ORIGINAL ARTICLE

The Effects of High-Intensity Interval Training on Body Composition and Lipid Profile

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ABSTRACT

This study aims to examine the effects of high-intensity interval training (HIIT) on body composition and lipid profile levels. The study was conducted with 24 male professional football players. The participants were randomly divided into two equal groups, which included 12 individuals in the control group and 12 individuals in the training group. The participants in the control group were not involved in any training program while the participants in the training group regularly participated in an 8-week long HIIT conducted 3 days a weak. Before and after the study, all the participants were examined for body weight, body mass index (BMI), heart rate, and blood samples. The blood samples were evaluated in terms of triglyceride, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and cholesterol levels. In the data analysis, SPSS package software was used, and the level of statistical significance was regarded as $p<0.05$. As a result of the study, statistically significant differences were observed in resting heart rate, BMI, and body weight levels according to intragroup pre and post-test results of the training group, and the post-test results of training and control groups ($p<0.05$). On the other hand, there was no statistically significant difference in the intragroup pre and post-test results of the control group ($p>0.05$). Furthermore, no statistically significant difference was observed in the triglyceride, LDL, HDL, and cholesterol levels between the intragroup pre and post-test results of the participants in the training and control groups ($p>0.05$) while statistically significant differences were observed in the triglyceride levels according to the post-test results of training and control groups ($p<0.05$). High-intensity interval training provides significant improvements in resting heart rate, BMI, body weight, and triglyceride levels.
Keywords: Lipid, BMI, Resting heart rate, High-intensity interval training, Total body fat percentage

INTRODUCTION

Exercise is defined as a process that provides dynamism in muscles and enables organisms to spend more energy compared to their resting states. Exercise covers planned, structured, and regular physical activities carried out to develop one or more elements of physical forms. On the other hand, physical activities cover any bodily movement that requires energy expenditure and are conducted by skeletal muscles while carrying out activities, such as working, playing games, conducting house and yard work, traveling, and entertainment activities. Therefore, it is necessary to distinguish the concepts of physical activity and exercise and define exercise as an aspect of physical activity that is structured and repetitive according to certain goals (WHO, 2020). Furthermore, the concept of training is an aspect of physical activity and covers a goal-oriented, planned, and structured process, just like exercise. However, the most significant aspect that distinguishes training from the other two concepts, physical activity, and exercise, is the emphasis on performance in terms of efficiency. In other words, training is defined as all the methods for the systematic preparation of athletes to achieve the highest efficiency in sports. These systematic methods may cover physical, technical, tactical, and psychological processes (Harre, 1982). Despite being interpreted in various conceptual ways, physical activity, exercise, and training have therapeutic influences on total body fat percentage, and the cardiovascular system through physical appearance, body composition, and health. In the current study, it was aimed to investigate certain physiological variables and lipid profile levels that may emerge following high-intensity interval training programs, which were conducted to enable athletes to achieve the highest efficiency in sports.

The continuous worldwide increases in obesity and overweightness have made the physical activities and aspects of them ever more important (Wilborn C et al., 2005; Pancallo M et al., 2015). This is because one of the most significant factors of chronic diseases, such as obesity, cardiovascular diseases, hypertension, and type 2 diabetes, is obesity, which is a global epidemic (Apovian et al., 2017; Mukhra et al., 2018).

Interval training or high-intensity interval training (HIIT) concepts cover repeated load stages ranging between 30 sec to 5 min (VO2 max at %90 - %100) and resting intervals between these repetitions for the same or shorter lengths (Daniels and Scardina, 1984). Similarly, interval training is based on high-intensity training sections that include long or short repetitions and light exercise or resting practices during the intervals between these sections to resume the next section in a readier way (Billat, 2001). Additionally, interval training covers a general framework that covers short/medium terms, 10 sec to 5 min, exercises concluded at a higher threshold than the anaerobic threshold in addition to covering a break interval to enable a little recovery section for the next set (Laursen and Jenkins, 2002). Certain physiological demands emerge in organisms based on the stress created by interval training practices. These physiological demands that emerge during and after exercise result in certain novel regulations and adaptations in organisms. Within the framework of this study, it was thought that interval training was effective on physiological parameters, such as resting heart rate, BMI, and total body weight, and serum lipid levels. This thought is based on the fact that interval training improves VO2 Max, lowers blood pressure (Gliemann et al., 2015), stimulate the utilization of fatty acids as fuel more (Jabbour et al., 2015), and benefiting weight loss in obese adolescents (Racil et al., 2016).

