

Does HIIT Frequency Matter? Effects of a Six-Week Programme on Body Composition and Lipid Profile in Physically Active Males

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ABSTRACT

Purpose: High-intensity interval training (HIIT) is a time-efficient and enjoyable form of exercise that has been shown to improve both health- and performance-related outcomes. Previous studies suggest that HIIT may promote greater fat loss compared with traditional endurance training, potentially through increased post-exercise metabolic rate and enhanced fat oxidation associated with higher total energy expenditure. In addition, HIIT has been linked to improvements in blood lipid profile. However, the effects of different weekly training frequencies of HIIT on health-related outcomes remain unclear. Therefore, the aim of this study was to compare the effects of HIIT performed at different weekly frequencies on body composition and blood lipid profile in physically active young males.

Method: Twenty-six physically active males (age: 20.1±2 years; height: 176.1 ± 5.1 cm; body weight: 72.8 ± 7.5 kg; body mass index: 23.5 ± 2.0 kg/m²; body fat percentage: 19.0 ± 4.4%) were randomly assigned to three groups (HIIT2, n=9; HIIT4, n=9; Control, n=8). The HIIT groups completed a six-week training programme performed either two or four times per week. Each session consisted of a Wingate-based intervals with 2-minute recovery periods, progressively increasing from four sets per session in week one to nine sets in week six. The control group maintained their habitual physical activity. Body composition was assessed using dual energy X-ray absorptiometry, and blood lipid profile (total cholesterol, triglycerides, HDL-C and LDL-C) was measured before and after the intervention. Dietary intake was monitored using 5-day nutrition records collected at three time points. Data were analysed using repeated-measures ANOVA.

Results: No significant group-by-time interactions were observed for body composition or blood lipid variables ($p>0.05$). Energy and nutrient intake did not differ significantly across the assessment points.

Conclusion: A six-week HIIT programme performed either two or four times per week did not result in significant changes in body composition or blood lipid profile in physically active young males.

Keywords: Blood lipid profile, Cholesterol, HIIT, Training frequency, Triglyceride

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ÖZET

HIIT Antrenman Sıklığı Önemli mi? Altı Haftalık Bir Programın Fiziksel Olarak Aktif Erkeklerde Vücut Kompozisyonu ve Lipid Profili Üzerindeki Etkileri

Amaç: Yüksek şiddetli aralıklı antrenman (HIIT), hem sağlık hem de performansla ilişkili parametreleri geliştirebilen, zaman açısından verimli ve etkili bir egzersiz yöntemidir. Önceki çalışmalar, HIIT'in geleneksel dayanıklılık antrenmanlarına kıyasla daha fazla yağ kaybına yol açabileceğini göstermektedir. Bu etkinin, egzersiz sonrası metabolik hızın yükselmesi ve toplam enerji harcamasındaki artışa bağlı olarak yağ oksidasyonunun artmasıyla ilişkili olduğu düşünülmektedir. Ayrıca HIIT'in kan lipid profilinde iyileşmeler sağlayabileceği de bildirilmektedir. Bununla birlikte, HIIT antrenmanlarının haftalık uygulanma sıklığının sağlıkla ilişkili değişkenler üzerindeki etkilerini inceleyen çalışmalar sınırlıdır. Bu nedenle bu çalışmanın amacı, farklı sıklıklarda uygulanan HIIT programlarının fiziksel olarak aktif erkeklerde vücut kompozisyonu ve kan lipid profili üzerindeki etkilerini karşılaştırmaktır.

Yöntem: Çalışmaya fiziksel olarak aktif 26 genç erkek (yaş: $20,1 \pm 2$ yıl; boy: $176,1 \pm 5,1$ cm; vücut ağırlığı: $72,8 \pm 7,5$ kg; BKİ: $23,5 \pm 2,0$ kg/m²; vücut yağ yüzdesi: $19,0 \pm 4,4\%$) dahil edilmiş ve katılımcılar rastgele üç gruba ayrılmıştır (HIIT2, n=9; HIIT4, n=9; kontrol, n=8). HIIT2 ve HIIT4 grupları altı hafta boyunca haftada iki veya dört gün HIIT programına katılmıştır. HIIT protokolü, iki dakikalık toparlanma aralıkları içeren standart Wingate temelli yüklenmelerden oluşmuş ve set sayısı birinci haftada dört setten başlayarak altıncı haftada dokuz sete kadar kademeli olarak artırılmıştır. Kontrol grubu ise rutin egzersiz programını sürdürmüştür. Çift enerjili x-ışını absorpsiyometrisi ile belirlenen vücut kompozisyonu değişkenleri ve kan lipid profili (toplam kolesterol, trigliserid, HDL-C ve LDL-C) antrenman öncesi ve sonrası ölçülmüştür. Ayrıca katılımcıların besin tüketimleri çalışma süresince üç farklı zamanda alınan beş günlük besin kayıtları ile değerlendirilmiştir. Veriler tekrarlı ölçümlerde ANOVA ile analiz edilmiştir.

