JOURNAL OF NUTRITION FASTING AND HEALTH

The Impact of High-Intensity Interval Training with Physical Fitness Course Using Royal Jelly Supplementation on Lipid Profile in Overweight and Obese Middle-Aged Men

Hassan Hazrati Nejad[1], Ali Khajehlandi[1*], Amin Mohammadi[1]

1. Department of Physical Education and Sports Science, Gachsaran Branch, Islamic Azad University, Gachsaran, Iran

ARTICLEINFO

Article type:
Research Paper

Article History:
Received: 12 Feb 2022
Accepted: 13 Mar 2022
Published: 20 May 2022

Keywords:
Royal Jelly
High intensity interval training
Lipid profile
Obesity

ABSTRACT

Introduction: Royal jelly contains large amounts of phenolic compounds from the flavonoid family, which can improve the lipid profile with exercise. This study aimed to study the effect of high intensity interval training (HIIT) using royal jelly consumption on triglyceride (TG), total cholesterol (TC), high-density lipoprotein (HDL), and low-density lipoprotein (LDL) in overweight and obese middle-aged men.

Methods: This study was conducted on 60 middle-aged men, who were randomly divided into four groups: 1) control + Placebo, 2) training, 3) royal jelly supplementation, and 4) training + royal jelly supplementation. The subjects of training and training + royal jelly supplementation groups performed the training protocol. The HIIT protocol was implemented for eight weeks with high intensity of 85-95% of the maximum heart rate, and active rest periods included 60-70% of the maximum heart rate. The participants in the royal jelly supplementation groups received a 1000 mg capsule once a day. The SPSS software version 22, one-way ANOVA, and Tukey's *post hoc* tests were utilized to perform intergroup data analysis, and a dependent sample t-test was used to carry out intra-group data analysis at a significance level as much as $P \leq 0.05$.

Results: LDL, TC, and TG serum levels were reduced and HDL was increased in HIIT training, consumption of royal jelly, and training + royal jelly supplementation in overweight and obese middle-aged men ($p \leq 0.05$).

Conclusion: According to the results, HIIT combined with royal jelly supplementation could improve lipid profile in obese or overweight people prone to cardiovascular disease and various types of diabetes.

► Please cite this paper as:
Hazrati Nejad H, Khajehlandi A, Mohammadi A. The Impact of High-Intensity Interval Training with Physical Fitness Course Using Royal Jelly Supplementation on Lipid Profile in Overweight and Obese Middle-Aged Men. J Nutr Fast Health. 2022; 10(2): 103-109. DOI: 10.22038/JNFH.2022.62978.1373.

Introduction

Globally, being overweight and obese is a significant public health concern, which puts a heavy financial burden on different communities. There were nearly 2 billion adults over 18 in 2016, and among them, 39 and 40% were obese. In other words, 11% of men and 15% of women, i.e., more than half a billion people, were obese worldwide. The rate of overweight and obesity has increased over the past 40 years [1]. Obesity is a complex, multifaceted disease, whose rate has been estimated to be doubled since 1980 worldwide, so approximately one-third of the world's population is now overweight or obese. The obesity rate has increased among all ages and genders, regardless of geographical location, ethnicity, or socioeconomic status. However, the prevalence of obesity is much higher in older people [2].

According to epidemiological data, heart and blood-related disease (CVD) is the primary cause of mortality and morbidity. People who develop CVD experience severe suffering and a decline in their quality of life, placing a heavy economic burden on their families and communities [3, 4]. Triglycerides, cholesterol, and related lipoproteins are the main components of human body fat, playing essential physiological roles including cell membrane stability, energy storage, hormone and bile acid synthesis, uptake and assembly of dietary fats, stress response, total cellular signaling, and calcium metabolism [5, 6]. Lipid metabolism disorders may result in several metabolic disorders, including instances of cardiovascular disease [7]. Plasma levels of

* *Corresponding author:* Ali Khajehlandi, Department of Physical Education and Sports Science, Gachsaran Branch, Islamic Azad University, Gachsaran, Iran. Tel: +987432335909, Email: Ali.Khajehlandi@iau.ac.ir.

total cholesterol (TC), low-density lipoprotein (LDL), and triglycerides (TG) increase the risk of cardiovascular disease, while high concentrations of high-density lipoprotein (HDL) can have a protective effect [8]. The reverse cholesterol transport process in which excess cholesterol from peripheral cells is transported and removed in the liver is one of HDL's most essential functions. Numerous epidemiological studies have clearly indicated that high concentrations of plasma HDL are associated with a lower risk of CVD. Therefore, increasing HDL levels is considered a promising treatment strategy [9].

