Comparison of Combined and Aerobic Training on ABCG1 Lymphocyte Gene Expression in Middle-Aged Men Undergoing Coronary Artery Bypass Grafting

Rokhsareh Moosavi (PhD) Department of Exercise Physiology, Islamic Azad University, Neyshabur Branch, Neyshabur, Iran

Amir Rashidlamir (PhD) Department of Exercise Physiology, Ferdowsi University of Mashhad, Mashhad, Iran

Rambod Khajeie (PhD) Department of Exercise Physiology, Islamic Azad University, Neyshabur Branch, Neyshabur, Iran

Mahmoud Hejazi (PhD) Department of Exercise Physiology, Islamic Azad University, Mashhad Branch, Mashhad, Iran

Corresponding Author: Dr. Rambod Khajeie
Tel: +989379092551
Email: r.khajeie@gmail.com
Address: Islamic Azad University, Neyshabur Branch, Neyshabur, Iran

Received: 2020/05/05
Revised: 2020/02/01
Accepted: 2020/07/05

DOI: 10.29252/mlj.15.2.28

This work is licensed under a Creative Commons Attribution 4.0 License.

ABSTRACT

Background and objectives: Cardiovascular disease is one of the most important causes of mortality worldwide. The present study aimed to compare two different cardiac rehabilitation protocols on ATP-binding cassette sub-family G member 1 (ABCG1) lymphocyte expression and blood lipid profile in middle-aged men undergoing coronary artery bypass grafting.

Methods: Forty five middle-aged men who had previously undergone coronary artery bypass surgery were randomly divided into three groups of control (C; n=15), aerobic training (AT; n=15) and combined training (CT; n=15). Blood samples were taken before the first and after the last exercise sessions. After isolation of mononuclear cells using Ficoll and mRNA purification, gene expression changes were examined by real-time PCR. Data were analyzed using one-way ANOVA and Bonferroni post-hoc tests.

Results: Eight weeks of training intervention resulted in a significant increase in ABCG1 expression as well as a significant decrease in plasma levels of LDL, triglyceride and total cholesterol in both training groups. However, there was no significant difference between the AT and CT groups. In addition, high-density lipoprotein was significantly increased in the AT and CT groups.

Conclusion: Both AT and CT can increase plasma LDL and increase ABCG1 expression and HDL concentrations, indicating the positive effects of both interventions on the prevention of atherosclerosis.

Keywords: Coronary Artery Bypass, Circuit-Based Exercise, ABCG1, Exercise.
INTRODUCTION
Atherosclerosis is a major cause of cardiovascular disease, including myocardial infarction, heart failure and stroke (1). Reverse cholesterol transfer (RCT) is a pathway by which accumulated cholesterol in the vessel walls transfers to the liver for excretion, thereby preventing atherosclerosis. Cholesterol delivery and excretion are regulated by the ATP-binding cassette (ABC) transporters superfamily membrane vectors. The human genome has 48 different ABC vectors, classified into seven ABCA to ABCG groups. ABCG1 belongs to the G index of the ABC transporter family. Animal studies have shown that ABCG1 plays a significant role in cholesterol outflow into high-density lipoprotein (HDL) and RCT. Overexpression of the ABCG1 gene in transgenic mice may have a protective role against lipid accumulation in the liver and lungs (2, 3). Research has shown that ABCG1 is highly expressed in endothelial cells. Partial vector plays a remarkable role in removing cholesterol from endothelial cells and protects against endothelial dysfunction as well as promoting cholesterol flow from endothelial cells to HDL and reduces the amount of existing cholesterol (4). Thus, regulation of RCT by ABCG1 indicates its important physiological role. It has been reported that ABCG1 and ABCA1 can synergistically enhance cellular cholesterol efflux in vitro (5). In addition to clinical interventions, it has been shown that physical activity protects against cardiovascular disease through suppression of sympathetic activity, blood pressure and heart rate, increased blood flow and nitric oxide production, vascular clearance, reduction of inflammatory cytokines and formation of reactive oxygen species (6). Regarding cardiovascular diseases, it has been reported that physical activity significantly increases expression of ABCG5 (7), ABCA1 and ABCG1 (8, 9). In regard to CABG patients, studies have shown a significant increase in ABCG gene expression following an aerobic training (AT) program (10). The role of combined training (CT) on ABCG1 gene expression changes in CABG patients has received little attention. The positive effect of physical activity on ABCG1 gene expression and the improvement of RCT provide a basis for their protective role in the process of atherosclerosis. However, studies comparing the two types of AT and CT protocols on ABCG1 lymphocyte gene expression changes in CABG patients are very limited, and most studies have focused on functional performance of these patients. Thus, the aim of the present study was to compare AT and CT protocols on ABCG1 lymphocyte gene expression and blood lipid profile in middle-aged men undergoing coronary artery bypass surgery.