Bulgular: Gruplar arasında vücut kompozisyonu ve kan lipid profili değişkenleri açısından anlamlı bir fark gözlenmemiştir ($p > 0,05$). Ayrıca besin öğeleri ve enerji alımının çalışma süresince benzer olduğu belirlenmiştir.

Sonuç: Haftada iki veya dört gün uygulanan altı haftalık HIIT programı fiziksel olarak aktif genç erkeklerde vücut kompozisyonu veya kan lipid profilinde anlamlı bir değişikliğe yol açmamıştır.

Anahtar Kelimeler: Kan lipid profili, Kolesterol, HIIT, Antrenman sıklığı, Trigliserid

INTRODUCTION

Physical inactivity is widely recognised as one of the most significant modifiable risk factors contributing to the development of various chronic diseases across modern societies. Sedentary lifestyles may increase the risk of coronary heart disease (CHD), particularly by negatively influencing cardiovascular fitness, vascular elasticity and blood circulation dynamics (Medicine, 2013). In other words, insufficient physical activity leads to physiological adaptations that weaken cardiovascular efficiency and metabolic regulation, thereby creating a favourable environment for cardiovascular pathologies. As a modifiable risk factor, physical inactivity plays a critical role in the development of CHD and its reduction may significantly lower disease risk (Pearson, Maron, Ridker, & Grundy, 2001). Therefore, interventions targeting increased physical activity levels are considered a cornerstone of preventive cardiology and public health strategies.

Exercise has a positive effect on lipid and carbohydrate metabolism, and it leads to moderate decreases in body weight, fat stores, total cholesterol (TC), serum triglycerides (TGs), low-density lipoprotein cholesterol (LDL-C), and an increase in antiatherogenic high-density lipoprotein cholesterol (HDL-C) (Tran & Weltman, 1985). These metabolic adaptations are particularly important because they help maintain cardiovascular homeostasis and improve the overall lipid profile, thereby reducing the likelihood of atherosclerotic plaque formation. Cholesterol can be produced by the body, and its levels can also change through nutrition. It has been reported that cholesterol and TG levels in the blood are very important for evaluating the risk of cardiovascular disease (CVD) (Libby, Bonow, & Mann, 2011). Consequently, monitoring lipid parameters is considered an essential diagnostic and preventive measure in clinical practice. Although a certain amount of cholesterol is necessary for the body, it is emphasised that excess cholesterol accumulates in the vessels, leading to deterioration of elasticity (atherosclerosis), blockages, hypertension, cardiovascular diseases, infarction, stroke, and paralysis (Genest, 2019). Such structural changes in arterial walls may eventually cause narrowing or obstruction of blood vessels, which significantly increases the risk of hypertension, myocardial infarction, stroke and other cardiovascular complications. A sedentary lifestyle causes many health problems. The most important of these are TC, LDL-C, and low HDL-C levels, which are among the main risk factors for CVD (Conroy et al., 2003; NCEP, 2002). In the follow-up studies of healthcare professionals, they report that physical activity is significantly and positively associated with HDL-C (Fung et al., 2000). This finding further emphasises the protective role of regular exercise against cardiovascular diseases. Abnormal increases and decreases in blood lipid profile are known as dyslipidaemia (Mora, Cook, Buring, Ridker, & Lee, 2007; Yusuf et al., 2004). Dyslipidaemia is considered a major metabolic disorder because it contributes to the development and progression of several chronic diseases. It represents an important risk factor for cardiovascular conditions such as ischaemic stroke (Goldstein et al., 2001); non-alcoholic fatty liver disease (Cohen & Fisher, 2013); and chronic pancreatitis (Ewald, Hardt, & Kloer, 2009). Therefore, strategies aimed at improving lipid metabolism are critically important for both preventive medicine and long-term health maintenance.

