Journal of Physical Activity and Hormones
Vol 4, No. 1, Ser. 13 (January 2020), 017-028

CrossFit training improves blood lipid profile in overweight men: A randomized controlled trial

Amin Moghimi Sarani[1]

Received: 18 December 2019 / Accepted: 25 January 2020

(1) MS in Exercise Physiology, Department of Exercise physiology, Marvdasht branch, Islamic Azad University, Marvdasht, Iran. MS in Exercise Physiology, E-mail: Amin88moghimi@gmail.com

Abstract

Introduction: CrossFit is recognized as one of the fastest growing modes of high-intensity functional training. Exercise training is a useful strategy for controlling blood lipid profile. The effect of CrossFit training on blood lipid profile is not well known. Thus, the aim of this study was to investigate the effect of 12 weeks CrossFit training on blood lipid parameters in overweight men.

Material & Methods: Twenty sedentary overweight men (BMI: 28.4 ± 1.4 kg.m^{-2}) participated in this study as the subject. The participants were divided into control (n=10) or CrossFit (n=10) group based on their maximum oxygen uptake randomly. The participants in CrossFit group were performed selected CrossFit training 5 days a week for 12 weeks. Blood samples were collected before and 48h after the intervention.

Results: Date indicated that plasma glucose (96.2±7.1 to 78.5±4.3), total cholesterol (TC) (162.6±11.0 to 139.2±6.3), triglycerides (TG) (98.2±33.4 to 58.4±13.4) and LDL (95.2±5.4 to 69.7±.7) were decreased and plasma HDL was increased (40.7±3.4 to 62.8±3.3) after CrossFit training in compare to the control group (P<0.001).

Conclusions: Data suggested that CrossFit training is a novel and useful strategy for controlling blood lipid levels and blood glycemia.

Keywords: CrossFit, High-intensity training, Blood lipid, Fasting blood glucose

1. Introduction

Obesity and overweight are a direct and indirect cause of serious chronic diseases such as hypertension, diabetes, heart disease, and cancer. Many studies during the past few decades have sought solutions to the problem of obesity. Despite those efforts, however, the prevalence of obesity and overweight has increased in many countries (1). Obesity is a metabolic abnormality characterized by increased levels of plasma free fatty acids and triglycerides, decreased levels of high density lipoprotein (HDL), and abnormal low density lipoprotein (LDL) composition (2). The most significant contributing factor for obesity-related dyslipidemia is likely uncontrolled fatty acid release from adipose tissue, especially visceral adipose tissue, through lipolysis, which causes increased delivery of fatty acids to the liver and synthesis of very low density lipoprotein (VLDL). Increased levels of free fatty acids can decrease mRNA expression or activity of lipoprotein lipase (LPL) in adipose tissue and skeletal muscle, and increased synthesis of VLDL in the liver can inhibit lipolysis of chylomicrons, which promotes hypertriglyceridemia (3).

Recent studies have described several interventions for obesity, including diet, physical activity or exercise, behavioral therapy, and medication. Among the various behavioral strategies, exercise interventions can provide effective weight maintenance, weight loss, weight maintenance after loss, and reduction of obesity (4). Physical inactivity is a state of concern as it leads to major health problems like obesity, hypertension and various metabolic disorders. Exercise is recommended as a therapeutic lifestyle change as it leads to various health benefits. It is also known to bring about changes in lipid parameters (5).

CrossFit is a unique type of high-intensity functional training (HIFT) that combines functional movements and is designed to be constantly varied and have a timed or scored component to each workout (6). This strength and conditioning program is used to optimize physical competence in ten fitness domains: (1) cardiovascular/respiratory endurance, (2) stamina, (3) strength, (4) flexibility, (5) power, (6) speed, (7) coordination, (8) agility, (9) balance, and (10) accuracy (7,8). CrossFit training is usually performed with high-intensity, functional movements called “workout of the day” (WOD) (9). In these training sessions, high-intensity exercises are executed quickly, repetitively, and with little or no recovery time between sets (10). With the focus on constantly varying functional movements, CrossFit training uses the main elements of gymnastics (e.g., handstand and ring exercises), weightlifting exercises (e.g., barbell squats and presses), and cardiovascular activities (e.g., running or rowing) as exercise tasks (11).

