Original Article

Effects of Different Modes of Exercise Training on Body Composition and Risk Factors for Cardiovascular Disease in Middle-aged Men

Abstract

Background: Previous studies have indicated that exercise training improves body composition and cardiovascular disease risk factors. The aim of the present study was to investigate the effect of 12 weeks of aerobic, strength and combined training on body composition, intercellular adhesion molecule-1 (ICAM-1), vascular cell adhesion molecule-1 (VCAM-1), and C-reactive protein (CRP) in sedentary middle-aged men. **Methods:** Forty-seven male aged 40–60 years voluntarily participated in this study and were divided in four groups: aerobic (n = 12), strength (n = 12), combined (n = 11), and control (n = 12) groups randomly. Body composition, ICAM-1, VCAM-1, and CRP were measured before and after 12 weeks. Data were analyzed using paired t-test and analysis of variance statistical methods. **Results:** There were significant differences in body weight between aerobic and strength training (P = 0.004) and aerobic and control groups (P = 0.018), body mass index between combined and strength training (P = 0.004) and combined and control groups (P = 0.001), fat percentage between aerobic training and control group (P = 0.017) and combined training and control groups (P = 0.004), and finally, fat-free mass between aerobic and strength training (P = 0.024), aerobic and combined training (P = 0.0001), strength and control groups (P = 0.035), and combined and control groups (P = 0.0001). **Conclusions:** The results indicated that 12-week workout, 20–60 min/session, 3 days a week of moderate intensity exercise improved body composition, ICAM-1, VCAM-1, and CRP compared to those who did not participate in any training. However, all three types of exercises had small benefits on body composition, ICAM-1, VCAM-1, and CRP in sedentary middle-aged men, and the importance of combined training required further investigations.

Keywords: *Body composition, cardiovascular risk factors, exercise training, middle-aged men*

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Introduction

Sedentary lifestyle is accompanied by increased prevalence of cardiovascular diseases (CVD) and almost two million deaths are caused by lack of exercise worldwide.[1] Sedentary lifestyle increases the risk of CVD in middle-aged individuals. However, participating in exercise training and being physically fit can reduce mortality.[2] Long-term studies show that decreased physical fitness in middle-aged individuals increases the risk of CVD up to 50%, so the lifetime benefits of regular exercise are accompanied by prevention of cardiac risk factors.[3-5]

Aging is associated with changes of body composition, physical functioning, and substrate utilization and muscle atrophy. Muscle atrophy leads to declining muscle strength and function, along with diminished quality of life. Age-related changes in body composition and muscle atrophy play an important role in frailty.[6,7] Exercise training influence on improving quality of life is correlated with decreasing body fat, obesity, increasing muscle strength, health improvement, and alleviating muscular pains. Furthermore, exercise training plays an important role in decreasing the risk of CVD, hypertension, osteoporosis, cancer, and diabetes.[8,9]

Chronic diseases account for approximately 60% of all deaths worldwide.[10] Recently, numerous other CVD risk factors and markers have been identified. Although the pathological role of these new investigated risk factors in the development of CVD is severely debated, their role is added to traditional risk factors in preventing and anticipating CVD and related death.[11-13] A number of recently identified factors associated with inflammation and which are new risk factors for CVD and form plaque on vessels walls are intercellular adhesion molecule-1 (ICAM-1), vascular

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cell adhesion molecule-1 (VCAM-1), and C-reactive protein (CRP).[14,15] However, the pathogenic role of these risk factors in the development of CVD is controversial. One of the most sensitive cellular markers in identifying the formation of atherosclerotic plaque on the walls of the vascular endothelial is attaching cell molecules such as ICAM-1 and VCAM-1.[16,17] ICAM-1 and VCAM-1 are two main groups of four groups of cell adhesion molecules.[18] These two molecules are glycoprotein that exist in some areas, such as vascular endothelial cells, leukocytes, and platelets and play the role of mediator in inflammation. Studies on the effect of aerobic and strength exercise on values of these adhesion molecules in adults are controversial.[19,20] Rankovic *et al*. surveyed the effect of aerobic training on the levels of VCAM-1 in middle-aged individuals and observed a significant decrease in the levels of VCAM-1.[21] Olson *et al*. studied the effects of 1-year strength training on middle-aged women and did not observe any significant reduction in the levels of VCAM-1.[22]