High intensity interval training (HIIT) has recently become popular among cardiovascular patients, defined by performing high-intensity workouts, as well as active or inactive rest intervals with spending less time than traditional endurance exercises [10,11]. Keating et al. (2014) found that three months of HIIT had no significant effect on body fat in overweight adults [12]. In contrast, Gillen et al. (2013) concluded that the HIIT course for six weeks improved body composition in obese adults [13].

Although HIIT is performed with different intensities, durations, and frequencies, its effect has not yet been well established on obesity, weight, and serum levels of lipid profile factors (TG, TC, LDL, and HDL). Royal jelly supplementation can improve lipid profile factors, a good treatment for obese people prone to cardiovascular disease. The following study is conducted to evaluate the effect of training exercises and specifically high intensity interval training using royal jelly supplementation on some major cardiovascular causes (triglycerides (TG), total cholesterol (TC), high-density lipoprotein (HDL), and low-density lipoprotein (LDL) in overweight and obese middle-aged men.

Materials and Method

This quasi-experimental study was conducted with four groups (one control group and three experimental groups). First, the researcher made an announcement to identify and invite the overweight and obese middle-aged men in Gachsaran who wanted to work out to improve their weight and physiological conditions.

The inclusion criteria were being male in an age range of 40-55 years, and the exclusion criteria were suffering chronic diseases, smoking in the past six months, and exercising regularly in the past six months.

In the next step, individuals were invited for initial examinations, among whom 60 people were selected who were physically and mentally healthy based on the general health questionnaire results and clinical symptoms by a physician. Then, the subjects were randomly assigned to four groups, including 1) control (C), 2) training (C), 3) royal jelly supplementation (RJ), and 4) training + royal jelly supplementation (T+RJ).

Subjects in the experimental groups of T and T + RJ supplementation groups performed the training protocol, and the C group continued their daily activities without intervention. A briefing session was held initially in which the research conditions, including benefits and potential risks, were explained. The necessary recommendations were made for each subject, and an informed consent was obtained to participate in all research stages. During this study, the subjects were asked not to participate in out-of-the-protocol activities and inform the researcher in case of lifestyle change. The subjects were also asked to follow their usual diet under the pre-program research. In addition, subjects were prohibited from taking any supplements, medications, or diet. Initial assessments of height, weight, and body environment in the experimental conditions were conducted before starting the program.

The high-intensity interval training protocol included four 4-minute intervals with 85-95% of the maximum heart rate (HR_{max}) and 3-minute bouts of active rest with 60-70% of the maximum heart rate (HR_{max}). The subjects started the training with 85% of the maximum heart rate (HR_{max}) and improving the subjects' preparation by adding 5% to the intensity of training every week. Following the subjects' attaining 95% of the maximum heart rate, the training condition was kept constant until the end of the protocol.

In each session, warming up and cooling down were performed similarly for both T groups and included 15 minutes of mild aerobic activity with static and dynamic stretching. The subjects' maximum heart rate was calculated by the formula (220 – age) [14, 15], who took a 1000 mg capsule (Royall jelly Sofgel, Defenvit OPD Pharma) once daily with a fixed diet for eight weeks in the royal jelly supplementation groups.

Moreover, the control group used a capsule containing starch powder [16].

Blood sampling was performed in two stages. The first stage was performed at the training site by taking 8 cc of the blood sample 48 hours before starting the training program at 8-9:00 a.m., following approximately 10 hours of overnight fasting. The second stage of blood sampling was performed 48 hours after the last training session in the intervention groups with the same conditions as the initial test. The subjects were prevented from participating in case of symptoms such as dizziness, fever, nausea, and absence of more than two sessions.