Accordingly, this study aims to investigate certain physiological changes and lipid profile levels that emerge as a result of high-intensity interval training practices.

MATERIAL and METHOD

Study Design: The sample of the study consisted of 24 male football players, who exercised regularly. The athletes were divided into two equal groups as the training group and the control group (mean age: 22.33; mean weight: 79.66; mean BMI: 23.20). The athletes were informed about the framework of the study. Accordingly, voluntary consent forms were provided by the participants, and the participants who did not have any obstruction for the training practice were included in the sample of the study. The randomly divided training and control groups of the study included 12 athletes in each group. The required analyses were conducted before the training program was initiated and 8 weeks after the conclusion of the training program. The athletes in the training group participated in regular training practices for 8 weeks, which were scheduled as 3 days a week. The training practices were conducted on Mondays, Wednesdays, and Saturdays at 17:00.

Type of Training: Warm-up running with a maximal heart rate (HRmax) of 130-15 was conducted for 10 min. After the warm-up run, a dynamic warm-up was conducted for 10 min. To prevent injuries, core development exercises, such as plank variations (3x20 sec), bird dog (3x12 sec), dead bug (3x20 sec), and prone plank with hip extension (3x20 sec), were conducted. In the main training phase, high-intensity interval training practices were conducted for 8-week, which were scheduled as 3 days a week. The participants initiated the HIIT at the VO2max intensity at 70-75% in the first week while increasing the intensity to VO2max at 85-90% following the third week. The HIIT practices were conducted as running at high intensities and for short distances. Following the training, cooling runs (5 min) and stretching exercises (5 min) were conducted.

Table 1. Training contents

Warm-up	Core exercise	Training period (sec)*	Distance (m)	Active resting (sec)	VO2max (%)
10 min warm-up (HRmax of 130-135) 10 min dynamic	Plank (3x20 sec) Bird dog (3x12 sec) Dead bug (3x20 sec) Prone plank with hip extension (3x20 sec)	15	75	15	
		15	75	15	
		15	75	15	85-90%
		15	75	15	
		15	75	15	
		2 min (passive resting)			
		20	95	22	
		20	95	22	
		20	95	22	85-90%
		20	95	22	
		20	95	22	
		3 min (passive resting)			

* This section was conducted with 10 repetitions at 2 sets.

Analyses

Biochemical Analyses: Blood lipid samples, 5 ml of venous blood samples, were drawn from the participants by experts in a private hospital to analyze the triglyceride, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and cholesterol levels. Then the blood samples were centrifuged at 5400 RPM/g for 10 min via the *Nüve-NF800* device. The serum samples were determined via the autoanalyzer. During the collection of the blood samples from the participants, it was paid attention that the participants did not consume any food.

Body weights: In the analysis of the body weights, a digital scale with a sensitivity of 0.01 kg was used (Name of the Scale, Brand, and Country). In the analyses, the participants were barefoot and only wore shorts. Accordingly, the pre and post-test values were recorded in the analyses.

Body Mass Index (BMI): The body mass indices of the participants were analyzed via Tanita bioelectrical impedance device. The participants only wore shorts during the analyses via the device.

Resting Heart Rate Analyses: The instructions to analyze resting heart rate were practically described to the participants. Then, the participants were asked to analyze their resting heart rates. Accordingly, the participants recorded their resting heart rates 1 minute after waking up in the morning at the supine position without leaving the bed, getting up, or moving. The analyses were conducted three times within the 1 minute, and the mean values were taken into account. The same practices were also carried out after the training practices were concluded.

Data Analysis: The obtained data in the study were analyzed by using SPSS 22.0 package software. The statistical calculations included numbers, percentage, mean, and standard deviation analyses. To test the normality of these variables, Kolmogorov Smirnov analysis, histogram graphs, skewness and kurtosis values, q-q plot, and stem and leaf plots were examined. Accordingly, it was observed that the distribution was normal. Thus, parametric tests were conducted in the data analyses. Paired samples t-test was conducted for intragroup pre and post-test analyses while independent samples t-test was conducted for post-test comparisons between the training and control groups. The level of statistical significance was regarded as $p<0.05$ in all the analyses.