CRP is a spherical plasma protein that is involved in systemic inflammatory response in most vertebrates and invertebrates. Rapid increase in CRP synthesis a few hours after infection or tissue damage indicates that it participates in host defense and is a part of the innate immune response. In liver cells, CRP is synthesized mainly by interleukin-6 (IL-6).[23,24] Increased CRP levels in blood cause tissue inflammation, lipid deposition, and blockage in vessel walls. The primary strategy for reducing CRP is medication therapy.[25,26] Libardi *et al*. examined the effects of strength, endurance, and combined training on CRP levels in middle-aged men and observed no statistically significant differences before and after exercise training.[27] Olson *et al*. examined the effect of 1-year strength training in middle-aged women and observed a significant improvement in CRP in strength training group.[22]

Effect of aerobic and strength exercise in prevention and reduction of CVD has been studied in many researches.[28,29] Given the role of inflammation in CVD, one of the mechanisms to reduce the disease is to improve body composition and inflammatory markers by regular aerobic and strength exercise in middle-aged people. In the past decade, many studies have been performed on the effects of aerobic and strength training on body composition and inflammation remarks; however, the results of these studies have been associated with many contradictions on the basis of case, type, and nature.[30,31] It is proven that daily physical activity improves general health in healthy middle-aged sedentary people. Most people do not have much time for exercise training, so finding the most effective and less time consuming exercise training is important.[4,32] The researches comparing the effectiveness of aerobic, strength, and combined training are limited and further researches seem necessary to better understand the effects of different types of exercise training on body composition and cardiac risk factors. Considering the limited studies about influence of different modes of exercise training on body composition, ICAM-1, VCAM-1, and CRP in sedentary middle-aged men, more future researches are necessary to clarify physiological response of different modes exercise training. Thus, in this study, we examined the effect of 12 weeks of aerobic, strength and combined training on body composition, ICAM-1, VCAM-1, and CRP in sedentary middle-aged men.

Methods

Subjects

This was a quasi-experimental study. Participants were informed of the objectives, procedure, as well as possible risks of training programs and their written information consent. Individuals were selected according to their age, <30 body mass index (BMI), physical health, not attending in exercise training for 6 months before the study, normal state of variables at pretest, lack of a specific diet, medication, and smoking. Exclusion criteria consisted of not participating in more than two training sessions and unwillingness to continue to participate in the study. The primary criteria for evaluating participants' health were to check the physical examination by a physician and review the health questionnaire. None of the participants were affected by chronic autoimmune, systemic, CVD, hepatic, or other diseases which can continuously change the body composition, ICAM-1, VCAM-1, and CRP status. In addition, at the preliminary session, the participants were asked not to change their diet and lifestyle during the 12 weeks. Qualified individuals were randomly assigned into four groups: aerobic (n = 12), strength (n = 12), combined (n = 11), and control (n = 12) groups. Researchers monitored the training sessions and the training sessions were held in the gym equipped with advanced devices.

Aerobic training program

The participants performed the training sessions using a treadmill three times a week (on nonconsecutive days) and 20 min presession (60% of maximum heart rate [HR]) to 60 min (75% of maximum HR). HR was also estimated by Karonen's formula. Furthermore, every session included 10–15 min of stretching and flexibility exercises for warm up and 10–15 min for cool down.

Target HR = ([max HR − resting HR] × % intensity) + resting HR.

Strength training program

Participants were taught the correct techniques before starting the training. The training program began 2 days a week in the 1st month and continued three nonconsecutive days a week. The training intensity was 60% one repetition maximum during the first 2 weeks of training and increased to 75%–80% one repetition maximum. Number of sets was 1–2 sets during the 1st month. The program included 10 strength movements for the lower and upper body muscle groups. Participants performed 3 sets of 8–10 repetitions (90–120 s rest between sets). Special strength exercises include bench press, seated row, shoulder press, chest press, lateral pull-down, abdominal crunches, leg press, leg extension, triceps pushdown, and seated bicep curls. Furthermore, every session included 10–15 min of stretching and flexibility exercises for warm up and 10–15 min for cool down.

Combined training program

Participants performed aerobic training along with strength training 3 days a week. They used treadmill 20–30 min in training sessions and then performed 2 sets of 8 strength movements with 8–10 repetitions. Furthermore, every session included 10–15 min of stretching and flexibility exercises for warm up and 10–15 min for cool down.