Physical inactivity may cause health problems such as weight gain, high blood pressure, hypercholesterolemia, and insulin resistance (Wu, Gao, Chen, & Van Dam, 2009) as well as an important cause of morbidity and mortality (Löllgen, Böckenhoff, & Knapp, 2009). For this reason, international organizations continuously emphasize the importance of regular

physical activity as an essential component of a healthy lifestyle. Current physical activity guidelines, including those from the Canadian Society for Exercise Physiology (CSEP), recommend that adults should accumulate at least 150 min of moderate- to vigorous-intensity aerobic physical activity per week to achieve health benefits (Tremblay et al., 2011). This recommendation is widely accepted in the literature as a minimum threshold required to stimulate beneficial physiological adaptations in cardiovascular and metabolic systems. Although the CSEP guidelines do not specifically define intensity ranges; however, guidelines from other agencies, including the American College of Sports Medicine, classify moderate intensity as 64%–76% of maximal heart rate (HR_{max}) (46%–63% of maximal oxygen uptake ($\dot{V}O_{2max}$) and vigorous intensity as 77%–95% of HR_{max} (64%–90% $\dot{V}O_{2max}$) (Garber et al., 2011). These classifications are important for exercise prescription because they help practitioners determine appropriate training loads and optimize physiological responses during exercise sessions. Exercise modalities that promote sustainable behavioural change and produce meaningful improvements in health-related parameters are continuously being explored. One of the most frequently reported barriers to regular exercise participation is the lack of sufficient time. Many individuals perceive traditional exercise programs as time-consuming, which often reduces adherence and long-term participation rates. In addition, most exercise protocols designed to enhance fat oxidation typically require long-term and continuous training interventions (Wu et al., 2009). High intensity interval training (HIIT) is an exercise trend that can be beneficial in this regard (Kilpatrick, Jung, & Little, 2014). HIIT (Tabata) appears to result in greater fat loss compared to traditional continuous running training (Tabata et al., 1996). Moreover, HIIT has been reported to induce significant metabolic stress and elevate post-exercise oxygen consumption, which may contribute to prolonged increases in energy expenditure following training sessions. It has been suggested that metabolic rate may remain elevated for up to 48 hours following HIIT sessions (Hickson, Foster, Pollock, Galassi, & Rich, 1985). This phenomenon, commonly referred to as excess post-exercise oxygen consumption (EPOC), may partially explain the effectiveness of HIIT in improving metabolic health despite its relatively short duration.

Considering these physiological advantages, HIIT has attracted increasing attention in recent years as a time-efficient training method that may promote both cardiovascular and metabolic health. However, there is still limited evidence regarding how different training frequencies of HIIT influence body composition, lipid metabolism and dietary intake patterns in physically active populations. Therefore, the aim of the present study was to compare the

effects of a six-week incremental HIIT programme performed at different weekly frequencies on body composition and blood lipid profile in physically active males.

METHODS

Research Design

The study was conducted using a parallel-group randomized controlled design. Participants attended the laboratory for an initial medical screening and consent process, as well as for assessment tests conducted before and after the training programme. The experimental protocol comprised pre-assessment tests, a six-week high-intensity interval training (HIIT) programme (two days per week for the HIIT2 group and four days per week for the HIIT4 group), and post-assessment tests. Pre-assessment tests included blood sampling, anthropometric measurements, body composition analysis,. In addition, 5-day dietary records were collected at baseline, midpoint (week 3), and post-intervention to monitor energy and macronutrient intake throughout the study. Anthropometric and body composition assessments were conducted following 12 hours of overnight fasting. This investigation constitutes a secondary analysis of data from a larger experimental protocol that also incorporated a maximal oxygen consumption ($\dot{V}O_{2max}$) assessment. In the primary study, participants consumed a standardized light breakfast before testing to ensure safety and optimal performance during the $\dot{V}O_{2max}$ test. As a result, baseline blood samples were collected in a postprandial state rather than after an overnight fast. This procedure was applied uniformly to all participants under controlled conditions. The composition and timing of the pre-test meal were standardized to reduce inter-individual variability. During the HIIT phase, the HIIT2 group completed two training sessions per week, while the HIIT4 group completed four sessions per week. Control group participants were instructed to maintain their habitual physical activity and dietary patterns throughout the study. Post-assessment tests were identical to the pre-assessment tests. All assessments were conducted in the morning between 07:00 and 10:00 to minimize the influence of circadian rhythm.