MATERIALS AND METHODS
This semi-experimental study was performed on middle-aged men (aged 40-60 years) undergoing coronary artery bypass surgery in the Javad Alaemeh Heart Hospital in Mashhad (Iran) in 2018. Blood samples, body measurements and cardiopulmonary fitness were collected before and after the training intervention. The subjects were randomly divided into three groups: AT (n=15), CT (n=15) and control (n=15). A primary clinical evaluation specialist evaluated the severity and extent of heart disease. Subsequently, individuals who had previously undergone coronary artery bypass surgery who were homogeneous in disease level and physically fit to exercise, entered the study. Inclusion criteria were as follows: systolic and diastolic blood pressure of no more than 160 mmHg and 100 mmHg, respectively, cognitive, visual and auditory health, no use of walking aids like canes and walkers, at least two months have passed since their surgery, oxygen uptake of more than five metabolic equivalent of task (11, 12) and age of 40 to 60 years. Exclusion criteria were unstable angina, uncomplicated heart failure, myocardial infarction, ventricular erythema, neurologic medication (13). The study received approval from the Human Subject Committee of Islamic Azad University of Neyshabur (IR.IAU.NEYSHABUR.REC.1397.007). Participants performed AT exercise three days a week for eight weeks. The exercise included treadmill walking (20 to 30 minutes), pedaling on a fixed bike (10 to 12 minutes) and arm ergometer (eight to ten minutes). Stretching exercises were used for warm up at the beginning of the session and for cool down at the end of the exercise session. Exercises began with moderate intensity. In addition to the amount of fatigue and cardiac symptoms,
the duration and intensity of exercise were adjusted at 60% of maximum heart rate. The intensity and duration of exercise gradually increased based on patients’ ability to reach 80% of their maximum heart rate in the last seven to ten sessions (14). In each session of CT, the patients first performed AT and performed simultaneous resistance training after a short rest as described below.

Resistance training consisted of specified exercises that were performed three sessions a week for eight weeks. The training was performed in two sets with 10 repetitions in the initial sessions and up to 15 repetitions in the next training sessions. Exercise included squat with physio ball, shoulder flexion, shoulder abduction, elbow flexion, hip flexion, hip abduction and plantar flexion and dorsiflexion of ankle.

Due to the ability of the participants, the exercises were initially performed without overload and merely by moving the limbs and gradually with a weak thera-band and finally with very light overloads (15). The movements were initially performed with seven repetitions using a light yellow thera-band (set as lower intensities). Then, the number of repetitions were gradually increased to 15 repetitions in the subsequent training sessions.

Blood sampling was performed in two stages, 48 hours before the first training session and 48 hours after the last training session, after 12 hours of overnight fasting. Blood samples (10 ml) were collected in test tubes with EDTA anticoagulant. After isolation of mononuclear cells by ficoll and centrifugation, mRNA was purified using a commercial kit. Quantitative real-time-PCR method was performed to evaluate the relative expression of the gene (16). Enzymatic method was used to measure lipid profile using Pars Azmoon kit (Tehran, Iran).

The mononuclear cells were embedded in liquid nitrogen, completely crushed, homogenized in RLT buffer and frozen for future use.

The lysate was transferred directly to the QIAshredder and centrifuged at high speed for two minutes. The 200 ng mRNA cDNA was synthesized using the Oligo primer (dT) and a kit (St. Leon-Rot Fermantas GmbH, Germany) according to the manufacturer’s instruction.

Real-time PCR was performed to investigate the relative expression of ABCG1 gene (11). The sequence of the primers and beta-actin are shown in table 1.

After confirming the normality of the data distribution by Shapiro–Wilk test, one-way ANOVA and Bonferroni post hoc test were used to examine intergroup and intragroup differences, respectively. All statistical analyses were performed using SPSS software (version 24) and at significance level of 0.05.

RESULTS
Subject’s characteristics are presented in table 2. There were significant main effects of time for ABSCG1 expression (Figure 1). There was a significant difference in ABCG1 lymphocyte gene expression between the AT and C groups (P=0.002) as well as CT and C groups (P=0.001). However, no significant difference was observed between the AT and CT groups (P>0.05). In addition, HDL and LDL levels differed significantly between the CT and C groups and between the C and CT groups (P<0.05).