FINDINGS

Table 2. Variations in the body mass (kg), BMI, and resting heart rate values of the participants

		Pre-test	Post-test				
Variable		Mean ± Sd	Mean ± Sd	Variation (%)	t	P*	Intragroup Post-test**
Body weight (kg)	Training	79.6±11.6	74.7±9.6	-6.15	7.523	0.003	0.012
	Control	83.5±8.6	85.0±8.3	1.79	-.372	0.735	
BMI	Training	24.2±2.5	22.8±1.6	5.78	4.522	0.002	0.006
	Control	23.8±2.2	25.3±2.2	6.30	-1.817	0.097	
Resting heart rate	Training	73.1±2.8	65.0±2.5	-11.08	6.642	0.001	0.001
	Control	74.8±2.0	76.5±3.4	2.27	-1.530	0.025	

p<0.05, * Intragroup pre and post-test, Paired samples t-test, ** Intragroup post-test, Independent samples t-test

As can be seen in Table 2, significant differences were observed in the body weight, BMI, and resting heart rate variables of the training group in the intragroup analyses (p<0.05). However, no significant difference was observed in the control group (p>0.05). In the intragroup analyses between the groups, statistically significant differences were observed in the body weight, BMI, and resting heart rate variables in the intragroup posttest comparisons between the groups (p<0.05).

Table 3. Variations in the serum lipid levels

		Pre-test	Post-test				
Variable		Mean ± Sd	Mean ± Sd	Variation (%)	t	P*	Intragroup Post-test**
Cholesterol	Training	156.7±20.4	153.2±25.1	-2.23	1.402	0.189	0.448
	Control	140.0±43.2	160.1±18.2	14.35	-1.000	0.339	
HDL	Training	45.0±5.2	43.4±3.2	-3.55	1.296	0.221	0.107
	Control	47.8±9.8	47.9±10.0	0.20	-1.000	0.339	
LDL	Training	96.5±17.9	93.0±25.4	-3.62	.824	0.427	0.245
	Control	97.5±17.9	104.0±21.1	6.66	1.483	0.166	
Triglyceride	Training	82.4±42.2	64.1±21.8	-22.20	1.609	0.136	0.000
	Control	128.0±34.4	137.5±30.9	7.37	-1.483	0.166	

p<0.05, * Intragroup pre and post-test, Paired samples t-test, ** Intragroup post-test, Independent samples t-test

As can be seen in Table 3, no statistically significant difference was observed in the cholesterol, triglyceride, HDL, and LDL levels in the intragroup pre and post-test results of the participants (p>0.05). On the other hand, statistically significant differences were observed in the triglyceride levels in the comparisons of intragroup post-test results of the training and control groups (p<0.05).

DISCUSSION AND RESULT

As a result of the current study, statistically significant differences were observed in body weight (kg), BMI, and resting heart rate variables of the pre and post-test results of the training group as well as significant differences in the mean post-test scores of the training and control groups. In other words, HIIT practices resulted in significant improvements in body weight (kg), BMI, and resting heart rate levels.

Mirghani et al. conducted interval training practices with 3 groups, containing 8 individuals each, for 4 weeks scheduled as 3 days a week (group 1: HIIT 60/60 activity-resting (sec); group 2: HIIT 60/30 activity-resting (sec); group 3: control). As a result of the study, no statistically significant difference was reported in terms of body weight percentages and body weights of the participants between groups while significant differences were determined in both total body fat percentage and body weight in two interval training groups in the intragroup pre and post-test comparisons. When this difference was compared to the other groups, the researchers reported that the HIIT 60/30 group had higher decreases in body fat percentage compared to the HIIT 60/60 group. In the same study, no statistically significant difference was reported in the BMI levels in both intergroup and intragroup comparisons. Nevertheless, it was emphasized that HIIT practices were significant means in terms of reducing obesity, and improving body composition and total body fat percentage (Mirghani et al., 2018).