Participants

Twenty-six healthy male volunteers (age 20.1 ± 2 years; height 176.1 ± 5.1 cm; body weight (BW) 72.8 ± 7.5 kg; body mass index (BMI) 23.5 ± 2.0 kg/m²; body fat percentage (BFP%) $19.0 \pm 4.4\%$) who engaged in recreational sports at least twice per week and had prior experience in team sports were recruited for the study. Participants were randomly assigned to one of three groups: HIIT2 (n=9), HIIT4 (n=9), or Control (n=8). The study protocol was approved by the Ankara University Clinical Research Ethics Board (decision

number 07-364-17) and was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants prior to participation. Exclusion criteria included the presence of chronic diseases, diabetes, or regular use of medications.

Data Collection Methods and Tools

Anthropometric Measurements

Height was measured to the nearest 0.1 cm using a stadiometer (Holtain stadiometer, UK) and body weight was measured to the nearest 0.1 kg using a scale (Tanita SC 330, Germany).

Body composition was assessed using dual-energy x-ray absorptiometry (DXA, Lunar Prodigy Pro Narrow Fan Beam, 4.5°, GE Healthcare, Madison, WI, USA) following a minimum 12-hour fast. Calibration was performed each morning prior to measurements using manufacturer-supplied phantoms. Participants were scanned in the supine position with arms positioned alongside the body, palms facing the legs, and thumbs pointing upwards, maintaining a standardized 1 cm gap between the palms and trunk. The head was aligned 3 cm below the horizontal reference line on the table pad, and Velcro straps were applied to secure the knees and feet to minimize movement during scanning. Body fat percentage (BFP%), fat mass (kg), fat-free mass (FFM, kg), and soft lean mass were automatically calculated using GE enCORE™ v17.0 software (GE Healthcare, Madison, WI, USA). Regions of interest were defined automatically by the software. In our laboratory, the DXA measurement coefficients of variation (CVs), determined on an independent cohort (n = 33), were as follows: body mass 0.18%, BFP %2,0 %, fat mass 2.09%, and FFM 0.75%.

Nutritional Standardization and Dietary Monitoring

To monitor potential changes in dietary habits during the intervention period, 5-day dietary records were collected at baseline, week 3, and week 6. These records were analyzed to determine participants' total energy, carbohydrate, protein, and fat intake using specific software (BEBIS 6.1, Nutrition Information System, Dr J. Erhardt, Stuttgart, Hohenheim, Germany).

HIIT Protocol

HIIT programme (30 sec × 4 repetitions / 120 sec passive recovery) protocol was performed using a cycle ergometer (Monark Ergonomic 894 E a; Pike Bike, Varberg, Sweden). Participants were instructed to perform the exercise bouts at maximal or near-maximal effort levels against a resistance corresponding to 7.5% of their individual body weight, which is a commonly used loading strategy in cycling-based high-intensity interval

protocols. Prior to the beginning of the intervention period, participants were familiarized with the ergometer and pedaling procedure to ensure that they clearly understood the exercise protocol and were able to perform the movements safely and effectively.

The participants took part in a HIIT training programme that lasted for six weeks. In order to examine the effect of different training frequencies, the subjects were randomly assigned to two experimental groups: HIIT2 (training 2 days per week) and HIIT4 (training 4 days per week). Both groups followed the same interval structure; however, the weekly training frequency differed between groups in order to evaluate whether a higher training frequency would produce different physiological responses.

The total number of sets performed during the HIIT sessions was progressively increased throughout the intervention period. Specifically, the programme was designed according to a progressive overload principle, where the number of sets increased by one set each week. As a result, both training groups reached a total of nine sets by the end of the sixth week. This progressive approach was implemented to gradually increase training stimulus while minimizing the risk of excessive fatigue or injury among the participants.

During each interval bout, participants were asked to pedal at a very high cadence. When the pedaling rate reached approximately 150 revolutions per minute (rpm), the predetermined resistance was applied, and the participants were instructed to continue pedaling as fast and as powerfully as possible for the 30-second high-intensity effort period. Following each work interval, a passive recovery period of 120 seconds was provided in order to allow partial recovery before the next high-intensity bout began. This work-to-rest ratio was selected in accordance with commonly used HIIT protocols designed to induce significant metabolic and cardiovascular stress.