Regarding aerobic and resistance exercise as a useful tool for obesity and lipid profile management, most studies agree that both short time exercise and longtime exercise training improve body composition and together with improvements in lipid profile (12-14). However the effects of CrossFit training on obesity and blood lipid profile is not well known. The present study aimed to assess the influence of CrossFit training on blood lipid profile in sedentary and overweight men.

2. Material & Methods

Subjects

20 sedentary and overweight men who subscribed in fitness center for training and body weight control have been recruited to participate to the present study. Inclusion criteria were: (1) To be able to brisk walk without assistance; (2) Without visual or hearing Impairments; to possess a BMI $>$ 25 and who gives a written consent to participate in exercise program and accept all testing protocols. Excluded were those with complicating conditions (i.e., stroke, Parkinson’s disease, renal failure, cardiac failure, pulmonary emphysema, or thyrotoxicosis). Prior

to the study, all participants were given detailed information on the aim of the study, the process of the study and the time of experimentation. A written consent was obtained from every subject. Participants in the present study were not involved in regular physical exercise, but they showed their willingness to begin and finish the all physical program set by the study. Subjects visited physician first, for different examinations purpose. They were examined in terms of health status, history of disease and cardiorespiratory fitness in order to be sure that they can safely participate in the training program. The participants were divided into control (n=10) or CrossFit (n=10) group based on their maximum oxygen uptake randomly.

CrossFit training

Participants completed a total of 60 sessions of CrossFit training (5 days a week for 12 weeks), which lasted up to 45 to 60 minutes in duration. The first two class periods were structured as an introduction to common movements used in CrossFit (e.g., squats, dead lift, press, jerks, barbell, dumbbell, and medicine ball cleans, pull-ups, kettle bell swings, among others). No scheduled workouts were given on days 1 and 2. Beginning on day 3 each CrossFit class consisted of 10-15 minutes of stretching and warm-up, 10-20 minutes of instruction and practicing techniques and movements, and 5-30 minutes for the workout of the day (WOD), performed at vigorous intensity, relative to each person's ability and fitness level. All weights and movements were individually prescribed and recorded for each CrossFit participant. The 12-week training intervention for individuals in the CrossFit group was derived from the multiple week CrossFit programs previously used in other studies (6,15-17).

Ethics Consideration

The ethic committee of the Islamic Azad University, Marvdasht branch approved the study method and protocol. Our research procedure followed the Helsinki Declaration. All participants were assured that their participation was entirely voluntary and that they could withdraw at any time. Qualified subjects were admitted participating to the study upon their written consent.

Anthropometric and body composition measurements

Height and body mass were measured, and body mass index (BMI) was calculated by dividing body mass (kg) by height (m^2). Waist circumference was determined by obtaining the minimum circumference (narrowest part of the torso, above the umbilicus) and the maximum hip circumference while standing with their heels together. The waist to hip ratio (WHR) was calculated by dividing waist by hip circumference (cm). Body fat percentage was assessed by skinfold thickness protocol. Skinfold thickness was measured sequentially, in triceps, abdominal, and suprailiac by the same investigator using a skinfold caliper (Harpenden, HSK-BI, British Indicators, West Sussex, UK) and a standard technique (18).

Measurement of maximum oxygen uptake

Rockport walking test was conducted 48 hours before taking blood sample and 48 hours after last session of aerobic training. VO_{2max} was calculated using the below formula (19):

$$VO_{2max} = 139.68 - (0.388 \times \text{age}) - [0.077 \times \text{body mass (pound)}] - [3.265 \times \text{time (min)}] - [0.156 \times \text{heart rate (bpm)}]$$

Blood samples and laboratory analysis

Fasting blood samples were collected at rest (before training) and after last session of training. All the subjects fasted at least for 14 hours and a fasting blood sample was obtained by venipuncture. Blood samples were kept in the temperature of –20°C. Glucose was determined by the oxidase method. The intra and inter-assay coefficients of variation for glucose were <1.3% and a sensitivity of 1 mg/dl. Serum total cholesterol (TC) and triglycerides (TG) levels were measured by enzymatic kits (Mann Chemical Company) using an auto analyzer. LDL-c and HDL-c were measured by an Auto analyzer using commercial kits (Pars Azema Company, Teheran, Iran).

Statistical analysis

Results were expressed as the mean ± SD and distributions of all variables were assessed for normality. Data were analyzed using independent and paired sample t-test. The level of significance in all statistical analyses was set at $P<0.05$. Data analysis was performed using SPSS software for windows (version 22, SPSS, Inc., Chicago, IL).

