



Cardiovascular Effects of Circular Training (Resistance-Interval) Combined with Berberine on Overweight Elderly Men

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Abstract

Background: Obesity and overweight, along with inactive lifestyle, have been introduced as the most important risk factors of cardiovascular diseases, especially among elderly. This study aimed to determine the effect of circular training (resistance-interval) combined with berberine on cardiovascular risk factors and C reactive protein (CRP) in overweight elderly men.

Methods: 40 sedentary healthy elderly male with the ages ranged from 50 to 55 years old were divided into 4 groups as following: circular training (resistance-interval, 8 weeks, 3 times/weekly) (CT), berberine supplementation (BS), circular training combined with berberine (CT-BS), and control (CON) groups (n = 10 each group). The duration of Intervention was 8 weeks. Fasting blood samples were collected before and 48 hours after the last training session to determine the cardiovascular risk factors (TG, TC, LDL, HDL) and serum CRP for all groups. Multivariate analysis of covariance (MANCOVA) was used to compare the groups' results.

Results: All interventions (CT, BS, and CT-BS) resulted in significant decrease in TG, TC, and LDL, and also an increase in DL. Serum CRP was significantly decreased in CT and CT-BS groups, but not in BS. In addition, significant difference was observed in cardiovascular risk factors and CRP within groups with emphasizing more on cardiovascular effects of CT-BS.

Conclusions: Based on the results, it is concluded that circular trainings combined with berberine supplementation is associated with more cardiovascular effectiveness than each one alone in overweight elderly men.

Keywords: Cardiovascular risk factor, Circular exercise, Berberine, Elderly, Overweight

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Introduction

Over recent years, the prevalence of obesity and overweight in both developed and developing countries has been remarkably increased as some experts have recognized it as a "hidden epidemic".¹ Nowadays, obesity is not only taken into consideration due to its association with chronic diseases such as cardiovascular diseases, diabetes, hypertension, hyperlipidemia, and cancer, but is also accentuated as a risk factor for mortality.² Obesity is associated with an increase in TG, TC, and LDL levels and a decrease in HDL level, in response to which the resistance of the peripheral vessels decreases, which is accompanied with coronary artery disease and hypertension.³ Moreover, the increased levels of pre-inflammatory cytokines such as CRP have also been reported

in the presence of obesity and overweight.⁴ The mentioned inflammatory marker has been introduced as one of the most significant clinical markers for the diagnosis of inflammation and cardiovascular diseases by the Centers for disease control and prevention (CDC) in the united states.² The findings obtained from the clinical trials have accentuated the higher levels of this inflammatory marker in patients with coronary artery disease, type 2 diabetes, obesity, and sedentary lifestyle.⁵ The prevalence of peripheral vascular diseases and sudden cardiac death can also be regarded as the consequences of the increased levels of CRP.⁶ However, some studies have suggested that CRP is not associated with LDL, as another risk factor for cardiovascular diseases.⁷ Considering the presented discussion, for the diagnosis of cardiovascular diseases, researchers propose that simultaneous evaluation of both CRP and LDL along with other cardiovascular risk factors are more appropriate than measuring each factor alone.

Hence, presentation of appropriate strategies employing intrinsic or extrinsic stimuli for reducing the body fat tissue in obese or overweight subjects with various age ranges, has always grasped the attention of health and wellness researchers. In this regard, scientific resources have acknowledged the role of exercise in reducing the levels of pro-inflammatory mediators in healthy or patient populations.⁸ It has been mentioned that weight loss programs proposed for obese subjects result in a reduction in the level of CRP along with an increase in adiponectin.⁹ Moreover, the findings of a study conducted by Kadoglou et al. (2007) indicated that aerobic training for three sessions per week for the period of six months not only resulted in a significant decrease in insulin resistance and lipid profile markers such as TG, TC, and LDL, but also caused an increase in the level of HDL in obese subjects.¹⁰ However, some studies have reported that the levels of CRP and other cardiovascular risk factors have not been changed following the long-term exercise training programs.¹¹ The findings presented by Bouchonville et al. (2013) indicated that 12 months of aerobic training resulted in no significant changes in the levels of lipid profile, glucose, and some inflammatory or anti-inflammatory markers.¹² Boroujeni et al. (2014) reported that eight weeks of resistance training in obese men caused no any significant changes in lipid profile markers such as TG, TC, and LDL.¹³

In addition to studies addressing the effects of exercise training on cardiovascular function, some studies have evaluated the effectiveness of nutritional or herbal supplements on cardiovascular function or other metabolic factors in different populations. In this respect, berberine has been

Smirnov. Independent sample T-test was used to compare all variables between two groups at baseline. Multivariate analysis of variance was used to examine baseline differences between groups. Paired t-test was used to determine the mean differences between pre and post-intervention values on all clinical and anthropometric variables. Significant level was set at 0.05.