Measurement of study variables

Participants' height and weight were recorded using a medical scale with stadiometer (Seca: 220, Germany). To measure body composition, body composition analyzer (Inbody version 3.0 made in South Korea) was used. Participants stand on device with minimum coverage and without any metals and hold device's electrodes. Participants should be smooth and without choking and head toward the front during the measurement. Time performing the measurement was the same for everyone and after at least 3 h of their meals (breakfast). All participants met considerations related to the execution of tests, including emptying bladder and intestines and not eating or drinking before the test. The reliability of the device has been declared between 1 and 0.98 in previous studies. The validity of the device to measure body composition is 98%. Blood samples were collected after 12 h fasting at pretest and 48 h after the last training session at posttest. Blood samples (10 cc) were taken from left hand in sitting position. ICAM-1 and VCAM-1 were assayed by EIA commercial kit (R and D System Co., Abington, UK). Pars Azmoon kit (Pars Azmoon Co., Tehran, Iran) was used to measure CRP levels.

Statistical procedures

Statistical analysis was performed using SPSS for Windows software, version 18 (SPSS Inc., Chicago, IL, USA). Data normality was determined by Kolmogorov–Smirnov test. Paired *t*-test was used for within-group comparison and one-way analysis of variance (ANOVA) was used for between-groups comparison. Tukey's test was used to determine the difference between groups. $P \leq 0.05$ was.

Results

Table 1 indicates the comparison of variables between groups before and after the interference. Findings indicated that body weight in aerobic and combined training had a significant decrease ($P = 0.003$ and $P = 0.006$, respectively). BMI values in aerobic and combined training were significantly lower than ($P = 0.007$ and $P = 0.001$, respectively). Levels of fat percentage were significantly reduced in all three groups ($P = 0.001$, $P = 0.005$, and $P = 0.009$, respectively). Amounts of fat-free mass in strength training and combined training was statistically significant ($P = 0.001$ and $P = 0.001$, respectively).

ICAM-1 levels were only significantly lower in the combined training ($P = 0.004$). VCAM-1 levels were significantly different in strength and combined training in posttest with regard to pretest ($P = 0.006$ and $P = 0.005$, respectively). Finally, CRP levels in only aerobic training were significantly different in posttest compared to pretest ($P = 0.008$).

Comparison of within-group variable changes following 12 weeks is shown in Table 2. The results showed that the amount of body weight, BMI, fat percentage, and fat-free mass were significantly different within the four groups ($P = 0.003$, $P = 0.001$, $P = 0.003$, and $P = 0.001$, respectively).

The results of Tukey's test are presented in Table 3 to compare the significance of ANOVA. Significant differences in body weight between aerobic and strength training ($P = 0.004$), and aerobic and control groups ($P = 0.018$), BMI between strength and combined training ($P = 0.004$) and combined and control groups ($P = 0.001$), body fat percentage between aerobic and control groups ($P = 0.017$) and combined and control groups ($P = 0.004$), and finally fat-free mass between aerobic and strength training ($P = 0.024$), aerobic and combined training ($P = 0.0001$), strength and control groups ($P = 0.035$), and combined and control groups ($P = 0.0001$) were observed.

Discussion

Various studies have indicated that aerobic, strength, and combined training cause small-to-moderate beneficial effects on body composition, ICAM-1, VCAM-1, and CRP in sedentary middle-aged men. Furthermore, few studies have confirmed the beneficial effect of combining aerobic and strength training.

According to the present study findings, body weight in aerobic and combined training decreased significantly in posttest compared to pretest. Furthermore, significant differences in body weight between aerobic and combined compared to strength groups and aerobic compared to combined training were observed after 12 weeks. Donges *et al*. examined the effect of 12 weeks of strength, aerobic, and combined training on body composition of sedentary middle-aged men and observed significant improvements in body weight values.[33] Ferrara *et al.* examined the effects of 6 months of aerobic and strength exercise on middle-aged men, and a significant decrease was observed

Table 1: Comparison of before (pre) and after (post) intervention value of measured variables

