http://jrhc.miau.ac.ir

Report of Health Care **Original Article**
Volume 3, Issue 3, 2017, p. 71- 80

Effect of Eight Weeks of Aerobic Training with Moqlenjan Supplementation on Lipid Profile and Glycemic Indices of Overweight Men

Ali Yosefi [1], Bahram Abedi [*1], Mansour Sayyah [2]
1. Department of Physical Education, Mahallat Branch, Islamic Azad University, Mahallat, Iran
2. Clinical Research Center, Kashan University of Medical Sciences, Kashan, Iran

Received: 15 May 2017
Accepted: 12 August 2017
Published online: 1September 2017

***Corresponding author:**
Bahram Abedi. Department of Physical Education, Mahallat Branch, Islamic Azad University, Mahallat, Iran

Phone: +98918 8667662
Fax: +98864 325 7554

Email: abedi@iaumahallat.ac.ir

Competing interests: The authors declare that no competing interests exist.

Citation: Yosefi A, Abedi B, Sayyah M. Effect of eight weeks of aerobic training with moqlenjan supplementation on lipid profile and glycemic indices of overweight men. Rep Health Care. 2017; 3 (3): 71- 80.

Abstract

Introduction: Moqlenjan supplement plays an important role in the treatment and prevention of dyslipidemia and diabetes and may increase the benefits of exercise. This study was conducted to examine the effect of aerobic training with Moqlenjan supplementation on lipid profiles and glycemic indices of overweight men.

Methods: In this clinical study, 32 overweight men in the age range of 35 to 45 years old and BMI 26.93±1.3 kg.m-2 were randomly divided into four groups of eight: 1) aerobic training, 2) Moqlenjan supplement, 3) aerobic training along with the Moqlenjan supplementation 4) control. Groups 1 and 3 performed aerobic exercise with 60-80% of maximum heart rate for eight weeks, three sessions per week, and each session for 40 to 50 minutes. Also, groups 1 and 3 consumed two 250 mg tablets per day for eight weeks. Before the start of the study and 48 hours after the last training session, the variables of the research were measured from all the groups. For data analysis, SPSS software version 21 was used for statistical analysis of variance analysis and paired sample t-test. The significance level of the tests was less than 0.05.

Results: Aerobic training, supplementation and aerobic training along with supplementation caused a significant decrease in fat, triglyceride, cholesterol, LDL, and insulin resistance, and a significant increase in HDL ($P \leq 0.05$), but did not change the weight and body mass index ($P > 0.05$). The results also showed that aerobic training along with supplementation has more effect on the above variables than aerobic training and supplement alone.

Conclusion: It seems that aerobic training along with Moqlenjan supplement results in a higher reduction in the percentage of fat, triglyceride, cholesterol, LDL, and insulin resistance, as well as a higher increase in the HDL in comparison with aerobic training exercise and supplementation alone. Therefore, it is recommended that these people use aerobic training with Moqlenjan supplement to lower blood lipids, improve insulin resistance, and prevent diabetes.

Keyword: Moqlenjan, Training, Lipid Profile, Glycemic Indices

Introduction

Industrial development in many countries have led to a sedentary life style, which increases overweight and obesity among all age groups, particularly young men and women, and consequently increases serum lipids, incidence of hypertension, diabetes, obesity, impaired glucose tolerance, and eventually cardiovascular disease (1, 2). According to a recent report from the world health organization, 16.7 million people worldwide die from cardiovascular disease every year (3). According to the center for statistics on cardiovascular Diseases in Iran, the age of cardiovascular disease is 7-10 years less than the other countries in the world (3). The risk factor that contributes to the incidence of