Kolmogorov-Smirnov test (KS) was used to determine the normality of research data distribution.

Given the normality of data distribution in the variables, one-way ANOVA and Tukey's *post hoc* tests were run to examine the intergroup analysis of data, and dependent samples t-test was carried out to examine the intragroup analysis of data. In addition, SPSS software Version 22 was used to perform data analysis. The significance level of the statistical analysis of the present study was considered as much as P ≤0.05.

Results

Table 1 presents the mean and standard deviation for weight in the study groups. The results of dependent sample t-test showed no significant difference in the pre-test and post-test levels of LDL (P =0.83), HDL (P =0.96), TC (P =0.53), and TG (P =0.80) in the C group. However, posttest levels of LDL (P =0.001), HDL (P =0.001) ,TC (P =0.001), and TG (P =0.005) in the JR group, as well as LDL (P =0.001), HDL (P =0.001) , TC (P =0.001), TG (P =0.001) in the T group, and posttest levels of LDL (P =0.0001), HDL (P =0.0001), TC (P =0.0001), TG (P =0.0001) in the T+JR group were significantly different (Figures 1-4).

Table 1. The mean and standard deviation of weight in the pre-test and post-test of the research groups

Group	Weight (kg) Pretest	Weight (kg) Posttest
C	90.16 ± 2.75	90.42 ± 3.09
RJ	90.83 ± 2.48	88.91 ± 2.28¶ €
T	91.41 ± 2.55	88.83 ± 2.55 ¥*
T+RJ	91.33 ± 2.60	88.25 ± 3.26 ¥*

* Significant decrease compared to the pre-test (p < 0.001).
€ Significant decrease compared to the pre-test (p < 0.01).
¥ Significant decrease compared to the C group (p < 0.001).
¶ Significant decrease compared to the C group (p < 0.01).

The one-way ANOVA results marked some significant differences in LDL (P =0.001, F=6.72), HDL (P =0.001, F=8.33), TC (P =0.001, F=11.76), and TG (P =0.001, F=11.35) in the study groups.

The post hoc test findings revealed that LDL blood levels in the JR (P = 0.025), T (P = 0.012), and T + JR (P = 0.001) groups were statistically lower than group C. LDL blood levels in the T + JR group (P = 0.040) were significantly lower than the JR group (0.044) (Figure 1).

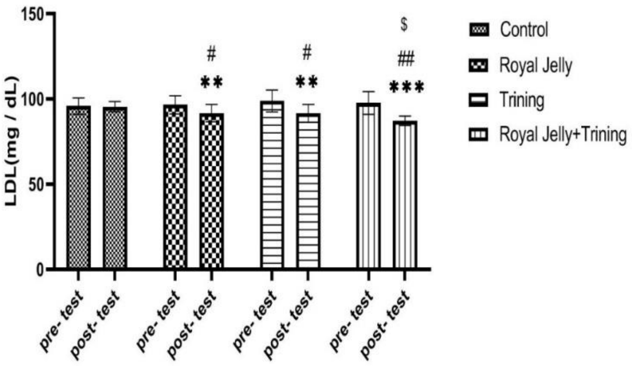

Figure 1. Mean and standard deviation of low-density-lipoprotein (mg / dL)
(P = 0<001) ; *(P = 0<0001)Significant decrease compared to the pre-test
#(P < 0.01) ; ##(P < 0.001) Significant difference compared to the C group in the post-test.
$ (P < 0.01) Significant difference compared to the RJ supplementation group in the post-test.

Furthermore, post hoc test results showed that HDL blood levels in the JR (P = 0.003), T (P = 0.002), and T + JR (P = 0.001) groups increased significantly compared to group C. There was no significant difference in the blood levels of HDL in the T + JR (P =0.905), JR, T (P = 0.925), and group T (Figure 2).