Parameter	Test	Aerobic training	Strength training	Combined training	Control group
Age (years)	-	48.16±5.68	49.50±7.63	46.72±4.19	46.50±4.37
Height (cm)	-	175.51±9.72	173.09±8.44	179.78±10.07	175.03±8.43
Body weight (kg)	Pre	72.89±7.99	70.71±8.24	74.75±7.68	74.16±8.77
	Post	67.44±6.32	71.72±8.31	71.73±6.44	74.25±8.72
P		0.003*	0.563	0.006*	0.926
BMI (kg/m²)	Pre	26.54±2.11	24.96±2.11	27.05±2.65	24.50±3.47
	Post	23.55±2.25	24.33±2.29	22.74±2.48	24.37±3.51
P		0.007*	0.244	0.001*	0.832
Body fat (%)	Pre	26.94±3.50	26.38±4.09	27.01±4.26	26.79±3.68
	Post	23.13±3.13	24.64±3.67	22.52±2.84	26.70±4.11
P		0.001*	0.005*	0.009*	0.911
Lean body mass (kg)	Pre	53.53±8.11	56.04±5.25	54.03±7.44	56.30±7.66
	Post	53.48±7.61	61.37±3.49	62.62±4.44	56.52±7.78
P		0.970	0.001*	0.001*	0.717
ICAM-1 (ng/ml)	Pre	209.58±24.87	242.60±30.85	222.19±35.72	237.01±21.38
	Post	203.38±34.16	241.12±25.25	213.29±31.45	242.45±25.54
P		0.283	0.771	0.004*	0.155
VCAM-1 (ng/ml)	Pre	503.69±41.97	583.70±39.98	600.66±49.95	507.08±45.65
	Post	496.10±49.01	565.72±41.88	585.50±50.68	520.16±83.13
P		0.082	0.005*	0.006*	0.580
CRP (mg/dl)	Pre	0.64±0.046	1.01±0.55	0.81±0.20	0.96±0.36
	Post	0.50±0.41	1.05±0.53	0.66±0.27	0.97±0.33
P		0.008*	0.742	0.230	0.870

All results are expressed as mean±SD. *Significant differences between the two stages ($P<0.05$). BMI=Body mass index, ICAM-1=Intercellular adhesion molecule-1, VCAM-1=Vascular cell adhesion molecule-1, CRP=C-reactive protein, SD=Standard deviation

Table 2: Comparison of changes in measured variables following 12 weeks in four groups

Parameter	Aerobic training	Strength training	Combined training	Control group	*P*
Body weight (kg)	5.44±4.88	−1.00±5.82	3.02±2.90	−0.08±3.12	0.003*
BMI (kg/m²)	2.48±2.58	0.63±1.78	4.31±3.12	0.12±1.98	0.001*
Body fat (%)	3.80±1.92	1.74±1.72	4.48±4.56	0.09±2.81	0.003*
Lean body mass (kg)	0.05±4.62	−5.33±4.34	−8.59±5.98	−0.22±2.05	0.001*
ICAM-1 (ng/ml)	6.20±19.02	1.47±17.14	8.89±8.04	−5.43±12.32	0.117
VCAM-1 (ng/ml)	7.58±13.71	17.97±17.64	15.16±14.68	−13.07±79.54	0.286
CRP (mg/dl)	0.14±0.15	−0.04±0.43	0.14±0.38	−0.01±0.24	0.350

All results are expressed as mean±SD. *The significant difference between groups ($P<0.05$). BMI=Body mass index, ICAM-1=Intercellular adhesion molecule-1, VCAM-1=Vascular cell adhesion molecule-1, CRP=C-reactive protein, SD=Standard deviation

in body weight in aerobic and strength exercise groups.[34] To maintain one's ideal body weight, the energy intake needs to be equal to the energy output, which is called energy balance and disturbing energy balance can cause over or under normal weight. It seems that exercising plays a critical role in controlling body weight. It is recommended to consider duration, intensity, and type of exercise training to lose weight.[35] Although both aerobic and combined training exercises resulted in decreased body weight, aerobic training led to better results in losing weight. Possibly, participants' participation in strength and combined training has resulted in increased fat-free mass; however, in aerobic training, only the fat percentage has decreased. Hence, aerobic training has shown better results in improving total body weight compared to other groups participating in the study.