cardiovascular disease is the rise of blood glucose level that on the long run leads to the development of diabetes. The increase in the prevalence of diabetes in the international arena is astonishing, to the extent that the prevalence of this disease in 2000 was 171 million in all age groups and is estimated to reach 439 million cases in 2030 (4). Due to insulin deficiency, carbohydrate metabolism, protein, and lipids are impaired in this disease. As a result, the risk of cardiovascular disease, the main cause of death in type 2 diabetes, is up to four times higher. (5). Therefore, hyperglycemia and hyperlipidemia are one of the most important causes of cardiovascular disease in the world today. Unfortunately, every year it takes millions of lives in the world and imposes many costs on governments, especially families. However, changing inactive lifestyles, drug treatments and oral supplements are solutions that have been studied individually or occasionally in order to control obesity, hyper-cholesterolemia and hyperglycemia, and their complications. Abedi *et al*. (2017) examined the effects of eight weeks of resistance training with supplementation of green tea on lipid profiles and insulin resistance of overweight and obese men. The authors reported that resistance training with the green tea supplement significantly reduced triglyceride, insulin and insulin resistance, and significantly increased high density lipoprotein (HDL), but did not affect the mean of low density lipoprotein (LDL), cholesterol and glucose in the blood. (6). Shahidi *et al.* (2017) also examined the effect of pomegranate oil supplementation during four weeks of resistance training on insulin resistance and lipid peroxidation in non-athlete men and concluded that HDL concentration level in the training with supplementation group significantly increased in post-test condition, but this increase was not statistically significant compared to the placebo-training group. (7). In addition, Nuhu *et al.* (2017) examined the effect of 12 weeks of mini trampoline rebound exercise program on insulin resistance, lipid profile and central obesity in individuals with type 2 diabetes and concluded that the exercise program significantly decreased insulin resistance and lipid profiles (8). Ramazani *et al*. (2016) also examined the effect of eight weeks of endurance, resistance and combination training program on metabolic risk factors of inactive obese children and concluded that exercise programs significantly increased body mass index (BMI), total cholesterol, triglyceride, LDL, very low density lipoprotein (VLDL) and insulin resistance (9). In another research Choi *et al*. (2009) showed that three months of aerobic training and moderate intensity resistance program did not show any significant change in insulin resistance despite a favorable weight loss (10). Lack of unanimity in these findings with regard to the effect of different types of exercise and supplementation on human or animal shows the need for further researches in this area. Commiphora Mukul is one of the most important medicinal plants in traditional medicine (11). There are research results that show this plant decreases fat level (12). In addition, it reduces insulin resistance, increases the activity of the lipoprotein lipase enzyme and reduces the activity of the reductase and nicotinamide adenine dinucleotide phosphate (NADPH) enzymes involved in lipid synthesis. Such properties make the plant a suitable candidate to use to treat diabetes mellitus. (12). In addition, the nature of this plant for its property to stimulate thyroid gland activity and increase body metabolism (13) makes it a topic to be examined in a carefully designed research. The most important ingredient in commiphora mukul is guggul estron with lipid-lowering property that has been shown to be effective in preventing atherosclerosis. The inhibition of free radicals is another property of the plant which is effective as an anti-inflammatory and anti-arthritic drug. Regarding the

fundamental role of free radicals in the development of diabetes, the antioxidant effect of this plant may play a role in the improvement of this disease (14). Reducing gastrointestinal reabsorption by the commiphora mukul plant via antagonizing - bile acid activating genes is another reason for its effectiveness (15). In this regard, due to the complications of treatment of diabetes, especially associated problem involved in the process of metabolic changes that occur in serum glucose and lipid profiles plus the inadequate and uncertain treatment of the disease, there seems to be a demand for efficient therapeutic recommendation that is cost-effective with less complication. Therefore, this study was designed to determine the effect of aerobic exercise with Moqlenjan supplement on lipid and glycemic indices of inactive men.