Results

Pre and post intervention of anthropometrical indexes of two groups are shown in table 1. No significant difference was observed in all anthropometrical markers between groups at baseline level (Pvalue > 0.05). Compared to pre-intervention, a significant decrease was observed for anthropometrical indexes by CT, BS and CT-BS groups; however, these variables remained without changed in control subjects (data by Paired T test, see table 1).

Clinical characteristics of pre and post intervention for the subjects are described in table 2. No significant difference was observed in these variables between groups at baseline (Pvalue > 0.05).

Based on Multivariate analysis variance, significant changes were observed for all cardiovascular risk factors (TG, TC, LDL, and HDL) between groups. On the other hand, data obtained by post-hoc LSD indicated significant change between CT-BS with CT and BS. These data demonstrated that CT-BS intervention resulted in significant decrease in TG, TC and LDL and increase in HDL as compared with each CT or BS alone (table 3).

Multivariate analysis variance also showed significant change in CRP between groups (Pvalue = 0.001). However, during comparing the groups together by post-hoc LSD, differences between CON with CT and CT-BS were significant. On the other hand, CT and CT-BS intervention resulted in significant decrease in serum CRP compared to control group; however, the difference between CON and BS was not significant. Significant difference was also observed between BS with CT-BS. On the other hand, serum CRP was significantly decreased in CT-BS compared to BS alone. In addition, no significant difference was observed in serum CRP between CT-BS with CT alone (see table 4).

Table 1. Pre and post intervention of anthropometrical indexes for all groups (M ± SD)

Variable	Time	CON	CT	BS	CT-BS
Weight (kg)	pre	84.70 ± 2.82	83.90 ± 3.07	83.90 ± 2.89	85 ± 3.27
	post	84.80 ± 2.75	82.10 ± 2.97	82.60 ± 3.08	81.2 ± 2.53
	sig	0.213	< 0.001	0.004	< 0.001
AC (cm)	pre	94.60 ± 2.63	93.50 ± 3.50	92.60 ± 4.43	93.5 ± 2.51
	post	94.90 ± 2.89	90.80 ± 2.97	90.90 ± 4.77	88.3 ± 1.83
	sig	0.279	< 0.001	< 0.001	< 0.001
HC (cm)	pre	96.10 ± 2.73	94.90 ± 3.28	98.50 ± 4.05	95.7 ± 2.71
	post	96.10 ± 2.96	92.30 ± 3.34	94.10 ± 3.99	91.8 ± 2.44
	sig	0.998	< 0.001	< 0.001	< 0.001
BF (%)	pre	28.17 ± 1.22	27.74 ± 0.81	28.25 ± 0.77	27.67 ± 0.73
	post	28.07 ± 0.97	26.60 ± 0.75	27.58 ± 0.61	26 ± 0.34
	sig	0.476	< 0.001	< 0.001	< 0.001
BMI (kg/m ²)	pre	28.59 ± 0.78	28.24 ± 0.74	28.16 ± 0.84	28.51 ± 0.70
	post	28.66 ± 0.72	27.60 ± 0.77	27.70 ± 1.00	27.3 ± 0.54
	sig	0.209	< 0.001	0.004	< 0.001

AC; abdominal circumference, HC; hip circumference, BF; body fat percentage, BMI; body mass index

Table 2. Pre and post intervention of anthropometrical indexes for all groups (mean ± SD)

Variable	Sampling time	CON	CT	BS	CT-BS
TG (mg/dL)	pre	165 ± 27	169 ± 10	162 ± 32	170 ± 80
	Post	161 ± 20	152 ± 14	142 ± 24	147 ± 50
TC (mg/dL)	pre	181 ± 30	183 ± 13	177 ± 22	187 ± 15
	Post	180 ± 25	163 ± 10	154 ± 13	159 ± 10
LDL (mg/dL)	pre	154 ± 15	165 ± 11	158 ± 22	160 ± 10
	Post	152 ± 12	150 ± 16	144 ± 23	141 ± 80
HDL (mg/dL)	Pre	42.0 ± 1.81	41.5 ± 1.35	41.8 ± 1.93	41.6 ± 1.84
	Post	42.4 ± 1.90	45.5 ± 2.22	44 ± 1.83	47 ± 1.56
CRP (pg/mL)	pre	6234 ± 943	6072 ± 725	6021 ± 845	6013 ± 864
	Post	6253 ± 918	55/3 ± 848	5498 ± 791	5154 ± 1156

AC; abdominal circumference, HC; hip circumference, BF; body fat percentage, BMI; body mass index