BMI in aerobic and combined training has significantly decreased in posttest compared to pretest. In addition, a significant difference in BMI between aerobic and combined training, aerobic and control groups, and strength and combined training was observed after 12 weeks. Ho *et al*. investigated the effect of combined aerobic and strength training on BMI values in middle-age men and women and observed a significant decrease after 12 weeks.[36] Bijeh *et al*. examined the effects of 6-month aerobic exercise on middle-aged women and observed significant changes in BMI values in these participants.[37] BMI is used to classify individuals based on normal weight, overweight, and obesity worldwide, increases when one grows older, and is associated with sex and ethnicity.[36] Values for BMI are influenced by both body fat percentage and lean body mass, and since body

Table 3: Resulted of Tukey's *post hoc* test for significant analysis of variance

Group	Body weight (kg)	BMI (kg/m^2)	Body fat (%)	Lean body mass (kg)	ICAM-1 (ng/ml)	VCAM-1 (ng/ml)	CRP (mg/dl)
Aerobic							
Strength	0.004*	0.250	0.324	0.024*	0.864	0.931	0.509
Combined	0.553	0.281	0.945	0.001*	972	0.973	1.000
Control	0.018*	0.092	0.017*	0.999	0.237	0.634	0.655
Strength							
Combined	0.141	0.004*	0.129	0.305	0.634	0.999	0.499
Control	0.956	0.955	0.516	0.305*	0.663	0.290	0.995
Combined							
Control	0.339	0.001*	0.004*	0.001*	0.113	0.391	0.641

*The significant difference between groups (P<0.05). BMI=Body mass index, ICAM-1=Intercellular adhesion molecule-1, VCAM-1=Vascular cell adhesion molecule-1, CRP=C-reactive protein

fat percentage decreased significantly in all three groups, lean body mass was also decreased; of course, aerobic and combined training led to better results because of further reduction in BMI values.

Body fat percentage decreased significantly in all three training groups in posttest compared to pretest. The aerobic and control group had a significant difference in body fat percentage after 12 weeks. Donges *et al*. investigated the effect of 12 weeks of strength, aerobic, and combined training on sedentary middle-aged men's body composition and observed significant improvements in the amounts of body fat percentage.[33] Willis *et al*. examined the effect of 3-month aerobic and strength training on the values of body fat percentage in sedentary adult participants and only a significant decrease was observed in combined exercise group.[38] Alteration in body composition is age related and has a strong genetic predisposition. It is also influenced by environmental factors such as nutrition, disease, and physical activity and changes along with age, especially in men. Weight gain has been commonly observed at the age of 20–50 and is accompanied by gains in adipose tissue. During middle-aged individuals, the increase in adipose tissue distribution happens along with an increase in central abdominal sites and a decrease in limbs' fat. Changes in body composition depend on type, intensity, and length of exercise training.[9,39] Participating in exercise training will not only decrease body fat percentage but also can induce favorable effects on health.

Fat-free mass in strength and combined training increased significantly in posttest compared to pretest. Furthermore, significant differences were observed in fat-free mass between aerobic and strength, strength and control, combined and aerobic, and combined and control training after 12 weeks. Willis *et al*. examined the effect of 3-month aerobic and strength training on lean body mass values in sedentary adult participants. They observed a significant increase in the aerobic exercise group, unchanged in strength training, and a significant increase in combined group.[38] Strength training led to more improvements in body composition and had a more appropriate role in improving body composition compared to aerobic training.[33] It seems that combined aerobic and strength training programs have more favorable effects on body composition.

ICAM-1 levels were decreased in all three groups, but only in combined training, it was significantly lowered in posttest compared to pretest. In addition, there was no significant difference between groups. Zoppini *et al*. reported reduced ICAM-1 levels after 6 months of training twice a week.[40] Olson *et al*. investigated the effect of strength training on middle-aged overweight women and did not observe a significant reduction in ICAM-1 levels.[22] Regular exercise prevents the releasing of inflammatory mediators from adipose tissue by reducing sympathetic stimulation and increasing anti-inflammatory cytokine and consequently reduces the concentration of attaching cell molecules.[41] Another mechanism in reducing the inflammatory marker of ICAM-1 might be the antioxidation effect of aerobic training. Oxygen-free radicals cause the increased expression of inflammatory mediators and attaching cell molecules. In addition, studies have shown that the antioxidative defense will improve by exercise training.[42] Exercise training may reduce sICAM-1 levels by improving antioxidative system.