Methods

This was a double-blind clinical trial using pre-test and post-test design. The subjects of the study were overweight men aged 35 to 45 years old in Khomein city, who had been called upon to obtain permission for participation in the study. The research plan was thoroughly explained to the volunteers and they were informed that they can withdraw at any stage. Then, the participants signed the consent form. Another form was used to record their personal characteristics. A 24-hour dietary recall questionnaire was completed for each subject at the beginning of the study, in the fourth week, and at the end of the study. The inclusion criteria were being overweight, men, aged 35 to 45 with a BMI between 25 and 30 kg/m^2 and being sedentary. Physical activity was measured through an international physical activity questionnaire (IPAQ) questionnaire, which was approved for validity and reliability (16). Exclusion criteria included cardiovascular, musculoskeletal, and all therapeutic interventions affecting laboratory results. After the initial study, 32 subjects were randomly selected and divided into four groups: 1) aerobic training, 2) supplementation, 3) aerobic training + supplementation, and 4) control, based on the criteria for entering the study. Subjects in group two and three received 250 mg capsule Moqlenjan supplement in two tablets after taking any main meal. The Moqlenjan supplement used in this research was the product of Shafa Kordestan Co., made in Iran (licensed under number 0125-91 of the food and drug administration of the ministry of health of the Islamic Republic of Iran). The training protocol consisted of eight weeks aerobic training, three sessions per week, each session for 40 to 50 minutes with intensity 60-80% of maximum heart rate. The aerobic training program was performed in the first week with 60%, the second and third weeks 65%, the fourth and fifth weeks 70%, the sixth and seventh weeks 75%, and the eighth week 80% maximum heart rate (220- age) (17). The height of the subjects was measured with a Stadiometer (model 44440 made by Kaveh Iran Co. with precision of ± 0.1 cm) and the subjects' weight was measured using a digital scale (JS-6537 made in Korea but accurate to ± 0.1 kg). To determine the fat percentage of subjects, firstly, the thickness of subcutaneous fat of three regions (triceps, abdomen and supra) was measured using calipers made in Iran and then calculated using the Jackson and Pollock equation (18). Blood samples were taken at 5 ml of the sialic vein of the subjects 48 hours before the start of the training program and 48 hours after the last training session. triglyceride (TG) plasma was measured by enzymatic calorimetric method and kits of Pars azmoon Co. of Iran (sensitivity of 1 $mg.dl^{-1}$ and coefficient of variation of 1.4%) and cholesterol (CHO) plasma by photometric enzymatic method and kits of Pars azmoon Co. of Iran (sensitivity of 3 $mg.dl^{-1}$ and coefficient of variation 1.5%) and LDL and HDL plasma by enzymatic photometric method and kits of Pars azmoon Co. of Iran (sensitivity of $1mg.dl^{-1}$ and the

coefficient of change was 1.5%). Glucose was measured by the glucose oxidase enzyme method and Hitachi 902 Auto analysis (Germany). Insulin was measured by ELISA method (DRG company kit, Germany, sensitivity 0.5 $UI.m^{-1}$, coefficient of intraocular change 6.45 and extraversion 45.6%). And insulin resistance was measured by the method of homoeostasis assessment (HOMA-IR) based on the concentration of blood glucose ($mg.dl^{-1}$) in insulin concentration (mu.ml-1) Division to 22.5 (19). Data were analyzed by SPSS software version 21 and by paired sample t-test and one-way ANOVA. The significance level of the tests is less than 0.05.

Results

The statistical population of this study was overweight men in Khomeini city. The anthropometric characteristics of the four groups are presented in Table 1. ANOVA test showed that the mean of anthropometric characteristics, lipid profiles and insulin resistance of subjects were not significantly different before intervention (P>0.05). After confirming the difference between the four groups after intervention, according to the pre and post data in each group and the normal distribution of data, paired t-test was used to determine the effectiveness of intervention in each group. The results showed a significant decrease in mean lipid, cholesterol, triglyceride, insulin resistance and significant increase in HDL in aerobic training, supplementation and aerobic training+ supplementation groups (P≤0.05). Tukey's post hoc test showed that there was a significant difference between the aerobic training, supplementation and aerobic training with supplementation groups with the control group (P≤0.05), while there was no significant difference between the three groups the aerobic training, supplementation and aerobic training with supplementation (P>0.05). The findings also showed that the aerobic training plus supplementation has a greater effect on the variables mentioned above than the supplement and exercise alone.