However, there was no significant difference between the AT and CT groups (P > 0.05).

| Group | Number | Age (year) | Height (cm) | Weight (kg) | Duration of disease (months) |
|-------|--------|------------|-------------|-------------|----------------------------|
| AT    | 15     | 46.9±3.23  | 171.1±3.6   | 80.1±9.12   | 150±68.19                 |
| CT    | 15     | 47.4±3.23  | 170.2±3.5   | 80.1±8.99   | 150±69.01                 |
| C     | 15     | 47.4±2.75  | 170.9±3.9   | 80.1±8.8    | 149±69.12                 |
and muscle strength in CABG patients (19).
However, Ghroubi et al. reported that
resistance training would result in a greater
increase in physical performance compared to
AT (16).
Most of the common atherogenic
abnormalities in humans appear to be due to
damage to the ABC transporters or
suppression of their expression. Diabetes and
other metabolic disorders decrease the
expression of ABC transporters vi
a several
mechanisms, which increases the risk of
cardiovascular disease.
CAD patients are relatively resistant to
interventions designed to increase expression
of ABC cholesterol transporters.
Thus, mechanisms that impair ABC transducers or
affect cellular pathways need to be specifically
and directly targeted therapeutically (20).
One of the important components of RCT is
the ABC transporter family genes by liver-x
receptor. These transporters, notably ABCA1
and ABCG1, are key regulators of cholesterol
and phospholipid removal from macrophage
foam cells (21). However, ABCA1 transduces
these substances into lipid-free lipoproteins,
causing early HDL formation (22).
In a study by Dashtkhaki Lily et al. on ABCG8 alterations in peripheral blood

DISCUSSION
We aimed to compare the effects of AT and
CT protocols on ABCG1 expression in
lymphocytes and blood lipid profile in middle-
aged men undergoing coronary artery bypass
surgery. The results showed that both AT and
CT increased ABCG1 gene expression in
mononuclear cells. Yamamoto et al. (2015)
showed that resistance training increased
muscle strength, exercise capacity and
mobility in middle-aged CAD patients (17).
Gambassi et al. (2019) showed that acute
response of AT in cardiovascular rehabilitation
program after CABG improved cardiac
autonomic control in patients undergoing
CABG (18). Although there has been limited
evidence about the effects of rehabilitation
training programs on CABG patients, there is
no significant consensus on the training
intensity, duration, and even type of
rehabilitation programs. In addition,
researchers have sought to assess different
training protocols such as AT, resistance
training and CT to draw definite
conclusions. The main findings of this study
showed that ABCG1 increased 108% in AT
group and 165% in CT group. In addition,
Gaieni indicated that eight weeks of CT is
more effective than AT in improving
functional capacity (cardiovascular fitness)
mononuclear cells, eight weeks of water-based and land-based resistance training in middle-aged women undergoing CABG induced similar adaptations regarding increments of ABCG8 expression that may indirectly prevent cholesterol accumulation in the coronary arteries (23). In this regard, Rashidelmir et al. (2012) investigated the influence of AT and RT on ABCG1 gene expression in peripheral blood mononuclear cells in female athletes, illustrating that CT could improve RCT and ABCG1 expression in peripheral blood mononuclear cells (20). Based on the results of the present study, both CT and AT improved cardiovascular function. In a previous study, 12 weeks of regular physical activity significantly increased the expression of ABCG1 in blood cells of sedentary obese women (24). Moreover, Ramezani et al. reported that eight weeks of AT could increase ABCG8 and improve RCT in overweight women (25). It has been also shown that ABCA1 and ABCG1 overexpression is associated with increased level of lipoprotein lipase, hepatic lipase, pre-beta HDL and cholesterol acetyltransferase (LCAT), which play important roles in the prevention of cardiovascular disease (11, 20).

ABCG1 is required for HDL to exert a protective effect against LDL. Physical activity and positive regulation of peroxisome activator receptors (PPARs) plays an important role in regulating the expression of genes involved in cellular cholesterol transmission and expression of the ABC transporter family. In addition, PPAR-α activity additionally increases the expression of lipoprotein lipase and apolipoprotein (apo A-I) A-V and simultaneously decreases the expression of llc-apo in the liver. This process is known to be one of the inhibitors of atherosclerosis, which increases the expression of liver X receptor. In this regard, it has been reported that CT significantly increases PPAR after six and twelve months (26). In our study, LDL level decreased by 8.69% in the AT group and by 6.97% in the CT group. The increase in HDL was more profound in the CT group compared to the AT group (12.92% vs 6.18%).