VCAM-1 levels in the strength and combined training were significantly different in posttest compared to pretest. Furthermore, there was no significant difference between groups participating in the study. Rankovic *et al*. examined the effect of aerobic training on VCAM-1 levels in middle-aged individuals and observed a significant decrease. The results are consistent with the results of the present study.[21] Sabatier *et al*. observed a significant decrease in the levels of VCAM-1after 14 weeks of aerobic training in healthy individuals. It has been shown that increased anti-inflammatory cytokine will prevent inflammatory agents release from adipose tissue, resulting in reduced attaching molecules levels. On the other hand, since cortisol acts as a strong anti-inflammatory agent in preventing cytokines secretion and anti-inflammatory mechanisms and since physical training often stimulates cortisol during exercise, perhaps exercise causes cortisol secretion and increases antioxidant capacity.[43] Finally, the mechanism related to these factors is probably the main factor of decreased VCAM-1.

CRP levels in aerobic training decreased significantly in posttest compared to pretest. Furthermore, there was no significant difference between groups participating in the study. Libardi *et al*. investigated the effect of strength, endurance, and combined training on CRP levels in middle-aged men and did not observe statistically significant difference before and after training.[27] Olson *et al*. investigated the effects of strength training in middle-aged women and observed significant improvements in CRP levels. Exercise training has beneficial effects on prevention and treatment of CVD.[22] Exercise training has indirect positive effects on cardiovascular system through a variety of mechanisms such as increased blood volume, decreased viscosity, increased stroke volume, decreased blood pressure, elevated antioxidant defense, and altered blood lipids. On the other hand, according to anti-inflammatory effects of exercise training and its role in reducing inflammatory markers, it can be a suitable solution against inflammatory agents and CVD risk factors. One of the mechanisms of inflammation is producing cytokines such as IL-6 and tumor necrosis factor alpha and consequently increasing CRP values.[27]

Conclusions

Population, sample size, nutrition, lack of physical activity control out of training sessions, and sleep and psychological states were limitations of the present study. The results showed that 12-week workout, 20–60 min/session, and 3 days a week of moderate intensity exercise improves body composition, ICAM-1, VCAM-1, and CRP than those who did not participate in any training. However, all three types of exercises had small benefits on body composition, ICAM-1, VCAM-1, and CRP in sedentary middle-aged men, and the importance of combining these types of training required further investigations. According to the results of this study, combined moderate-intensity exercise is recommended to prevent CVD and improve general health in sedentary middle-aged people. However, further studies are needed to control other mechanisms in various exercises.

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Conflicts of interest

There are no conflicts of interest.