Discussion

This research was designed to examine the effect of eight weeks of aerobic exercise with Moqlenjan supplement on lipid profiles and insulin resistance in overweight men. The results indicated that eight weeks of aerobic training and taking green tea supplementation improved the glycemic index (glucose, insulin, insulin resistance) of overweight men. The results of this study were in agreement with the findings of Abedi *et al.* (2017) (6) Nuhu *et al* (2017) (8) and Marson *et al.* (2016) (20), but did not support the findings of Shahidi *et al.* (2017) (7), Ramezani *et al.* (2016) (9), and Marson *et al*. (2016) (20). Glucose does not leak out freely from plasma membrane; the cellular reception of this nutrient is performed by membrane transporting protein. Glucose transporter type 4 (GLUT-4) is one of the most important protein receptors for the transfer of glucose to fat and muscle tissue, and its key role is to regulate the total body glucose and facilitate the perfusion mechanism. GLUT4 is expressed more often in insulin-sensitive tissues such as skeletal, cardiovascular muscle and white and brown adipose tissue (21). GLUT4 is a protein of 510-509 amino acids with a molecular weight of approximately 55 kilo Daltons in humans, cows, rats, and households. In basic condition, it is often found in intracellular compositions whereas when stimulated through exercise or insulin from intracellular regions, it is transmitted to plasma membrane. Overweight causes fatty acids produced from adipose tissue to accumulate in the muscle cells, disrupt the transfer of GLUT4 to the surface of these cells. Exercise increases the glutamate transferase of GLUT4 to the level of the muscle cells and has beneficial effects in reducing glucose in the blood and improves metabolic control (21).

Table 1. Demographic characteristics of all subject

Variable	group	Measuring time		P1	P2	F
		Pre-test (M±SD)	Post-test (M±SD)	Inter group	Betwe en group	
Age (years)	aerobic training	34.41±3	-	-	-	-
	Moqlenjan	34.91±3.37	-	-		
	Control	34.93±2.89	-	-		
	aerobic training + Moqlenjan	35.29±3.23	-	-		
Height (cm)	aerobic training	179±3.62	-	-	-	-
	Moqlenjan	178.75±5.25	-	-		
	Control	175.52±6.58	-	-		
	aerobic training + Moqlenjan	180.37±4.37	-	-		
Weight (kg)	Moqlenjan	80.14±4.27	81.24±3.27	0.061	0.125	3.78
	aerobic training	82.53±3.18	82.83±2.28	0.071		
	aerobic training + Moqlenjan	82.97±5.30	83.17±3.20	0.085		
	Control	84.44±5.08	85.1±4.78	0.165		
Fat%	Moqlenjan	22.68±2.74	22.03±2.62	0.008*	0.001*	4.01
	aerobic training	21.62±2.78	20.49±2.20	0.002*		
	aerobic training + Moqlenjan	21.56±1.60	20.36±1.47	0.000*		
	Control	24.5±2.20	24.16±2.31	0.171		
BMI (Kg. m^{-2})	Moqlenjan	26.78±1.13	26.78±1.13	0.084	0.157	3.89
	aerobic training	26.66±1.04	27.13±1.14	0.068		
	aerobic training + Moqlenjan	26.84±1.25	27.34±1.25	0.120		
	Control	27.80±1.30	27.22±1.12	0.098		

It has been claimed that regular physical activity not only increases the number of GLUT4 receptors and carriers but also has a beneficiary effect on glucose uptake by muscles. Regular physical activity improves lipid metabolism and glucose uptake through increased insulin sensitivity, increased HDL, decreased Triglyceride (TG) and LDL triglycerides. It seems like a fact that long-term exercise improves glucose transporters to muscle cells (GLUT4) and insulin receptor substrate (IRS) as well as muscle mass. More than 75% of glucose uptake in muscle tissues is attributed to insulin stimulation. This leads body to respond by increasing insulin and insulin sensitivity sensitivity, thus, is useful in preventing obesity and its subsequent complications such as type 2 diabetes (21). In a study conducted by Philippe *et al.* (2016), it was found that after one hour of exercise performed at an intensity of 55% of maximal oxygen consumption, insulin resistance was improved; a finding consistent with the results of the present study (22). However, in some studies contradictory findings were reported (23).

Table 2. The results of paired sample t-test and one way ANOVA tests for compare the lipid profine between and within groups