Controlling lipid profile is essential for improving cardiovascular risk factors, which is very important for individuals with CAD. Cholesterol concentration can be reduced by taking fat-lowering drugs, which can reduce risk of mortality following cardiovascular disease (27).

Regarding the effect of AT on reducing atherogenic factors, it can be argued that AT is associated with a decrease in body fat and LDL concentration as well as an increase in HDL. However, both environment and liver tissues and affect the increased activity of LCAT enzyme during short-term or long-term physical activity (28). These changes in lipid profile markers may be related to other mechanisms, including changes in lipoprotein lipase concentrations (29). The reduction of cholesterol biosynthesis decreases the intracellular cholesterol content. In hepatocytes, lowering cholesterol reduces the secretion of lipoproteins containing Apo B and increases the activity of LDL receptors, which both reduce blood LDL levels (30). Increasing the expression of the ABCG8 gene can also reduce the production of Apo-B, which is the main precursor to LDL production (31).

CONCLUSION

Based on the results, CT may result in overexpression of the ABCGI gene via increasing the function of RCT in CABG patients. The results indicate that CT improves RCT function and expression of lymphocyte ABCG1 and reduces plasma LDL concentrations. A limitation of the present study was failure to accurately control the diet of the participants. However, they were instructed to maintain their previous dietary habits. Based on the results, performing AT as well as CT can improve muscle strength, functional capacity, blood pressure and lipid profile in CABG patients (27).

ACKNOWLEDGMENTS

The authors would like to express their gratitude to the Rehabilitation Department of Javad Al-A'meh Heart Hospital and the patients who helped us in this study.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding publication of this article.
References

1. Bagheri R, Darroudi S, Hosseini SM, Nikkar H, Rashidlamir A. Effects of High-Intensity Resistance Training and Aerobic Exercise on Expression of ABCG4, ABCG5 and ABCG8 Genes in Female Athletes. Medical Laboratory Journal. 2020;14(3):40-5. [DOI:10.29252/mlj.14.3.40] [Google Scholar]

2. Out R, Hoekstra M, Hildebrand RB, Kruijt JK, Meurs I, Li Z, et al. Macrophage ABCG1 deletion disrupts lipid homeostasis in alveolar macrophages and moderately influences atherosclerotic lesion development in LDL receptor-deficient mice. Arteriosclerosis, thrombosis, and vascular biology. 2006;26(10):2295-300. [DOI:10.1161/01.ATV.0000237629.29842.4c] [Google Scholar]

3. Wang HH, Patel SB, Carey MC, Wang DQH. Quantifying anomalous intestinal sterol uptake, lymphatic transport, and biliary secretion in Abcg8−/− mice. Hepatology. 2007;45(4):998-1006. [DOI:10.1002/hep.21579] [PubMed] [Google Scholar]

4. Terasaka N, Westerterp M, Koetsveld J, Fernández-Hernando C, Yvan-Charvet L, Wang N, et al. ATP-binding cassette transporter G1 and high-density lipoprotein promote endothelial NO synthesis through a decrease in the interaction of caveolin-1 and endothelial NO synthase. Arteriosclerosis, thrombosis, and vascular biology. 2010;30(11):2219-25. [DOI:10.1161/ATVBAHA.110.213215] [PubMed] [Google Scholar]

5. Gelissen IC, Harris M, Rye K-A, Quinn C, Brown AJ, Kockx M, et al. ABCA1 and ABCG1 synergize to mediate cholesterol export to apoA-I. Arteriosclerosis, thrombosis, and vascular biology. 2006;26(3):534-40. [DOI:10.1161/01.ATV.000020082.58536.e1] [PubMed] [Google Scholar]

6. Tian D, Meng J. Exercise for prevention and relief of cardiovascular disease: prognoses, mechanisms, and approaches. Oxidative Medicine and Cellular Longevity. 2019;2019. [DOI:10.1155/2019/3756750] [Google Scholar]

7. KHAJEI R, HAGHIGHI AH, HAMEDINIYA MR, RASHID LA. Effects of Eight Week Aerobic Training on Monocytes ABCG5 Gene Expression in Middle-Aged Men after Heart Bypass Surgery. 2017. [Google Scholar]