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References

1. Lucero AA, Lambrick DM, Faulkner JA, Fryer S, Tarrant MA, Poudevigne M, *et al.* Modifiable cardiovascular disease risk factors among indigenous populations. Adv Prev Med 2014;2014:547018.
2. Santos-Parker JR, LaRocca TJ, Seals DR. Aerobic exercise and other healthy lifestyle factors that influence vascular aging. Adv Physiol Educ 2014;38:296-307.
3. Terrados N, Valcárcel G, Venta R. New cardiovascular risk factors and physical activity. Apunts Med Esport 2010;45:201-8.
4. Gidding SS. Physical activity, physical fitness, and cardiovascular risk factors in childhood. Am J Lifestyle Med 2007;1:499-505.
5. Hur S, Cho BJ, Kim SR. Comparison of the effects of exercise participation on psychosocial risk factors and cardiovascular disease in women. J Phys Ther Sci 2014;26:1795-8.
6. Gómez-Cabello A, Vicente Rodríguez G, Vila-Maldonado S, Casajús JA, Ara I. Aging and body composition: The sarcopenic obesity in Spain. Nutr Hosp 2012;27:22-30.
7. Zajac A, Wilk M, Socha T, Maszczyk A, Chycki J. Effects of growth hormone and testosterone therapy on aerobic and anaerobic fitness, body composition and lipoprotein profile in middle-aged men. Ann Agric Environ Med 2014;21:156-60.
8. Hayes LD, Grace FM, Sculthorpe N, Herbert P, Ratcliffe JW, Kilduff LP, *et al.* The effects of a formal exercise training programme on salivary hormone concentrations and body composition in previously sedentary aging men. Springerplus 2013;2:18.
9. Randáková R. Effect of regular training on body composition and physical performance in young cross-country skiers: As compared with normal controls. Acta Univ Palacki Olomuc Gymn 2005;35:17-25.
10. Weyer C, Yudkin JS, Stehouwer CD, Schalkwijk CG, Pratley RE, Tataranni PA. Humoral markers of inflammation and endothelial dysfunction in relation to adiposity and *in vivo* insulin action in Pima Indians. Atherosclerosis 2002;161:233-42.
11. Yeh GY, Wang C, Wayne PM, Phillips R. Tai chi exercise for patients with cardiovascular conditions and risk factors: A systematic review. J Cardiopulm Rehabil Prev 2009;29:152-60.
12. Lavie CJ, Milani RV, Ventura HO. Obesity and cardiovascular disease: Risk factor, paradox, and impact of weight loss. J Am Coll Cardiol 2009;53:1925-32.
13. Najjar SS, Scuteri A, Lakatta EG. Arterial aging: Is it an immutable cardiovascular risk factor? Hypertension 2005;46:454-62.
14. Benedini S, Caimi A, Alberti G, Terruzzi I, Dellerma N, La Torre A, *et al.* Increase in homocysteine levels after a half-marathon running: A detrimental metabolic effect of sport? Sport Sci Health 2010;6:35-41.
15. von Känel R, Mausbach BT, Dimsdale JE, Mills PJ, Patterson TL, Ancoli-Israel S, *et al.* Ways of coping and biomarkers of an increased atherothrombotic cardiovascular disease risk in elderly individuals. Cardiovasc Psychiatry Neurol 2012;2012:875876.
16. Karásek D, Vaverková H, Halenka M, Budíková M, Novotný D. Soluble cell adhesion molecules s-VCAM-1 and s-ICAM-1 in subjects with familial combined hyperlipidemia. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub 2005;149:101-8.
17. Pradhan AD, Rifai N, Ridker PM. Soluble intercellular adhesion molecule-1, soluble vascular adhesion molecule-1, and the development of symptomatic peripheral arterial disease in men. Circulation 2002;106:820-5.
18. Petridou A, Chatzinikolaou A, Fatouros I, Mastorakos G, Mitrakou A, Chandrinou H, *et al.* Resistance exercise does not affect the serum concentrations of cell adhesion molecules. Br J Sports Med 2007;41:76-9.
19. Cook MD, Heffernan KS, Ranadive S, Woods JA, Fernhall B. Effect of resistance training on biomarkers of vascular function and oxidative stress in young African-American and Caucasian men. J Hum Hypertens 2013;27:388-92.
20. Sallam N, Laher I. Exercise modulates oxidative stress and inflammation in aging and cardiovascular diseases. Oxid Med Cell Longev 2016;2016:7239639.