Table 3. Results of multivariate analysis variance for cardiovascular risk factors

Variables	Sum of Squares	df	Mean Square	F	Pvalue
TG	1712	3	428	1.174	< 0.001
TC	2818	3	705	2.10	< 0.001
LDL	1720	3	430	1.743	< 0.001
HDL	114	3	28.6	6.590	< 0.001

Table 4. Results of post-hoc LSD for serum CRP for studied groups

Group	Group	Difference mean	standard error	Pvalue
Control	CT	660.6	272.83	0.018
	BS	1484.1	272.83	0.080
	CT-BS	1089.2	272.83	0.001
CT	BS	176.5	272.83	0.521
	CT-BS	428.6	272.83	0.121
BS	CT-BS	605.1	272.83	0.030

Discussion

The findings of the present study revealed the effectiveness of combined exercise training along with berberine consumption on cardiovascular health condition among overweight elderly men. Moreover, the findings indicated an improvement in the cardiovascular risk factors (TG, TC, LDL, and HDL) and the level of CRP in response to the combination of berberine with circular trainings as compared with each one alone. In other words, 8 weeks of combined circular training (interval-resistance) along with berberine consumption resulted in a significant reduction in the levels of TG, TC, and LDL and a significant increase in the level of HDL in overweight elderly men, who had a sedentary lifestyle, previously. In line with the findings of the present study, Racil et al. (2013) expressed that 4 weeks of moderate and high intensity interval training could significantly lead to a reduction in the anthropometric indices and insulin resistance as well as a significant increase in HDL in obese subjects.²³ Jorge et al. (2011) in their study addressed the effect of various training methods on metabolic factors in diabetic obese subjects, and expressed that 12 weeks of aerobic, resistance, and combined trainings reduced the fasting glucose levels and improved the lipid profile markers (TG, TC, LDL, and HDL).²⁴ Similarly, Riesco et al. (2013) reported a significant increase in HDL as well as improvements in other lipid profile markers following a 16-week brisk walking program in obese or overweight subjects.²⁵

However, in contrast with the findings of this study and the presented piece of evidence, Nazari et al. (2015) reported no significant changes in the metabolic syndrome factors such as fasting glucose, TG, systolic and diastolic blood pressure, waist-hip ratio, and the level of HDL and LDL in obese and overweight subjects with type 2 diabetes after 8 weeks of circular-resistance training.²⁶ In the study conducted by Colombo et al. (2013), no changes were observed in the level of TG, TC, and LDL in patients with metabolic syndrome after 12 weeks of brisk walking.²⁷ Usefipour et al. (2015) found that 8 weeks of aerobic training resulted in no changes in HDL and TC as compared with that of the control group.²⁸ Moreover, the findings of a study by Afshon Pour et al. (2016) revealed that although 8 weeks circular-resistance training led to a significant increase in HDL in male patients with type 2 diabetes, no significant changes were observed in the levels of TG, TC, and LDL.²⁹

In spite of improvements in the cardiovascular risk factors in response to combined circular training, the levels of the mentioned risk factors were also improved in a group that received only supplementary berberine. In other words, an 8-

week berberine supplementation led to a decrease in the levels of TG, TC, and LDL, and an increase in HDL. The presented findings clarify the fact that each of the combined circular training and berberine consumption are capable of improving the cardiovascular risk factors amongst overweight elderly subjects. In addition, the findings revealed that the improvement of the cardiovascular risk factors following the circular training along with berberine consumption was remarkably higher than the improvements provided by each of the interventions alone. In this regard, although the presented evidence is limited, some clinical studies have supported the effectiveness of berberine on cardiovascular risk factors in both human and animal samples. Berberine could lead to a reduction in the level of TC in blood circulatory system by negative regulation of LDL-C, inhibition of TC absorption, and acceleration of its excretion. In this regard, the available evidence reveals that Berberine consumption is associated with a 50% reduction in the TC absorption rate from the diet.¹⁶ Furthermore, reduction of TC absorption in intestinal absorption cells and excretion of TC from the liver to the bile, can be considered as the other beneficial effects of berberine on the level of blood lipids.³⁰ Based on the presented evidence, it seems that in the combined circular training and Berberine group, decreased TC absorption rate or increased liver excretion by berberine consumption, along with the reducing effect of circular training (interval-resistance) concurrently paves the way for a significant improvement in the cardiovascular risk factors, as compared with each of the training and berberine groups alone.