8. HOSEINI SM, DARRUDI S, TALEBI K, RASHIDLAMIR A. EFFECT OF RESISTANCE AND AEROBIC TRAINING ON ABCA1, ABCG1 GENE EXPRESSION, HDL-C AND LDL-C LIPOPROTEIN LEVELS: FEMALE ATHLETES. 2017. [Google Scholar]

9. Haj Ghasemi Alireza RAA, Kurdi Mohammad Reza, Rashid lamir Amir, Gharghi Akhtiar. Investigating the effect of cardiac rehabilitation exercise on the expression of abca1 gene in PBMN cells of patients with cardiac ischemia. Journal of Knowledge and Health. 2016. [Google Scholar]

10. Rashidlamir A, Dastani M, Saadatnia A, Bassami MR. Effect of Cardiac Rehabilitation Training on ABCA1 Expression in Lymphocytes of Patients Undergoing Coronary Artery Bypass Graft Operation. Zahedan Journal of Research in Medical Sciences. 2018;20(6). [DOI:10.5812/zj rms.11277] [Google Scholar]

11. Ghanbari-Niaki A, Rahmati-Ahmadabad S, Zare-Kookandeh N. ABCG8 gene responses to 8 weeks treadmill running with or without Pistacia atlantica (Baneh) extraction in female rats. International journal of endocrinology and metabolism. 2012;10(4):604. [DOI:10.5812/ijem.5305] [PubMed] [Google Scholar]

12. Arthur HM, Gunn E, Thorpe KE, Ginis KM, Matazeje L, McCartney N, et al. Effect of aerobic vs combined aerobic-strength training on 1-year, post-cardiac rehabilitation outcomes in women after a cardiac event. Journal of rehabilitation medicine. 2008;39(9):730-5. [DOI:10.2340/16501977-0122] [PubMed] [Google Scholar]

13. Gayda M, Brun C, Juneau M, Levesque S, Nigam A. Long-term cardiac rehabilitation and exercise training programs improve metabolic parameters in metabolic syndrome patients with and without coronary heart disease. Nutrition, Metabolism and Cardiovascular Diseases. 2008;18(2):142-51. [DOI:10.1016/j.numecd.2006.07.003] [PubMed] [Google Scholar]

14. KHAJEI R, HAGHIGHI AH, HAMEDINIYA M, RASHID LA. THE EFFECT OF EIGHT WEEKS AEROBIC EXERCISE ON THE EXPRESSION OF LIVER MONOCYTE X-RECEPTOR GENE VALUE AND LIPID PROFILE OF MIDDLE-AGED MEN AFTER CARDIAC ARTERY BYPASS GRAFT SURGERY. 2018. [Google Scholar]

15. Pollock ML, Franklin BA, Balady GJ, Chaïm BL, Fleg JL, Fletcher B, et al. Resistance exercise in individuals with and without cardiovascular disease: benefits, rationale, safety, and prescription an advisory from the committee on exercise, rehabilitation, and prevention, council on clinical cardiology, American Heart Association. Circulation. 2000;101(7):828-33. [DOI:10.1161/01.CIR.101.7.828] [PubMed] [Google Scholar]

16. Ghroubi S, Elleuch W, Abid L, Abdenadher M, Kammoun S, Elleuch M. Effects of a low-intensity dynamic-resistance training protocol using an isokinetic dynamometer on muscular strength and aerobic capacity after coronary artery bypass grafting. Annals of physical and rehabilitation medicine. 2013;56(2):85-101. [DOI:10.1016/j.rehab.2012.10.006] [PubMed] [Google Scholar]

17. Yamamoto S, Hotta K, Ota E, Mori R, Matsunaga A. Effects of resistance training on muscle strength, exercise capacity, and mobility in middle-aged and elderly patients with coronary artery disease: a meta-analysis. Journal of Cardiology. 2016;68(2):125-34. [DOI:10.1016/j.j jcc.2015.09.005] [PubMed] [Google Scholar]
18. Gambassi BB, Almeida FdJF, Almeida AEAF, Ribeiro DAF, Gomes RSA, Chaves LFC, et al. Acute Response to Aerobic Exercise on Autonomic Cardiac Control of Patients in Phase III of a Cardiovascular Rehabilitation Program Following Coronary Artery Bypass Grafting. Brazilian journal of cardiovascular surgery. 2019;34(3):305-10. [DOI:10.21470/1678-9741-2019-0030] [PubMed] [Google Scholar]

19. Gaieni A. COMPARISON OF EIGHT WEEKS OF COMBINED AND AEROBIC TRAINING ON FUNCTIONAL CAPACITY, BODY COMPOSITION AND STRENGTH IN POST-CORONARY ARTERY BYPASS GRAFT CARDIAC PATIENTS. 2013. [Google Scholar]

