anti-inflammatory pathways is due to further reducing body fat percentage compared to low intensity training, which partly related to greater stimulation of muscle mass during high intensity circuit resistance training.

Conflict of interest

The authors declare that no conflict of interest exists.

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