Variable	group	Measuring time		P1	P2	F
		Pre-test (M±SD)	Post-test (M±SD)	Inter group	Between Group	
Cholesterol ($mg.dl^{-1}$)	Moqlenjan	190.13±12.25	186±9.79	0.006*	0.007*	3.12
	aerobic training	183.63±12.02	177.25±11.65	0.003*		
	aerobic training + Moqlenjan	179.75±11.15	172.63±10.4	0.001*		
	Control	191.75±11.81	192.63±11.46	0.087		
Triglyceride ($mg.dl^{-1}$)	Moqlenjan	133.25±13.92	132.12±14.15	0.026*	0.011*	2.91
	aerobic training	127.5±12.18	125.25±11.51	0.005*		
	aerobic training + Moqlenjan	125.37±12.22	122.5±11.21	0.001*		
	Control	141.5±10.19	141±9.66	0.104		
HDL ($mg.dl^{-1}$)	Moqlenjan	44.50±6.18	45.50±6.45	0.007*	0.042*	2.15
	aerobic training	46.37±6.14	48.75±7.4	0.005*		
	aerobic training + Moqlenjan	52.12±8.35	54.87±9.58	0.002*		
	Control	45.75±6.13	45.05±6.02	0.351		
LDL ($mg.dl^{-1}$)	Moqlenjan	116±12.02	115.25±12.15	0.048*	0.032*	2.16
	aerobic training	110.12±12.48	108.62±13.28	0.009*		
	aerobic training + Moqlenjan	110.25±12.17	108.37±12.58	0.004*		
	Control	123.62±10.88	123.50±10.98	0.685		

The discrepancy of findings may be attributed to factors such as fatigue and damage due to intense exercise on glucose uptake and insulin resistance index, as well as the short duration of exercise or high intensity exercises employed in these researches. In this study, eight weeks of aerobic training plus supplementing Moqlenjan resulted in an increase in HDL levels, a decrease in cholesterol, triglyceride and LDL. These results are consistent with the findings of other researchers including (24-26), whereas, it did not support the findings of (27-29). The result of some studies show that regular physical activity, increases aerobic and physical fitness and improves lifestyle by reducing dietary fat intake, increases high density lipoprotein and reduces harmful fats (30). Claim that exercise rarely has a significant effect on lipid profile unless accompanied by diet, weight loss and consuming some supplements (31). The mechanism of changes in lipoprotein density following exercise is quite complex. Enzymes such as lipoprotein lipase, triglyceride liver lipase and carbohydrate ester of cholesterol play important role in changing the density of high density lipoprotein. Lipoprotein lipase is the most important factor in the development of high density lipoprotein through the hydrolysis of triglyceride.

Table 3. The results of paired sample t-test and one way ANOVA tests for compare the glycemic indices between and within groups

Variable	group	Measuring time		P1	P2	F
		Pre-test (M±SD)	Post-test (M±SD)	Inter group	Between group	
Insulin ($mg.dl^{-1}$)	Moqlenjan	8. 45±0.89	8.38±0.86	0.021*	0.003*	3.61
	aerobic training	8.11±.079	8.04±0.78	0.001*		
	aerobic training +Moqlenjan	7.87±0.6	7.73±0.65	0.008*		
	Control	8.96±0.40	8.97±0.40	0.111		
Glucose ($mg.dl^{-1}$)	Moqlenjan	90.75±9.13	89.87±9.69	0.021*	0.042*	2.16
	aerobic training	87.25±8.06	86±8.06	0.002*		
	aerobic training +Moqlenjan	85.62±4.56	84.25±4.39	0.001*		
	Control	93.87±7.03	94.12±7.01	0.699		
Insulin resistance	Moqlenjan	1.91±0.38	1.88±0.37	0.015*	0.013*	2.97
	aerobic training	1.76±0.36	1.72±0.32	0.001*		
	aerobic training + Moqlenjan	1.66±0.21	1.61±0.21	0.000*		
	Control	2.08±0.24	2.09±0.23	0.60		

However, increased lipoprotein lipase activity is not responsible for the formation of high density lipoprotein following exercise. The increase in concentration of high density lipoprotein immediately after exercise may be due to a decrease in the activity of the proteins involved in the production of cholesterol. Cholesterol carbohydrate proteins are responsible for carrying fats in high density lipoprotein molecules and other lipoproteins and decreases after exercise. The decrease in carbohydrate content of cholesterol ester allows the slowdown of lipoprotein liposome catabolism (increased half-life) and eventually increases the concentration of lipoprotein (29). Therefore, it is expected that with more exercise, supplemental intake at a longer time and more accurate control of nutrition, sleep and rest of the participants, the indicators measured would show a better trend, which was one of the limitations of this study. Also, differences in age, height, physiological and biochemical indices of the samples before and after intervention and between the groups were confounding factors, which were controlled by randomization and statistical tests.