20. Rashidlamar A. Investigation of the effect of aerobic and resistance exercises on peripheral blood mononuclear cells ABCG1 gene expression in female athletes. SSU Journals. 2012;20(1):1-9. [Google Scholar]

21. Li AC, Binder CJ, Gutierrez A, Brown KK, Plotkin CR, Pattison JW, et al. Differential inhibition of macrophage foam-cell formation and atherosclerosis in mice by PPARα, β/δ, and γ. The Journal of clinical investigation. 2004;114(11):1564-76. [DOI:10.1172/JCI18730] [PubMed] [Google Scholar]

22. Butcher LR, Thomas A, Backx K, Roberts A, Webb R, Morris K. Low-intensity exercise exerts beneficial effects on plasma lipids via PPARγ. Medicine & Science in Sports & Exercise. 2008;40(7):1263-70. [DOI:10.1249/MSS.0b013e31816c091d] [PubMed] [Google Scholar]

23. Dashtkhaki Lily Ziauddin RlA, Naqibi Saeed. Changes in ABCG8 gene expression in PBMN cells following eight weeks of water resistance and drought resistance in middle-aged women after coronary artery bypass graft surgery. Journal of Sabzevar University of Medical Sciences. 2017;25.

24. TOFIQHY A. TWELVE WEEKS OF AEROBIC TRAINING EFFECT ON GENE EXPRESSION IN OBSESE SEDENTARY WOMEN ABCG1. 2013.

25. Ramezani Z, Hejazi SM, Rashidlamar A. The Effect of Eight Weeks Aerobic Exercising on the Atheroogenic Ratio and ABCG8 Gene Expression in PBMC Globules of Overweight Women. Iranian Journal of Diabetes and Obesity. 2017;9(3):95-100. [Google Scholar]

26. Fatone C, Guescini M, Balducci S, Battistoni S, Settequattrini A, Pippi R, et al. Two weekly sessions of combined aerobic and resistance exercise are sufficient to provide beneficial effects in subjects with Type 2 diabetes mellitus and metabolic syndrome. Journal of endocrinological investigation. 2010;33(7):489-95. [DOI:10.1007/BF03346630] [PubMed] [Google Scholar]

27. Afzal Aghaei Ehsan HMR, Attarbashi Moghadam Behrooz, Tavakol Kamran, Zandparsa Amir Farhang, Jalaei Shohreh, Abdollahi Alireza, Mousavi Shiva. Investigating the effect of cardiac rehabilitation on changes in blood lipid profile of Iranian men and women with coronary artery disease referred to the cardiac rehabilitation department of Imam Khomeini Hospital. New rehabilitation. 2010;4:45-9. [Google Scholar]

28. Ghanbari Niaki Abbas FR, Ramroodi Soghra. Effect of 8 weeks of endurance training with different periods on total HDL, HDL2 and HDL3 plasma rest levels in male rats. Sports and move Biological Sciences. 2011;10:27-36.

29. Tamalis K, Panagiotakos DB, Kavouras SA, Sidossis LS. Responses of blood lipids to aerobic, resistance, and combined aerobic with resistance exercise training: a systematic review of current evidence. Angiology. 2009;60(5):614-32. [DOI:10.1177/0003319708324927] [PubMed] [Google Scholar]

30. Kajinami K, Brousseau ME, Nartsupha C, Ordovas JM, Schaefer EJ. ATP binding cassette transporter G5 and G8 genotypes and plasma lipoprotein levels before and after treatment with atorvastatin. Journal of lipid research. 2004;45(4):653-6. [DOI:10.1194/jlr.M300278-JLR200] [PubMed] [Google Scholar]

31. Chan D, Watts G, Barrett P, Whitfield A, Van Bockxmeer F. ATP-binding cassette transporter G8 gene as a determinant of apolipoprotein B-100 kinetics in overweight men. Arteriosclerosis, thrombosis, and vascular biology. 2004;24(11):2188-91. [DOI:10.1161/01.ATV.0000143522.93729.d6] [PubMed] [Google Scholar]

How to Cite:
Moosavi R, Rashidlamar A, Khajeie R, Hejazi MJ[Comparison of Combined and Aerobic Training on ABCG1 Lymphocyte Gene Expression in Middle-Aged Men Undergoing Coronary Artery Bypass Grafting]. mljgoums. 2021; 15(2): 28-34 DOI: 10.29252/mlj.15.2.28
© The authors