3. Results

All data were not significant for normality check. Anthropometric and body composition characteristics of the subjects before and after training are presented in Table 1. Before the intervention, there were no significant differences in any of variables among the two groups. Body mass (P=0.001), BMI (P=0.001) and body fat percent decreased (P=0.001) and VO_{2max} increased (P=0.001) after 12 weeks CrossFit training compared to the control group. For WHR no significant differences were observed in response to CrossFit training (P=0.52).

Table 1. Anthropometric and body composition characteristics (mean ± SD) of the subjects before and after training

	Control		**CrossFit**	
	Pre	**Post**	**Pre**	**Post**
Age	23.9 ± 1.9		25 ± 2.9	
Height (cm)	176.3 ± 4.7		178.3 ± 3.4	
Body mass (kg)	87.7 ± 4.3	88.8 ± 4.1	91.4 ± 4.5	82.3 ± 4.2[ab]
BMI (kg/m^2)	28.1 ± 1.7	28.5 ± 1.2	28.7 ± 1.8	25.8 ± 1.7[ab]
Body fat (%)	26.2 ± 1.9	26.4 ± 1.7	25.7 ± 2.5	20.6 ± 2.6[ab]
WHR	1.03 ± 0.02	1.02 ± 0.02	1.02 ± 0.07	1.02 ± 0.02
VO_{2max} (ml/kg/min)	41.8 ± 2.5	44.1 ± 2.1	41.8 ± 3.4	50.4 ± 3.0[ab]

[a] $P<0.05$ for between-group differences.

[b] $P<0.05$, pretraining *vs.* posttraining values.

Changes of plasma glucose and lipid profile are presented in the Table 2. Date revealed that plasma glucose (t= –5.8, P=0.001), total cholesterol (TC) (t= –7.3, P=0.001), triglycerides (TG) (t= –37.6, P=0.001) and LDL (t= –2.4, P=0.02) were decreased and plasma HDL was increased (t=19.5, P=0.001) after CrossFit training in compare to the control group.

Table 2. Plasma glucose and blood lipid profile of the participants in response to 12 weeks CrossFit training (mean±SD)

Variables		Cross-Fit	Control	Independent sample t-test	P Value
Glucose (mg/dl)					
	Pre	96.2±7.1	94.4±7.2	–5.8	0.001
	post	78.5±4.3	97.1±6.2		
TC (mg/dl)					
	Pre	162.6±11.0	159.2±6.9	–7.3	0.001
	post	139.2±6.3	166.9±10.3		
TG (mg/dl)					
	Pre	98.2±33.4	79.3±32.2	–37.6	0.001
	post	58.4±13.4	88.9±38.7		
LDL (mg/dl)					
	Pre	95.2±5.4	93.3±12.3	–2.4	0.02
	post	69.7±0.7	98.2±3.0		
HDL (mg/dl)					
	Pre	40.7±3.4	41.8±5.1	19.5	0.001
	post	62.8±3.3	35.9±3.0		

4. Discussion

After the completion of the 12 weeks CrossFit training program, blood lipid profile indicators have improved. The results revealed that LDL and HDL improved after the CrossFit training program. What is critical for the good health is not only the rise amount of cholesterol in the blood, but how it is distributed in different lipoprotein fractions is also equally important (20). Raised concentration of plasma LDL and a low concentration of HDL fractions associated with high blood presence are the important risk factors of coronary heart disease (1,3). LDL constitutes the major transport form of cholesterol in the blood, which carry cholesterol from the liver to the various parts of body. An excess of cholesterol gets deposited in the arteries hence LDL is commonly known as bad cholesterol (20).

The present study indicated that LDL decreased after 12 weeks of CrossFit training. According to the previous studies conducted by Ngayimbesha et al. (2019) and Olson and colleagues (2007), LDL and cholesterol are strongly affected by exercise (20,21). In aerobic exercise, fat is used as the main source of energy. The decrease of LDL level in the blood after this training period can be explained by the effect of aerobic exercise on fat. In fact, during this type of physical exercise, fat is continuously broken down to produce energy required by the physical activity (20). Wong et al. (2008) explain that physical activity, especially aerobic exercise increase lipoprotein lipase enzyme activity, and Lecithin Cholesterol Acyltransferase (LCAT) (22). These two enzymes decrease TG, LDL, and TC while increase HDL. In addition, aerobic exercise absorbs TC, decrease LDL, and subsequently prevent cardiovascular disease (23).