Conclusion

The results of this study indicated that 8 weeks of aerobic training plus Moqlenjan supplementation decreases the health risk of heart associated metabolic diseases. Therefore, it is recommended that overweight and obese individuals to participate in sports programs and use this herbal supplement in consultation with a nutrition expert to avoid or improve

metabolic associated disorders. However, more carefully designed research with larger sample is needed to examine the effect of training with added herbal supplements on serum lipids and glycemic index.

Ethical issues

Not applicable

Authors' contributions

All authors equally contributed to the writing and revision of this paper.

Acknowledgments

This article is a part of the results of the Master of Science degree requirement completed in 2016 with the ethical committee code 20021404941022. The author wishes to thank all the participants who fully cooperated in the completion of the project.

References

1. Harari G, Green MS, Zelber-Sagi S. Estimation and development of 10-and 20-year cardiovascular mortality risk models in an industrial male workers database. Prev Med. 2017; 103: 26- 32.
2. Teo KK, Dokainish H. The emerging epidemic of cardiovascular risk factors and atherosclerotic disease in developing countries. Canadian J Cardiol. 2017; 33 (3): 358- 365.
3. Ghorpade AG, Shrivastava SR, Kar SS, Sarkar S, Majgi SM, Roy G. Estimation of the cardiovascular risk using world health organization/ international society of hypertension (WHO/ISH) risk prediction charts in a rural population of South India. Int J Health Policy Manag. 2015; 4 (8): 531.
4. Rezaeian M, Dehdarinejad A, Esmaili Nadimi A, Tabatabaie S. Geographical epidemiology of deaths due to cardiovascular diseases in counties of Kerman province. Iranian J Epidemiol. 2008; 4 (1): 35- 41.
5. Pandey A, Swift DL, McGuire DK, Ayers CR, Neeland IJ, Blair SN, et al. Metabolic effects of exercise training among fitness nonresponsive patients with type 2 diabetes mellitus: the HART-D study. Diabetes Care. 2015: dc142378.
6. Abedi B, Poorfahkimi Abarghu J, Ghadami A, Amini Rarani S. The effects of resistance training and green tea supplementation on lipid profile and insulin resistance in obese and overweight men. Compl Med J Faculty Nurs Midwifery. 2017; 7 (1): 1767- 1776.
7. Shahidi F, Moonikh K. Effects of pomegranate seed oil followed by resistance exercise on insulin resistance and lipid profile in non-athletic men. Feyz J. 2017; 21 (3): 224- 231.
8. Nuhu JM, Maharaj SS. Influence of a mini-trampoline rebound exercise program on insulin resistance, lipid profile and central obesity in individuals with type 2 diabetes. J Sports Med Phys Fitness. 2017; 58 (4): 503- 509.
9. Ramezani A, Gaeini A, Hosseini M, Mohammadi J. Effect of endurance, strength and combined training on lipid profile, insulin resistance, and serum adiponectin levels in inactive obese children. Armaghane Danesh J. 2016; 21 (7): 641- 654.
10. Choi K, Kim T, Yoo H, Lee K, Cho G, Hwang T, et al. Effect of exercise training on A-FABP, lipocalin-2 and RBP4 levels in obese women. Clin Endocrin. 2009; 70 (4): 569- 574.
11. Jain S. Ethnobotany and research in medicinal plants in India. Ethnobot Search New Drugs. 1994; 185: 153- 168.
12. Choi SH, Zhao ZS, Lee YJ, Kim SK, Kim DJ, Ahn CW, et al. The different mechanisms of insulin sensitizers to prevent type 2 diabetes in OLETF rats. Diabetes Metab Res Rev. 2007; 23 (5): 411- 418.
13. Wang X, Greilberger J, Ledinski G, Kager G, Paigen B, Jürgens G. The