Blood Sampling

Blood samples used for the analysis of cholesterol and triglyceride concentrations were collected from the participants 48 hours before the beginning of the HIIT programme and again 48 hours after the completion of the 6-week training intervention. This time interval was chosen to minimize the acute effects of the last exercise session on blood lipid concentrations and to better reflect the chronic physiological adaptations to the training programme. Blood samples were obtained between 09:00 and 11:00 a.m. in the morning while the participants were at rest and in a non-fasting (postprandial) condition. The blood collection procedure was performed by a medical doctor using a sterile syringe after applying a tourniquet to the upper arm. Samples were obtained from the forearm veins, specifically from the vena mediana

cubiti or vena cephalica, which are commonly used sites for venipuncture due to their accessibility and reliability. After collection, the blood samples were transferred into appropriate collection tubes and placed in cooled containers. All samples were transported to the laboratory within two hours to maintain sample integrity and prevent biochemical degradation.

Before biochemical analysis, all tubes were centrifuged at 1500–2000 revolutions per minute for approximately 10–15 minutes to separate the serum from other blood components. Following centrifugation, the serum samples were analyzed using the chemiluminescence method with a immunoassay analyzer (Siemens Centaur XP). This automated system enables precise and reliable measurement of biochemical parameters such as cholesterol and triglyceride concentrations, thereby ensuring the accuracy of the laboratory results obtained in the present study.

Data Analysis

A priori power analysis was performed using G*Power (version 3.1.9.7; Franz Faul, Universitat Kiel, Dusseldorf, Germany) for repeated measures ANOVA (within–between interaction). A total of 42 participants would be required to achieve 80% power to detect medium effect sizes ($f = 0.25$). Due to practical constraints, the present study included 26 participants (HIIT2: $n = 9$; HIIT4: $n = 9$; Control: $n = 8$), which may have limited the statistical power to detect moderate changes. Descriptive statistics for all variables were calculated and presented as mean $\pm$ standard deviation (SD). These descriptive values were used to summarize the general characteristics of the participants and to provide an overview of the data distribution prior to further statistical analysis. In order to determine the effects of HIIT training performed at two different weekly frequencies, repeated measures analysis of variance (ANOVA) was applied.

This statistical approach allowed the researchers to examine both the within-subject changes over time (pre- and post-training) and the differences between the experimental groups. Specifically, the analysis evaluated the effects of training on body composition parameters, blood lipid profile variables, as well as food and energy intake of the participants. In addition, the interaction effect between group and time was examined to determine whether the training frequency produced differential effects across the intervention period. All statistical analyses were computed using Statistical Package for the Social Sciences (SPSS) for Windows, Version 21.0 (IBM Corp., Armonk, NY, USA), with significance set at $p < 0.05$.

RESULTS

Anthropometric outcome measures for HIIT2, HIIT4, and control groups at baseline and after six weeks of intervention are presented in Table 1.

Table 1. Anthropometric outcome measures before and after six weeks of HIIT

Variables	Groups	Pre-test	Post-test	Within subjects			Between subjects			Group*time interaction		
				F	p	η^2	F	p	η^2	F	p	η^2
BW (kg)	CG	71.37±4.63	72.61±5.91									
	HIIT2	71.84±7.35	72.75±7.36	9.20	.006*	.286	.636	.539	.052	.131	.878	.011
	HIIT4	75.27±9.66	76.12±9.43									
FM (kg)	CG	14.67±2.91	15.00±3.42									
	HIIT2	13.79±4.46	13.42±4.15	.353	.558	.015	.166	.848	.014	1.22	.313	.096
	HIIT4	14.32±5.63	14.00±5.07									
BFP (%)	CG	20.21±3.25	20.27±3.31									
	HIIT2	18.74±4.69	18.08±4.55	3.10	.092	.119	.554	.582	.046	1.03	.371	.083
	HIIT4	18.44±5.29	17.90±4.75									
SLM (kg)	CG	54.41±3.22	55.32±3.67									
	HIIT2	55.95±4.87	57.21±5.68	17.8	<.001*	.438	1.56	.230	.120	.173	.842	.015
	HIIT4	58.52±5.80	59.76±6.09									
FFM (kg)	CG	72.32±4.57	73.52±5.87									
	HIIT2	72.71±7.27	73.62±7.43	9.89	.005*	.301	.630	.542	.052	.091	.913	.008
	HIIT4	76.11±9.56	77.01±9.35									