In addition to the effectiveness of circular training and berberine consumption on the cardiovascular risk factors in the present study and some other studies, their anti-inflammatory effects have also been reported several times.^{10,24} Kadoglou et al. (2007) reported a significant increase in serum IL-10, decrease in CRP and IL-18, and improvement in the cardiovascular risk factors and insulin resistance in response to aerobic training, for 3 sessions per week during six months in obese patients.¹⁰ In a study conducted by Jorge et al. (2011), 12 weeks of aerobic, resistance, and combined trainings led to a decrease in fasting blood glucose, blood pressure, and CRP in diabetic obese subjects.²⁴ In this regard, the findings of the present study revealed the anti-inflammatory effect of combined circular trainings in obese male subjects. Eight weeks of combined circular training in the form of resistance and interval trainings could cause a reduction in the serum level of CRP in overweight elderly men.

In this respect, although there are few studies that merely examined the effects of combined circular training (interval -

resistance), some studies have reported the effects of other training methods on CRP. In line with the present study and in addition to the findings of the studies presented by Kadoglou (2007) and Jorge (2011), Etemad et al. (2016) revealed that two circular-resistance training programs with different rest intervals lasting for 8 weeks would result in a significant reduction in homocysteine and CRP in a group of healthy men.³¹ Abbasi Delui et al. (2016) also indicated a significant reduction in CRP along with the weight and body fat tissue loss following eight weeks of resistance training in obese or overweight women.³² Olson et al. (2007) reported a significant reduction in the serum level of CRP by passing one year from resistance training in obese subjects.³³ However, in contrast with the presented findings, in a recently conducted study, six months of aerobic training led to no significant changes in the level of CRP and some other inflammatory mediators such as TNF- α and IL-6 in obese or overweight subjects.³⁴ In another study, despite a significant improvement in TNF- α and IL-6, 12 weeks of aerobic and resistance training had no effect on the level of CRP levels in middle-aged obese men.³⁵ The observed contradiction in the findings can be attributed to the type, intensity, duration of the training program, the baseline levels of the inflammatory mediators, and the type of studied population.

Despite the findings of the present study and majority of the mentioned studies that acknowledged the anti-inflammatory properties of regular exercise training, significant changes in the level of CRP were not observed in the berberine group in comparison with the control group. The mentioned finding demonstrated that 8 weeks of berberine consumption can lead to no significant changes in the serum level of CRP. Lack of changes in the berberine group in the present study is in contrast with a recent study, in which berberine consumption in laboratory mice with induced hypertension led to a reduction in inflammatory mediators such as IL-6 and TNF- α in aortic endothelial cells.³⁶ In another study, as compared with the placebo consumption, 45 days of berberine consumption by STZ-induced diabetic rats resulted in a significant reduction in the TNF- α and NF- κ B inflammatory mediators and apoptotic proteins such as caspase-8 as well as an increase in the anti-inflammatory mediators such as IL-10.³⁷ Based on the available evidence that supports the anti-inflammatory effects of berberine, insignificant changes in the level of CRP in response to berberine supplementation may be attributed to the small sample size, distribution of scores, or dosage and manner of berberine consumption during the intervention period. However, Li et al. (2016) have expressed that 28 days of berberine consumption with 100 or 200 mg per kg of body weight reduces the IL-1 β , IL-4, IL-5, IL-6, IL-13, and IL-17 inflammatory markers, the level of pulmonary inflammation index, the activity of NF- κ B signaling pathways, and the production of IgE in bronchoalveolar lavage fluid (BALF) in rats with ovalbumin-induced asthma.³⁸

In conclusion, the results of the present study revealed that the level of CRP decreased in the training group; however, it had no change in the berberine group as compared with the

control group. Moreover, there was no significant difference in the level of CRP between the training and the combined (berberine + training) groups. Meanwhile, there was a significant difference between the berberine and the combined (berberine + training) groups. The mentioned findings indicated that berberine supplementation with the mentioned dose and duration in the present study could not cause a significant change in the level of CRP in overweight elderly men. Based on the clinical evidence regarding this supplement, these results are somewhat controversial, and suggest the necessity of conducting further studies by manipulating the dose or duration of berberine consumption. In addition, it should be taken into account that Hu et al. (2012), in line with the earlier mentioned findings, have expressed that in comparison with the placebo group, taking 500 mg of berberine three times per day for 12 weeks by obese subjects resulted in a significant decrease in TG and TC; however, no significant changes were observed in the inflammatory mediators of IL-6, CRP, and TNF- α .³⁹

Considering the available evidence, the implementation of circular trainings (interval + resistance) along with berberine consumption has more cardiovascular and anti-inflammatory effects, in comparison with application of each one alone. An eight-week circular training along with berberine supplementation has more positive effects on the cardiovascular risk factors along with reduced level of CRP in overweight elderly men. However, the recognition and understanding of the interactive effects of exercise training and berberine consumption on the factors of cardiovascular function require further research, especially over the elderly period.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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