In line with the present study, recently Dehghanzadeh Suraki et al. (2021) reported that blood lipid profile improved in response to CrossFit training in overweight people (16). Dehghanzadeh Suraki et al. (2021) found that body weight, BMI, body fat percentage, VO_{2max}, TG, LDL and LDL/HDL ratio significantly improved in twenty-six overweight young men after 4 weeks of CrossFit training; however, WHR, HDL and vLDL were not significantly different between CrossFit and control groups (16).

In literature, other researchers found results different to ours. For example, and Choi et al. (2017) by studied on Korean college students concluded that 14 weeks of supervised CrossFit exercise is effective in modifying body composition; however, it is not effective in modifying blood profiles (24). This difference may be attributed to duration of training different or to difference of participant body constitution. The present study indicated that HDL increased after 12 weeks of CrossFit training. This increase tendency of HDL has also been observed by Singh and Sankhla (2015) (25). This increase in HDL-C may be due to increased enzymatic activity (LPL) of lipoprotein lipase. LPL enzyme effectively converted vLDL to HDL. Increased activity of LPL enzyme increased levels of HDL. Furthermore, Lecithin Cholesterol Acyltransferase (LCAT) converts LDL cholesterol to HDL particles. Increasing this enzyme may be responsible for increasing HDL as a result of exercise (26). Another possible reason for the increase in HDL may be due to increased HDL production by the liver followed by a change in (LPL) enzymatic activity and decrease in hepatic lipase followed by physical activity (20). In the present study results, level of TG in blood lowed after 12 weeks of CrossFit training. Triglycerides are the main source of energy during aerobic exercise, and aerobic exercises are known to increase the enzymatic activity of LPL. This enzyme is involved in fat metabolism. With the increase in this enzyme activity, the uptake of blood TG is also increased. In other word, the increase of LPL as result of aerobic activity decreases TG level in the blood.

The second and main aim of the present study was to determine the influence of CrossFit training on glucose metabolism Obtained results showed that CrossFit training program has positively influenced glucose uptake. Our study results are in accordance with another study result's conducted by Li et al. (2012) (27). Exercise increases insulin-mediated GLUT4 translocation to the sarcolemma and subsequent glucose uptake, which may reflect a transient elevation as a consequence of the "last bout" (28). The underlying increase in GLUT4 transcription and expression of GLUT4 mRNA has been shown to persist for 3 to 24 hours after exercise (29,30). In this way, regular exercise translates into a steady-state increase of GLUT4 protein expression, and subsequent improvement in glucose control over time (29).

5. Conclusion

Data suggested that 12 weeks of CrossFit training is effective in modifying body composition, glucose uptake and blood lipid profile in overweight men.

6. Acknowledgment

The work was supported by grants from the Marvdasht branch, Islamic Azad University. The author gratefully acknowledges the all subjects whom cooperated in this investigation.

References

1. Kim KB, Kim K, Kim C, Kang SJ, Kim HJ, Yoon S, et al. Effects of exercise on the body composition and lipid profile of individuals with obesity: A systematic review and meta-analysis. J Obes Metab Syndr 2019; 28: 278-294.