Values are mean ± SD for HIIT2 (n = 9), HIIT4 (n = 9), and control (n = 8) groups. BW: Body weight; FM: Fat Mass; BFP: Body Fat Percentage; FFM: Fat-free mass; SLM: Soft lean mass; CG: Control group

Table 1 shows that there was a statistically significant difference within subjects in BW, FFM and SLM ($p_{BW}=.006$; $p_{SLM}<.001$, $p_{FFM}=.005$) however there was no statistically significant difference between subjects and group by time interaction ($p > 0.05$). FM and BFP did not show statistically significant difference within subject, between subjects and group by time interaction ($p > 0.05$).

Changes in blood lipid profile following six weeks of HIIT are shown in Table 2.

Table 2. Comparison of blood lipid profile before and after six weeks of HIIT programme

Variables	Groups	Pre-test	Post-test	Within subjects			Between subjects			Group*time interaction		
				F	p	η^2	F	p	η^2	F	p	η^2
TC mg.dL⁻¹	CG	164.25±25.7	161.12±41.5									
	HIIT2	169.55±35.6	170.66±33.6	.188	.669	.008	.151	.861	.013	.117	.890	.010
	HIIT4	170.44±23.2	165.88±25.3									
HDL-C mg.dL⁻¹	CG	42.25±5.8	43.37±4.3									
	HIIT2	46.33±8.6	44.66±7.6	.004	.949	.000	.597	.559	.049	.601	.557	.050
	HIIT4	47.55±12.5	47.88±14.0									
LDL-C mg.dL⁻¹	CG	102.37±22.8	93.125±34.4									
	HIIT2	106.00±25.6	102.77±22	2.08	.162	.083	.500	.613	.042	.171	.844	.015
	HIIT4	95.88±24.7	90.22±27.4									
TG mg.dL⁻¹	CG	99.25±46.7	122.62±67.0									
	HIIT2	86.00±22.5	114.22±64.2	2.38	.136	.094	.404	.673	.034	1.23	.310	.097
	HIIT4	135.00±70.4	138.77±69.3									

Values are mean ± SD for HIIT2 (n = 9), HIIT4 (n = 9), and control (n = 8) groups. TC: Total Cholesterol; HDL: High Density Lipoprotein-Cholesterol; LDL: Low Density Lipoprotein- Cholesterol; TG: Triglyceride; CG: Control group

No statistically significant differences were observed in within-subject, between-subject, or group-by-time interactions for any of the variables, as shown in Table 2. ($p > 0.05$). Energy and macro-nutrient intake measured at baseline (pre), at the third week (mid), and after six weeks (post) of HIIT is shown in Table 3.

Table 3. Energy and macro-nutrient intake before, during, and after six weeks of HIIT

				Within subjects			Between subjects			Group*time interaction		
CG		HIIT2	HIIT4	F	p	η^2	F	p	η^2	F	p	η^2
Energy intake (kcal)												
Pre	1760.7±337	1864.2±520	2541.8±574									
Mid	2021±479	1856.4±467	2425.8±899	.072	.891	.003	2.52	.102	.180	1.36	.268	.106
Post	1948.8±712	2066.8±648	2218±733									
Protein (g)												
Pre	84.830±15.5	85.692±20.5	116.11±37.1									
Mid	90.738±21.6	93.025±23.2	112.82±48.8	.529	.593	.022	2.43	.110	.175	.190	.942	.016
Post	92.795±29.1	95.272±32.8	116.66±42.5									
Fat (g)												
Pre	66.121±15.6	72.326±27.2	85.26±21.3									
Mid	73.64±19.3	70.95±24.0	79.14±40.9	.401	.615	.017	.663	.525	.055	.279	.841	.024
Post	73.66±33.6	81.34±33.3	83.83±31.3									
CHO (g)												
Pre	196.84±50.6	203.77 ±64.5	313.07±128									
Mid	229.46±58.3	200.94±75.3	302.27±149	.385	.683	.016	1.92	.168	.144	2.54	.052	.181
Post	220.74± 81.4	229.75±84.0	239.55±143									

Values are mean ± SD for HIIT2 (n = 9), HIIT4 (n = 9), and Control (n = 8) groups. Cho: Carbohydrate, CG: Control Group

Table 3 shows that there were no statistically significant differences in nutrient (protein, fat, carbohydrate) and energy intake for within-subject, between-subject, or group-by-time interaction effects ($p > 0.05$).