21. Rankovic G, Milicic B, Savic T, Dindic B, Mancev Z, Pesic G. Effects of physical exercise on inflammatory parameters and risk for repeated acute coronary syndrome in patients with ischemic heart disease. Vojnosanit Pregl 2009;66:44-8.
22. Olson TP, Dengel DR, Leon AS, Schmitz KH. Changes in inflammatory biomarkers following one-year of moderate resistance training in overweight women. Int J Obes (Lond) 2007;31:996-1003.
23. Windgassen EB, Funtowicz L, Lunsford TN, Harris LA, Mulvagh SL. C-reactive protein and high-sensitivity C-reactive protein: An update for clinicians. Postgrad Med 2011;123:114-9.
24. Wang Q, Hunt SC, Xu Q, Chen YE, Province MA, Eckfeldt JH, *et al.* Association study of CRP gene polymorphisms with serum CRP level and cardiovascular risk in the NHLBI Family Heart Study. Am J Physiol Heart Circ Physiol 2006;291:H2752-7.
25. Martins RA, Veríssimo MT, Coelho e Silva MJ, Cumming SP, Teixeira AM. Effects of aerobic and strength-based training on metabolic health indicators in older adults. Lipids Health Dis 2010;9:76.
26. Campbell KL, Campbell PT, Ulrich CM, Wener M, Alfano CM, Foster-Schubert K, *et al.* No reduction in C-reactive protein following a 12-month randomized controlled trial of exercise in men and women. Cancer Epidemiol Biomarkers Prev 2008;17:1714-8.
27. Libardi CA, De Souza GV, Cavaglieri CR, Madruga VA, Chacon-Mikahil MP. Effect of resistance, endurance, and concurrent training on TNF-a, IL-6, and CRP. Med Sci Sports Exerc 2012;44:50-6.
28. Perez-Gomez J, Vicente-Rodríguez G, Ara Royo I, Martínez-Redondo D, Puzo Foncillas J, Moreno LA, *et al.* Effect of endurance and resistance training on regional fat mass and lipid profile. Nutr Hosp 2013;28:340-6.
29. Esfahani PS, Gharakhanlou R, Karimian J, Khazaei M, Feizi A, Safarzade A. Effect of resistance training on plasma nitric oxide and asymmetric dimethylarginine concentrations in type I diabetic rats. Int J Prev Med 2013;4 Suppl 1:S78-84.
30. Tan S, Li W, Wang J. Effects of six months of combined aerobic and resistance training for elderly patients with a long history of type 2 diabetes. J Sports Sci Med 2012;11:495-501.
31. Short KR, Vittone JL, Bigelow ML, Proctor DN, Nair KS. Age and aerobic exercise training effects on whole body and muscle protein metabolism. Am J Physiol Endocrinol Metab 2004;286:E92-101.
32. Rahmati Najarkolaei FG, Gholami Fesharaki M, Jonaidi Jafari N. Nutrition and physical activity educational intervention on CHD risk factors: A systematic review study. Arch Iran Med 2015;18:51.
33. Donges CE, Duffield R, Guelfi KJ, Smith GC, Adams DR, Edge JA. Comparative effects of single-mode vs. duration-matched concurrent exercise training on body composition, low-grade inflammation, and glucose regulation in sedentary, overweight, middle-aged men. Appl Physiol Nutr Metab 2013;38:779-88.
34. Ferrara CM, Goldberg AP, Ortmeyer HK, Ryan AS. Effects of aerobic and resistive exercise training on glucose disposal and skeletal muscle metabolism in older men. J Gerontol A Biol Sci Med Sci 2006;61:480-7.
35. Donges CE, Duffield R. Effects of resistance or aerobic exercise training on total and regional body composition in sedentary overweight middle-aged adults. Appl Physiol Nutr Metab 2012;37:499-509.
36. Ho SS, Dhaliwal SS, Hills AP, Pal S. The effect of 12 weeks of aerobic, resistance or combination exercise training on cardiovascular risk factors in the overweight and obese in a randomized trial. BMC Public Health 2012;12:704.
37. Bijeh N, Moazami M, Ahmadi A, Samadpour F, Zabihi AR. Effect of 6 months of aerobic exercise training on serum leptin, cortisol, insulin and glucose levels in thin middle-aged women. Kowsar Med J 2011;16:53-9.
38. Willis LH, Slentz CA, Bateman LA, Shields AT, Piner LW, Bales CW, *et al.* Effects of aerobic and/or resistance training on body mass and fat mass in overweight or obese adults. J Appl Physiol 2012;113:1831-7.
39. Bemben MG, Massey BH, Bemben DA, Boileau RA, Misner JE. Age-related variability in body composition methods for assessment of percent fat and fat-free mass in men aged 20-74 years. Age Ageing 1998;27:147-53.
40. Zoppini G, Targher G, Zamboni C, Venturi C, Cacciatori V, Moghetti P, *et al.* Effects of moderate-intensity exercise training on plasma biomarkers of inflammation and endothelial dysfunction in older patients with type 2 diabetes. Nutr Metab Cardiovasc Dis 2006;16:543-9.
41. Ziccardi P, Nappo F, Giugliano G, Esposito K, Marfella R, Cioffi M, *et al.* Reduction of inflammatory cytokine concentrations and improvement of endothelial functions in obese women after weight loss over one year. Circulation 2002;105:804-9.
42. Witkowska AM. Soluble ICAM-1: A marker of vascular inflammation and lifestyle. Cytokine 2005;31:127-34.
43. Sabatier MJ, Schwark EH, Lewis R, Sloan G, Cannon J, McCully K. Femoral artery remodeling after aerobic exercise training without weight loss in women. Dyn Med 2008;7:13.