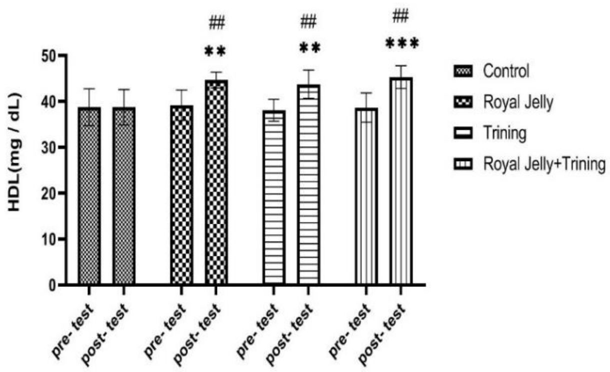

Figure 2. Mean and standard deviation of high-density lipoprotein (mg / dL)
(P = 0<001) ; *(P = 0<0001)Significant decrease compared to the pre-test
##(P < 0.001) Significant difference compared to the C group in the post-test.

The results of the Tukey's post hoc test revealed that the blood levels of TC in the JR (p=0.030), T (p=0.001), and T + JR (p = 0.001) groups were significantly much lower than group C. The levels of TC blood in the T + JR group (p = 0.028) were significantly different from the JR groups (Figure 3).

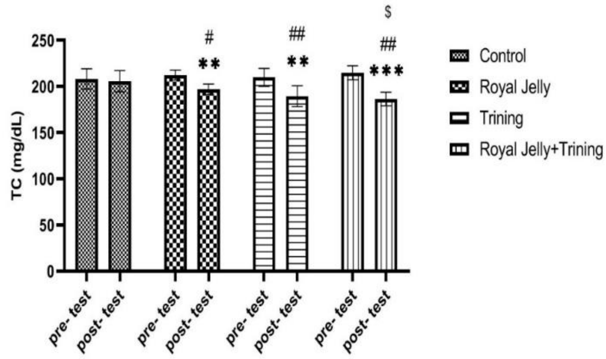

Figure 3. Mean and standard deviation of total cholesterol (mg / dL)
(P = 0<001) ; *(P = 0<0001)Significant decrease compared to the pre-test
#(P < 0.01) ; ##(P < 0.001) Significant difference compared to the C group in the post-test.
$ (P < 0.01) Significant difference compared to the RJ supplementation group in the post-test.

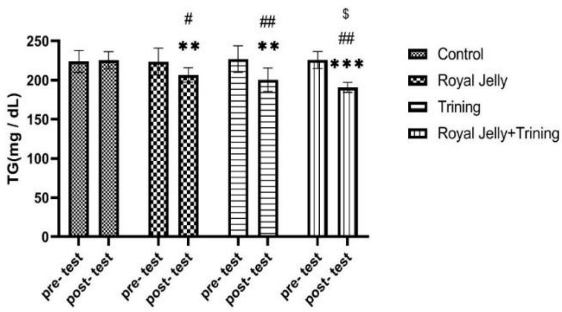

Figure 4. Mean and standard deviation of triglyceride (mg / dL)
(P = 0<001) ; *(P = 0<0001)Significant decrease compared to the pre-test
#(P < 0.01) ; ##(P < 0.001) Significant difference compared to the C group in the post-test.
$ (P < 0.01) Significant difference compared to the RJ supplementation group in the post-test.

The results of the Tukey post hoc test showed that the blood levels of TG in the JR ($p = 0.034$), A ($p = 0.001$), and A + S ($p = 0.001$) group were significantly lower than group C. The levels of blood TG on the T + JR ($p=0.044$) group differ significantly from that of JR group (Figure 4).

Discussion

Our findings revealed a noticeable reduction in the subjects' weight regarding the pre-test and post-test in the RJ supplementation, training, and T + RJ supplementation groups.

In contrast, LDL, TG, and TC levels significantly decreased between post-test groups and pre-test/post-test groups. In contrast, HDL levels significantly increased between post-test and pre-test/post-test groups alike.

Proper physical activity is one of the least expensive ways to maintain health and prevent non-contagious diseases like high blood pressure and cardiovascular disease. Sports experts and physiologists have proven that appropriate physical activity can promote human health, vitality, and vigor [17]. In this regard, Khammassi et al. (2018) studied the effect of four months of high-intensity training, excluding the calorie restriction on body composition and lipid profile in overweight/obese youth. The HIIT protocol included three sessions of training per week (30 seconds of work at maximum speed) consisting of 30 seconds of recovery. The results revealed a significant reduction in TC and TG levels, while LDL/HDL levels remained unchanged [18].