DISCUSSION and CONCLUSION

In the present study, we aimed to examine the effects of a six-week HIIT program, performed either two or four times per week, on body composition and blood lipid profile in physically active young males. The findings showed that this intervention did not lead to significant changes in body composition and blood lipid profile. Moreover, no differences were observed between groups with different weekly training frequencies.

As it is known, HIIT has emerged as one of the most popular exercise trends in recent years due to its time-efficient structure and its potential to induce significant metabolic and cardiovascular adaptations. The growing popularity of HIIT can largely be explained by the fact that it allows individuals to achieve meaningful physiological improvements in relatively short training sessions compared with traditional continuous endurance exercise. Most of the

studies investigating the effects of HIIT on blood lipid profile have been conducted in populations with metabolic disorders such as obesity, diabetes, and metabolic syndrome, and generally positive results have been reported in these groups (Fisher et al., 2015; Kong et al., 2016; Matsuo, So, Shimojo, & Tanaka, 2015; Paoli et al., 2013; Ruffino et al., 2017). In these clinical populations, HIIT interventions often lead to improvements in lipid metabolism, insulin sensitivity, and body composition due to the relatively poor metabolic status of the participants prior to the intervention.

However, there are relatively few studies examining how HIIT affects blood lipid profile and body composition in physically active individuals who do not present any metabolic or cardiovascular health problems (Lira et al., 2019; Musa, Adeniran, Dikko, & Sayers, 2009). This lack of research is important because the physiological responses to exercise may differ considerably between healthy, physically active individuals and those with metabolic disorders. Importantly, since the participants in the present study were already physically active and exhibited relatively optimal baseline values, their capacity for further physiological improvement may have been limited, which can be explained by a potential “ceiling effect.” Individuals who already have relatively healthy metabolic profiles may demonstrate smaller physiological changes in response to exercise interventions compared with sedentary or clinical populations.

In the current study, when the anthropometric measurements of the participants were examined, statistically significant differences were observed in BW, SLM and TMM values within subjects. However, no statistically significant differences were found in group-by-time interactions. This finding suggests that although certain body composition parameters changed throughout the intervention period, the magnitude of these changes was not sufficiently different between the groups to demonstrate a clear effect of training frequency. When fat mass (FM) and body fat percentage (BFP) were evaluated, a decreasing trend was observed in both training groups (HIIT2 and HIIT4), while the control group demonstrated a slight increase in these parameters. However, since these changes were not statistically significant, they should be interpreted with caution and do not provide sufficient evidence to support a definitive effect of the intervention.

Previous studies reporting significant reductions in body fat typically implemented longer HIIT interventions (Dunn, 2009; Schröder et al., 2004; Trapp, Chisholm, Freund, & Boutcher, 2008). Longer intervention periods allow cumulative metabolic adaptations to occur, such as increased mitochondrial density, improved fat oxidation capacity and enhanced

metabolic flexibility. These physiological adaptations generally require several weeks or months of consistent training before measurable changes in body fat can be detected. Therefore, the six-week duration of the present intervention may have been insufficient to elicit significant changes in body composition and lipid profile variables, as supported by previous literature indicating that longer training periods are often necessary to observe meaningful physiological adaptations. In the present study, the lack of significant fat loss may therefore be explained by the relatively short duration of the training programme, which lasted only six weeks.

Another possible explanation for the absence of significant changes in fat mass may be related to the characteristics of the study population. Unlike many previous studies that recruited overweight or obese individuals, the participants in the present study were physically active males with relatively optimal body fat levels at baseline. When individuals already have normal or healthy body composition values, the magnitude of change that can be achieved through training interventions tends to be smaller. This phenomenon is often referred to as a “ceiling effect”, where individuals who already possess favorable physiological characteristics exhibit limited improvement potential compared with those who begin the intervention with poorer baseline values. Previous studies conducted with overweight or obese populations have reported more pronounced reductions in body fat following HIIT training (Gremeaux et al., 2012; Kong et al., 2016; Smith-Ryan, Trexler, Wingfield, & Blue, 2016). Therefore, the relatively healthy baseline characteristics of the participants in the present study may partially explain why statistically significant changes in fat mass and body fat percentage were not observed. In addition, it should also be considered that anthropometric changes typically occur more gradually compared with metabolic adaptations. Changes in body composition are influenced not only by training stimuli but also by nutritional intake, hormonal regulation, and daily energy expenditure. Consequently, the relatively short intervention duration of six weeks may have limited the ability to detect meaningful changes in body fat levels.