In another study, Negaresh et al. investigated the effects of interval training of fatigue, depression, and body composition (weight and BMI) in patients with multiple sclerosis (MS), who included pre-obese control (n=15), pre-obese training (n=18), normal weight control (n=15), and normal weight training (n=18) groups, for 8 weeks scheduled as 3 days a week. In the study, the body composition interval of normal weight and pre-obese individuals were determined as 20-25 kg/m2 and 25-30 BMI kg/m2, respectively. The patients with MS initiated the training at the VO2 max intensity at 60%, and the intensity was gradually increased up to VO2 max at 75% for 8 weeks, starting from the second week. In the training, 10 min of warm-up and 10 min of cooling processes were conducted while the training, which lasted 42 min in the first week, was gradually extended up to 66 min. The resting processes were limited to 2 min. In the study, the exercise and control group that included normal-weight individuals had mean body weight values of 60.1±2.1 and 62.1±3.2, respectively. On the other hand, the individuals who were in the pre-obese exercise and control groups had mean body weight values of 77.8±3.2 78±3, respectively. In the same study, the mean BMI values of the normal-weight training and control group were 21.4±0.8 21.8±1.6, respectively, while pre-obese training and control groups had mean BMI values of 27.7±1.3 28.3±1.3, respectively. In the conclusion of the study, it was reported that the exercise group demonstrated improved values although no statistically significant difference was observed. Negarest et al. associated the lack of a significant difference with the interval training period and stated that longer interval training practices could significantly affect body weight and BMI levels (Negarest et al., 2019).

In a study conducted by Silva et al., the participants, who were 14-17 years old and did not conduct physical activities, were divided into two groups as normal-weight individuals (NW; n=13) and obese/overweight individuals (OW, n=25). Then, the participants were analyzed in terms of body composition, lipid profile, physical fitness, and endothelial functions. The HIIT program in the study was conducted for 12 weeks. One week before the study, the participants were prepared for the HIIT program via related exercises. The training program included HIIT for approximately 15 min and various sports activities for 30 min three times a week without any diet program. In conclusion, the researchers reported improved physical fitness levels in the participants. Furthermore, it was reported that pre and post-test results of the OW group demonstrated relatively significant improvements within the group, especially notable improvements in BMI value, skinfold analysis, body fat percentage and abdominal circumference (Da Silva et al., 2020).

Another point of focus in our study is whether the HIIT practices caused any changes in lipid profile levels. As a result of our study, no statistically significant difference was observed in cholesterol, triglyceride, HDL, and LDL levels in intragroup pre and post-test comparisons of the participants. However, the post-test comparisons between the training and control groups exhibited significant differences in triglyceride levels. This difference indicated improvements in the triglyceride levels of the training group. Thus, HIIT practices improved triglyceride levels. In the study conducted by Da Silva et al., HIIT practices resulted in similar total cholesterol, HDL, and LDL levels in lipid profiles of NW and OW groups, except for the triglyceride levels of OW groups, where higher triglyceride values were observed compared to the pre-test results. In other words, the triglyceride levels analyzed before the training was commenced were higher compared to the conclusion of the training. The researchers associated the results of body composition and lipid profile levels with inappropriate dietary conditions and suggested further care for this matter in future studies (Da Silva et al., 2020).

In another study that was conducted with laboratory animals fed with a high-fat diet program, four groups were created as HIIT, intermittent fasting (IF), HIIT-IF, and control groups. In the study, all the groups were fed high-fat diets for 12 weeks. As a result, the researchers reported significant decreases in LDL levels in the HIIT group compared to the control group. However, no significant difference was observed in HDL levels. In the same study, it was determined that the rats in the IF group exhibited significant decreases in triglyceride levels when the IF group was compared with HIIT and HIIT-IF groups. In the conclusion of the study, the researchers emphasized that body fat profile variables of rats could be improved via HIIT and IF (Abbasi et al., 2020).

Within this framework, these differences may result from individual differences in samples rather than certain contradictions. Furthermore, it is believed that the metabolic efficiency levels of individuals can play significant roles in the improvement of body composition and lipid profile variables. Seebohar (2011) reported that metabolic efficiency was the relationship between carbohydrate and fat oxidations at varying exercise intensities. Accordingly, the required energy was mainly obtained from the carbohydrates in the body as the intensities of the exercises were increased. However, Seebohar emphasized that athletes should improve their metabolic efficiency abilities to utilize fat storage as the main source of fuel, especially in terms of meeting the energy demand in face of varying exercise intensities. Finally, it was noted that a suitable diet should be conducted with the aerobic training programs to be successful.

In conclusion, aerobic exercises should be included in training programs for HIIT programs to influence body composition and lipid profiles, which can improve the metabolic efficiency of individuals. In our study, it was thought that the improvements observed in the body compositions and lipid profile levels of the participants were related to the long-term exercise experiences of the participants. Therefore, the results of the study were associated with investigating individuals who had metabolisms that were accustomed to fat oxidation. Accordingly, it can be stated that metabolism that is accustomed to fat oxidation processes could provide more results that are more positive (in terms of improvements in body composition and lipid profile levels).

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