The results of Khammassi et al. (2018) were consistent to ours concerning TC and TG levels because both studies showed a decrease in levels of some markers. However, the results of these two studies are opposite in terms of LDL and HDL levels because in the present study, LDL levels decreased and HDL levels increased, while in Khammassi et al. (2018), both remained unchanged. The training protocol of both studies was HIIT, but the training time of Khammassi et al.'s study was four weeks longer than the present study.

Another difference between the two studies was the age and type of subjects. Although the subjects were overweight and obese in both studies, only middle-aged people were selected in the present study, while young ones were only studied by Khammassi et al. (2018).

One of the main characteristics of HIIT is the intensity of training, which can change many physiological factors in the human body. In this regard, Kannan et al. (2014) investigated the role of intensity training on lipid profile (LDL, HDL, and TG levels) in inactive older adults. The subjects performed moderate-intensity training on the treadmill for 40 minutes 5 days a week with high-intensity training for 20 minutes a day for three days a week for 15 weeks. The results indicated that moderate and high-intensity training significantly effected lipid profile, reduced LDL/TG levels, and increased HDL levels [19].

The intensity of HIIT can be a significant factor affecting lipid profile levels. Kannan et al. (2014) and the present study revealed that HIIT could significantly reduce LDL/TG and increase HDL

Factors such as duration of the training period, characteristics and principles of training, type of subjects, as well as type, intensity, and duration of the training in each session can change lipid profile levels as a reason for conflicting research results.

Other research studies have found that aerobic, resistance or combined training can modulate LDL, TC, and TG levels and improve HDL levels. In this regard, Dianatinasab et al. (2020) investigated the role of aerobics, resistance, and combined training on LDL, HDL, TC, and TG levels in women. Aerobic training included stretching, walking, and running on a treadmill and stationary bike. Resistance training included bodybuilding exercises. Aerobic, resistance training, and combined training led to significant reductions in weight, LDL, TC, and TG levels. HDL levels significantly increased only in the combined T group [20].

The results of Dianatinasab et al. (2020) were not consistent to those of the present study. Both results showed a significant decrease in LDL, TC, and TG levels and increase in HDL levels. Hence, the results can improve the lipid profile when the intensity, duration, and other factors regarding training principles are considered appropriate in training programs.

In this study, the effect of RJ supplementation and HIIT on lipid profile were also examined.

According to findings, taking RJ supplementation like exercise can improve lipid profile levels, and the best results are obtained when taking RJ supplementation is used concurrently with exercise. In line with the effectiveness of RJ supplementation, a study showed that RJ consumption significantly reduces the TC, TG, and LDL levels in the blood serum of diabetic rats. In addition, it was shown that HDL levels increased significantly following RJ supplementation. The researchers suggested that RJ can be used to C and reduce the complications of diabetes and cardiovascular disease. The hypoglycemic and hypolipidemic effects of RJ are probably due to various antioxidants in it [21].

Saritas et al. (2011) investigated the effect of different levels of RJ supplementation on biochemical parameters in swimmers. Participants practiced swimming 20 km in 2 hours, five days a week for four weeks. No significant change was detected in LDL, HDL, TC, and TG levels [22].

The results of Saritas et al. (2011) were not aligned to those ours. In the current study, in TC, TG, and LDL levels decreased in the blood serum of overweight or obese subjects following HIIT/RJ supplementation. On the contrary, in Saritas et al. (2011), exercise training and RJ supplementation could not make a change in the lipid profile levels. The first important factor was the type of exercise activity, which was HIIT on a treadmill in the present study and swimming training in Saritas et al. c. Another important factor was the type of subjects and the training duration.

The current study was conducted on overweight and obese people for eight weeks, while Saritas et al. (2011) was performed on swimmers for four weeks. RJ contained large amounts of phenolic compounds from the flavonoid family, the most important of which were quercetin, camphor, apigenin, and luteolin [23]. Flavonoids regulate carbohydrate and lipid metabolism and reduce hyperglycemia, dyslipidemia, and insulin resistance, and reduce levels of oxidative stress and inflammatory responses.