When the blood lipid profile results of the current study were examined, no statistically significant differences were observed in TC, HDL-C, LDL-C and triglyceride values either within subjects or in group-by-time interactions. These findings suggest that the HIIT programme applied in this study did not produce strong alterations in lipid metabolism among physically active individuals over the six-week period. Although minor changes were observed in some variables, these were not statistically significant and therefore should not be

as meaningful physiological adaptations. Accordingly, the present findings do not provide sufficient evidence to support a clear effect of HIIT training frequency on blood lipid profile in this population. For instance, in the HIIT4 group, TC decreased by 2.67% and LDL-C decreased by 5.90%. However, since these changes were not statistically significant, they cannot be considered as evidence of a meaningful physiological response. The TC/HDL-C ratio showed a slight increase of approximately 1% (pre: 27.89% / post: 28.86%). Given the lack of statistical significance, this change should also be interpreted with caution.

Triglyceride levels increased slightly in all groups after the six-week intervention period. However, these values remained below the recommended threshold of 150 mg/dL for healthy adult individuals. Therefore, despite the observed increase, triglyceride levels remained within a physiologically normal range and do not indicate a clinically meaningful deterioration in lipid metabolism. The increase in triglyceride levels was more pronounced in the control and HIIT2 groups, whereas only a slight increase was observed in the HIIT4 group. This pattern may suggest that a higher weekly frequency of HIIT training could potentially moderate triglyceride responses, although further research is needed to confirm this hypothesis. Similar findings have been reported in the literature. Nybo et al. (2010) observed no significant changes in TC, HDL, LDL or the TC/HDL ratio following a 12-week HIIT programme. These results support the idea that HIIT interventions may not always produce large changes in lipid profiles in already healthy or physically active individuals (Nybo et al., 2010). According to Musa et al. (2009), although HIIT programmes may have some influence on blood lipid profile, the magnitude and consistency of these effects remain unclear (Musa et al., 2009). This inconsistency across studies may be explained by differences in training duration, exercise intensity, participant characteristics, nutritional habits and baseline metabolic status. In conclusion, although the changes observed in the present study were not statistically significant, the direction of several variables suggests potentially favorable physiological adaptations following the HIIT intervention. In particular, decreases observed in TC and LDL-C values in the higher-frequency HIIT group may indicate that longer intervention periods or larger sample sizes could reveal more pronounced effects. Future studies should therefore investigate the long-term effects of HIIT training on lipid metabolism in physically active populations, as well as examine how training frequency, duration and nutritional factors interact to influence cardiovascular health outcomes.

The findings of the present study indicate that a six-week HIIT programme performed at different weekly frequencies did not produce statistically significant differences between

the groups in terms of body composition parameters (BW, SLM, BFP, TMM) or blood lipid profile variables (TC, HDL-C, LDL-C, TG). Although some variables showed slight numerical changes, these findings should be interpreted cautiously due to the lack of statistical significance.

These results suggest that, within the relatively short intervention period applied in this study, increasing the weekly frequency of HIIT training may not lead to substantially different physiological outcomes in physically active individuals who already possess relatively healthy metabolic profiles. It is possible that the limited duration of the training programme, as well as the baseline fitness and body composition levels of the participants, may have reduced the magnitude of observable changes. Therefore, based on the findings of the present study, there is currently insufficient evidence to support the superiority of one HIIT training frequency over another with respect to improvements in body composition or blood lipid profile in physically active males. However, the small improvements observed in some variables, particularly in lipid profile markers, may still indicate a potential positive effect of HIIT training that could become more pronounced with longer training interventions.

Future research should consider longer intervention durations, larger sample sizes, and different training intensities in order to better understand the relationship between HIIT training frequency and metabolic adaptations. In addition, examining the combined effects of exercise interventions and dietary strategies may provide further insight into how HIIT can be optimized for improving cardiovascular health and body composition outcomes. Future studies should investigate the effects of HIIT training frequency in populations with impaired metabolic health, such as individuals with metabolic disorders and older adults, to better understand its potential clinical and physiological benefits.

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