2. Jung UJ, Choi MS. Obesity and its metabolic complications: The role of adipokines and the relation of obesity, inflammation, insulin resistance, dyslipidemia and non-alcoholic fatty disease. Int J Mol Sci 2014; 15: 6184-6223.
3. Saleh J, Sniderman AD, Cianflone K. Regulation of Plasma fatty acid metabolism. Clin Chim Acta 1999; 286: 163-180.
4. Dietz WH. The effects of physical activity on obesity. Quest 2004; 56:1-11.
5. Kannan U, Vasudevan K, Balasubramaniam K, Yerrabelli D, Shanmugavel K, John NA. Effect of Exercise Intensity on Lipid Profile in Sedentary Obese Adults. J Clin Diagn Res 2014; 8: BC08-BC10.
6. Patel R. The influence of a CrossFit exercise intervention on glucose control in overweight and obese adults. A thesis for the degree of Master of Science 2012; PP: 8.
7. Claudino JG, Gabbett TJ, Bourgeois F, de Sá Souza H, Miranda RC, Bruno Mezêncio, et al. CrossFit overview: Systematic review and meta-analysis. Sports Medicine 2018; 4: 11-25.
8. Glassman G. What is fitness. CrossFit J 2002; 3: 1-11.
9. Glassman G. Understanding CrossFit. CrossFit J 2007; 56: 1-2.
10. Sprey JWC, Ferreira T, de Lima MV, Duarte A, Jorge PB, Santili C. An epidemiological profile of crossfit athletes in Brazil. Orthop J Sport Med 2016; 4: 1-6.
11. Fisker FY, Kildegaard S, Thygesen M, Grosen K, Pfeiffer-Jensen M. Acute tendon changes in intense CrossFit workout: an observational cohort study. Scand J Med Sci Sports 2017; 27: 1258-1262.
12. Nematollahzadeh mahani M. Effect of regular exercise with different intensities on oxidized LDL levels in obese men. J Physic Act Horm 2018; 2: 1-14.
13. Ghasemianpoor J, Nematollahzadeh Mahani M. Effects of short term lifestyle activity modification on lipid profiles in obese and overweight middle aged men with type 2 diabetes. J Physic Act Horm 2017; 1: 1-10.

14. Rafiee P, Rahimi E. The effects of concurrent training with and without branch chain amino acids on lipid profiles and testosterone level of male body-builders. J Physic Act Horm 2017; 1: 63-76.

15. Yüksel O, Gündüz B, Kayhan M. Effect of Crossfit training on jump and strength. J Edu Train Stud 2019; 7:121-124.

16. Dehghanzadeh Suraki R, Mohsenzade M, Tibana RA, Ahmadizad S. Effects of CrossFit training on lipid profiles, body composition and physical fitness in overweight men. Sport Sci Health 2021; in press.

17. Mcweeny D K. The effect of CrossFit vs. resistance training on aerobic, anaerobic, and musculoskeletal fitness. A thesis for the degree of Master of Science 2019.

18. ACSM. ACSM guidelines for exercise testing and prescription. 7th ed. Philadelphia: Lippincott, Williams and Wilkins 2005; 21-30.

19. Robert A, Scott O. Fundamental principles of exercise physiology for fitness, performance, and health. McGraw Hill, USA; 2000.

20. Ngayimbesha A, Bizimana JB, Gakima MS. Effect of eight weeks of exercise training on lipid profile and insulin sensitivity in obese person. Int J Sports Exerc Med 2019, 5: 119-125.

21. Olson TP, Dengel DR, Leon AS, Schmitz KH. Changes in inflammatory biomerkers following one year of moderate resistance training in overweight women. Int J Obes 2007; 31: 996-1003.

22. Wong PC, Chai YH, Tson YH, Darren L. Effects of 8 weeks of exercise training program on aerobic fitness, body composition, blood lipid and C-reactive protein in adolescents with obesity. Ann Acad Med Singapore 2008; 37: 86-93.

23. Wilund KR, Feeney LA, Tomayko EP, Weiss EP, Hagberg JM. Effect of endurance exercise training on markers of cholesterol absorption and synthesis. Physiol Res 2009; 58: 545-552.

24. Choi EJ, So WY, Jeong TT. Effects of the CrossFit exercise data analysis on body composition and blood profiles. Iran J Public Health 2017; 46: 1292-1294.

25. Singh A, Sankhla A. Aerobic exercise improves lipid levels of normal and obese subjects. Int J Pure App Biosci 2015; 3: 265-270.

26. Olivecrona G. Role of lipoprotein lipase in lipid metabolism. Curr Opin Lipidol 2016; 27: 233-241.
27. Li J, Zhang W, Guo Q, Liu X, Zhang Q, Dong R, et al. Duration of exercise as a key determinant of improvement in insulin sensitivity in type 2 diabetes patients. Tohoku J Exp Med 2012; 227: 289-296.
28. Kraniou GN, Cameron-Smith D, Hargreaves M. Acute exercise and GLUT4 expression in human skeletal muscle: influence of exercise intensity. J Appl Physiol (1985) 2006; 101: 934-937.
29. Borghouts LB, Keizer HA. Exercise and insulin sensitivity: a review. Int J Sports Med 2000; 21: 1-12.
30. Richter EA, Hargreaves M. Exercise, GLUT4, and skeletal muscle glucose uptake. Physiol Rev 2013; 93: 993-1017.