Flavonoids, especially quercetin played a role in weight regulation and prevent weight loss in people with conditions such as diabetes [24, 25]. Research has shown that taking RJ supplementation can be an effective solution to overweight, high blood sugar, and hepatic steatosis by enhancing metabolic thermogenesis in rats' brown adipose tissues. The researchers suggested that RJ supplementation may be a promising new nutrient in the fight against obesity and metabolic disorders [26]. Therefore, taking RJ supplementation can increase the metabolism of brown adipose tissue by converting white adipose tissue to this tissue to improve the lipid profile in obese people. Eventually, eight weeks of HIIT regulated the lipid profile in overweight and obese men, which meant that HIIT could be prescribed for these people as a great way to regulate weight and improve their lipid profile. In the current study, the small size of the sample could be regarded as a limitation. Therefore, working on a bigger sample size can increase the reliability of the findings in the related studies. The lack of complete diet monitoring throughout the study is another setback. It should be noted that some other non-athletic physical tasks were not fully observed. Therefore, an analogous study is recommended to fully observe the participants' diet control and physical activity. A meticulous study should examine and explain the mechanisms in the variables studied as well as the results obtained.

Conclusion

The present study results showed that RJ supplementation could improve lipid profiles, like HIIT. In addition, taking this jelly and HIIT could be more effective for obese people.

Conflicts of Interest

The authors declared no conflict of interest.

Acknowledgments

The researchers appreciate the spiritual assistance of the Department of research of this university.

References

1. Semlitsch T, Stigler FL, Jeitler K, Horvath K, Siebenhofer A. Management of overweight and obesity in primary care - A systematic overview of international evidence-based guidelines. Obes Rev. 2019; 20(9):1218-30.

2. Chooi YC, Ding C, Magkos F. The epidemiology of obesity. Metabolism. 2019; 92:6-10.

3. Niiranen TJ, Vasan RS. Epidemiology of cardiovascular disease: recent novel outlooks on risk factors and clinical approaches. Expert Rev Cardiovasc Ther. 2016; 14(7):855-69.

4. Ahluwalia A, Gladwin M, Coleman GD, Hord N, Howard G, Kim-Shapiro DB, Lajous M, Larsen FJ, Lefer DJ, McClure LA, Nolan BT. Dietary nitrate and the epidemiology of cardiovascular disease: report from a National Heart, Lung, and Blood Institute Workshop. *J Am Heart Assoc*. 2016; 5(7):e003402.

5. Ramos-Lopez O, Riezu-Boj JI, Milagro FI, Cuervo M, Goni L, Martinez JA. Prediction of blood lipid phenotypes using obesity-related genetic