hypolipidemic natural product Commiphora mukul and its component guggulsterone inhibit oxidative modification of LDL. Atherosclerosis. 2004; 172 (2): 239- 246.
14. Mary N, Babu B, Padikkala J. Antiatherogenic effect of Caps HT2, a herbal Ayurvedic medicine formulation. Phytomedicine. 2003; 10 (6/7): 474.
15. Cui J, Huang L, Zhao A, Lew J-L, Yu J, Sahoo S, et al. Guggulsterone is an FXR antagonist in coactivator association assays but acts to enhance transcription of bile salt export pump. J Biol Chem. 2003; 2: 11- 18.
16. Mâsse LC, de Niet JE. Sources of validity evidence needed with self-report measures of physical activity. J Phys Act Health. 2012; 9 (s1): S44- S55.
17. Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee I-M, et al. American college of sports medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med Sci Sports Exe. 2011; 43 (7): 1334- 1359.
18. Matthews DR, Hosker JP, Rudenski AS, Naylor BA, Treacher DF, Turner RC. Homeostasis model assessment: insulin resistance and beta-cell function from fasting plasma glucose and insulin concentrations in man. Diabetologia. 1985; 28 (7): 412- 419.
19. de Groot PCE, Hjeltnes N, Heijboer AC, Stal W, Birkeland K. Effect of training intensity on physical capacity, lipid profile and insulin sensitivity in early rehabilitation of spinal cord injured individuals. Spinal Cord. 2012; 41: 673.
20. Marson EC, Delevatti RS, Prado AK, Netto N, Kruel LF. Effects of aerobic, resistance, and combined exercise training on insulin resistance markers in overweight or obese children and adolescents: A systematic review and meta-analysis. Prev Med. 2016; 93: 211- 218.
21. Yu J, Zheng J, Liu XF, Feng ZL, Zhang XP, Cao LL, et al. Exercise improved lipid metabolism and insulin sensitivity in rats fed a high-fat diet by regulating glucose transporter 4 (GLUT4) and musclin expression. Brazilian J Med Biol Res. 2016; 49 (5): e5129.
22. Philippe M, Krusmann PJ, Mersa L, Eder EM, Gatterer H, Melmer A, et al. Acute effects of concentric and eccentric exercise on glucose metabolism and interleukin-6 concentration in healthy males. Biol Sport. 2016; 33 (2): 153- 158.
23. Philippe M, Junker G, Gatterer H, Melmer A, Burtscher M. Acute effects of concentric and eccentric exercise matched for energy expenditure on glucose metabolism in healthy females: a randomized crossover trial. Springer Plus. 2016; 5 (1): 1455.
24. Posadzki P, AlBedah AM, Khalil MM, AlQaed MS. Complementary and alternative medicine for lowering blood lipid levels: A systematic review of systematic reviews. Compl Ther Med. 2016; 29: 141- 151.
25. Kazeminasab F, Marandi M, Ghaedi K, Esfarjani F, Moshtaghian J. Effects of a 4-week aerobic exercise on lipid profile and expression of LXRalpha in rat liver. Cell J. 2017; 19 (1): 45- 49.
26. Kazeminasab F, Marandi M, Ghaedi K, Esfarjani F, Moshtaghian J. Endurance training enhances LXRalpha gene expression in Wistar male rats. Eur J Appl Physiol. 2013; 113 (9): 2285- 2290.
27. Nybo L, Sundstrup E, Jakobsen MD, Mohr M, Hornstrup T, Simonsen L, et al. High-intensity training versus traditional exercise interventions for promoting health. Med Sci Sports Exerc. 2010; 42 (10): 1951- 1958.
28. O'Donovan G, Owen A, Bird SR, Kearney EM, Nevill AM, Jones DW, et al. Changes

in cardiorespiratory fitness and coronary heart disease risk factors following 24 wk of moderate- or high-intensity exercise of equal energy cost. J Appl Physiol. 2005; 98 (5): 1619- 1625.
29. Wang Y, Xu D. Effects of aerobic exercise on lipids and lipoproteins. Lipids Health Dis. 2017; 16 (1): 132.
30. Engbers MJ, van Hylckama Vlieg A, Rosendaal FR. Venous thrombosis in the elderly: incidence, risk factors and risk groups. JTH. 2010; 8 (10): 2105- 2112.
31. Kraus WE, Houmard JA, Duscha BD, Knetzger KJ, Wharton MB, McCartney JS, et al. Effects of the amount and intensity of exercise on plasma lipoproteins. New England J Med. 2002; 347 (19): 1483- 1492.