polymorphisms and lifestyle data in subjects with excessive body weight. *Int J Genomics*. 2018; 19.
6. Errico TL, Chen X, JM MC, Julve J, Blanco-Vaca F. Basic mechanisms: structure, function and metabolism of plasma lipoproteins. Clinica E Investigacion En Arteriosclerosis. 2013; 25(2):98-103.
7. Colantonio LD, Bittner V, Reynolds K, Levitan EB, Rosenson RS, Banach M, Kent ST, Derose SF, Zhou H, Safford MM, Muntner P. Association of serum lipids and coronary heart disease in contemporary observational studies. Circulation. 2016; 133(3):256-64.
8. Piepoli MF, Hoes AW, Agewall S, Albus C, Brotons C, Catapano AL, Cooney MT, Corra U, Cosyns B, Deaton C, Graham I. 2016 European Guidelines on cardiovascular disease prevention in clinical practice. Kardiologia Polska (Polish Heart Journal). 2016; 74(9):821-936.
9. Niiranen TJ, Vasan RS. Epidemiology of cardiovascular disease: recent novel outlooks on risk factors and clinical approaches. Expert Rev Cardiovasc Ther. 2016; 14(7):855-69.
10. Terada T, Friesen A, Chahal BS, Bell GJ, McCargar LJ, Boulé NG. Feasibility and preliminary efficacy of high intensity interval training in type 2 diabetes. *Diabetes Res Clin Pract*. 2013; 99(2):120-9.
11. Weston M, Taylor KL, Batterham AM, Hopkins WG. Effects of low-volume high-intensity interval training (HIT) on fitness in adults: a meta-analysis of controlled and non-controlled trials. Sports Medicine. 2014; 44(7):1005-17.
12. Keating SE, Machan EA, O'Connor HT, Gerofi JA, Sainsbury A, Caterson ID, Johnson NA. Continuous exercise but not high intensity interval training improves fat distribution in overweight adults. J Obes. 2014.
13. Gillen JB, Percival ME, Ludzki A, Tarnopolsky MA, Gibala MJ. Interval training in the fed or fasted state improves body composition and muscle oxidative capacity in overweight women. Obesity. 2013; 21(11):2249-55.
14. Ramos JS, Dalleck LC, Tjonna AE, Beetham KS, Coombes JS. The impact of high-intensity interval training versus moderate-intensity continuous training on vascular function: a systematic review and meta-analysis. Sports Med. 2015; 45(5): 679-92.
15. Iellamo F, Caminiti G, Sposato B, Vitale C, Massaro M, Rosano G, et al. Effect of High-Intensity interval training versus moderate continuous training on 24-h blood pressure profile and insulin resistance in patients with chronic heart failure. Intern Emerg Med. 2014; 9(5): 547-52.
16. Shidfar F, Jazayeri S, Mousavi SN, Malek M, fateme HOSSEINI A, Khoshpey B. Does supplementation with royal jelly improve oxidative stress and insulin resistance in type 2 diabetic patients?. Iran J Public Health. 2015; 44(6):797.
17. Sadeghi-Bazargani H, Jafarzadeh H, Fallah M, Hekmat S, Bashiri J, Hosseingolizadeh GH, Soltanmohammadzadeh MS, Mortezazadeh A, Shaker A, Danehzan M, Zohouri A. Risk factor investigation for cardiovascular health through WHO STEPS approach in Ardabil, Iran. Vasc Health Risk Manag. 2011; 7: 417.
18. Khammassi M, Ouerghi N, Hadj-Taieb S, Feki M, Thivel D, Bouassida A. Impact of a 12-week high-intensity interval training without caloric restriction on body composition and lipid profile in sedentary healthy overweight/obese youth. J Exerc Rehabil. 2018; 14(1):118.
19. 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 (7): 8-10.
20. Dianatinasab A, Koroni R, Bahramian M, Bagheri-Hosseinabadi Z, Vaismoradi M, Fararouei M, Amanat S. The effects of aerobic, resistance, and combined exercises on the plasma irisin levels, HOMA-IR, and lipid profiles in women with metabolic syndrome: A randomized controlled trial. *J* Exerc Sci Fit. 2020; 18(3):168-76.
21. Asgari M, Asle-Rousta M, Sofiabadi M. Effect of Royal Jelly on Blood Glucose and Lipids in Streptozotocin Induced Type 1 Diabetic Rats. J Arak Uni Med Sci. 2017; 20 (5) :48-56
22. Saritas N, Yildiz K, Büyükipekci S, Coskun B. Effect of different levels of royal jelly on biochemical parameters of swimmers. Afr J Biotechnol. 2011; 10(52):10718-23.
23. Viuda-Martos M, Ruiz-Navajas Y, Fernández-López J, Pérez-Álvarez JA. Functional properties of honey, propolis, and royal jelly. J Food Sci .2008; 73(9): R117-24.
24. Testa R, Bonfigli AR, Genovese S, De Nigris V, Ceriello A. The possible role of flavonoids in the prevention of diabetic complications. Nutrients. 2016; 8(5): 310.
25. Rauter AP, Martins A, Borges C, Mota-Filipe H, Pinto R, Sepodes B, Justino J. Antihyperglycaemic and protective effects of flavonoids on streptozotocin–induced diabetic rats. Phytother Res. 2010; 24(S2): S133-8.
26. Yoneshiro T, Kaede R, Nagaya K, Aoyama J, Saito M, Okamatsu-Ogura Y, Kimura K, Terao A. Royal jelly ameliorates diet-induced obesity and glucose intolerance by promoting brown adipose tissue thermogenesis in mice. Obes Res Clin Pract. 2018; 12(1):127-37.