The Acute Effect of High-Intensity Functional Exercises on Circadian Rhythm and Anaerobic Performance Parameters

Yüksek Yoğunluklu Fonksiyonel Egzersizlerin Sirkadiyen Ritim ve Anaerobik Performans Parametreleri Üzerindeki Akut Etkisi

Özgür EKEN[1], Ramazan BAYER[2], Serdar BAYRAKDAROĞLU[3]

ABSTRACT

Kickboxing is a sport that involves high intensity and short intervals. High intensity functional training can contribute to training kickboxers specific to the competition. The purpose of this study is to examine the acute effect of high-intensity functional exercises on circadian rhythm and anaerobic performance parameters. The study consisted of 15 volunteer male kickboxers (age, 20.67± 1.23 years; height, 173.60± 3.18 cm; 69, 20±2.67 kg; BMI 23.03±.49) between the ages of 18-25. The research protocol consisted of multimodal HIFT exercises performed at different times of the day. After HIFT protocol; T-line agility, vertical jump, average and peak power data were obtained from the volunteers at different times of day (09.00 am; 01.00 pm; 05.00 pm). There was find statistically significant difference between vertical jump [F(1,145)= 129.54 p=.000, partial eta square:,902], peak power values [F(1,275)= 122.89 p=.000, partial eta square:,898], average power values [F(1,139)= 124.23 p=.000, partial eta square:,899], T-line agility times [F(1,925)= 39,227 p=.000, partial eta square:,737] after HIFT in the morning, afternoon and evening protocols (p< 0.05). The best scores were obtained in the evening (05.00 pm) values for all parameters. It was determined that HIFT had better effect on vertical jump, average power, peak power and T-line agility in the evening than morning and afternoon hours.

Keywords: Kickboxing, Circadian rhythm, High intensity functional training, Vertical jump.

ÖZ

Kickboks, yüksek yoğunlukta ve kısa aralıklarla yapılan bir spordur. Yüksek yoğunluklu fonksiyonel antrenman, müsabakaya özel kickboksçuların antrenmanına katkıda bulunabilir. Bu çalışmanın amacı, yüksek yoğunluklu fonksiyonel egzersizlerin sirkadiyen ritim ve anaerobik performans parametreleri üzerindeki akut etkisini incelemektir. Araştırmaya 18-25 yaşları arasında gönüllü 15 erkek kick boks sporcusu (yaş, 20.67± 1.23 yıl; boy, 173.60± 3.18 cm; 69, 20±2.67 kg; VKİ 23.03±.49) katıldı. Araştırma protokolü günün farklı saatlerinde gerçekleştirilen multimodel HIFT egzersizlerinden oluşmaktadır. HIFT protokolünden sonra; gönüllülerden günün farklı saatlerinde (09.00; 13.00; 17.00) T-line çeviklik, dikey sıçrama, ortalama ve zirve güç verileri elde edildi. Dikey sıçrama [F(1,145)= 129.54 p=.000, kısmi eta kare:,902], zirve güç değerleri [F(1.275)= 122.89 p=.000, kısmi eta kare:,898], ortalama güç değerleri [F(1,139)= 124.23 p=.000, kısmi eta kare:,899], T-line çeviklik süreleri [F(1.925)= 39.227 p=.000, kısmi eta kare:,737] sabah, öğle ve akşam protokollerinde sonra uygulanan HIFT arasında istatistiksel olarak anlamlı fark bulundu (p< 0.05). Tüm parametreler için en iyi değerler akşam saatinde (05.00 pm) elde edildi. Akşam saatlerinde dikey sıçrama, ortalama güç, zirve güç ve T-line çevikliği üzerinde HIFT'in sabah ve öğleden sonra saatlerine göre daha iyi bir etkiye sahip olduğu belirlendi.

Anahtar Kelimeler: Kickboks, Sirkadiyen ritim, Yüksek yoğunluklu fonksiyonel antrenman, Dikey sıçrama.

The study was approved by the ethics committee of the Institute's Clinical Research Ethics Committee (register no. 2021/2624).

[1]Dr., Özgür EKEN, Physical Education and Sport, Physical Education and Sports Teaching, Inonu University, Malatya, ozgureken86@gmail.com, ORCID: 0000-0002-5488-3158

[2]Dr., Ramazan BAYER, Physical Education and Sport, Turgut Ozal University, rmznbayer@gmail.com, ORCID: 0000-0002-2161-5886

[3]Dr., Serdar BAYRAKDAROĞLU, Physical Education and Sport, Gumushane University, Department of Training Science, bayrakdaroglu85@gmail.com, ORCID: 0000-0002-2166-6675

İletişim / Corresponding Author: Özgür EKEN
e-posta/e-mail: ozgureken86@gmail.com

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INTRODUCTION

Kickboxing is a sport in which a trainer constantly supervises the athletes, includes punching and kicking techniques, and kickboxers are allowed to hit certain parts of their opponents' bodies. Adequate physical fitness is required in order to perform the techniques and to obtain efficiency from the techniques.[1,2] However, maintaining a kickboxer's body mass is one of the most important elements of the training process and can enable the competitive kickboxer to choose the weight category in which he/she believes he/she can provide best mentally and physically.[3] Kickboxing, which is still an elite sport today, is among the modern combat sports. The psychophysiological demands that the kickboxer is exposed to during a kickboxing tournament can enable kickboxers to reach high thresholds of their physical capacity. Nowadays, amateur and elite male kickboxers report significantly improved muscle mass, lower body fat percentage, and higher mesomorphic ratio. Although the maximum oxygen uptake capacities of kickboxers differ when considered individually, moderate to high cardio-respiratory levels have been reported overall. A high peak and average anaerobic power output have been reported regardless of the kickboxer's level. Top level kickboxing performance needs well-developed muscle strength in whole limbs.[4] Along with these, the physical and psychological demands of a highly competitive competition can be reported as important sources of stress for kickboxers. Kickboxing competitions are scored at the end of the bout by the referee's stop, knockout, or judgment based on actions, and are usually divided into rounds of 2 to 4 minutes each, with a 1 to 2 minute rest break between rounds.[5] Competitions consist of 3 to 12 rounds, but this may change depending on the duration.[6]

Kickboxing competitions start in the morning and the final competitions end in the evening. For this reason, the importance of circadian rhythm in kickboxers should not be forgotten. There are some reasons that effect the quality of performance. Kickboxer's performance may vary depending on the circadian rhythm. These changes have been reported psychologically and physiologically.[7,8] Within days, physical performance (muscle endurance, muscle strength, cardiac-respiratory endurance) is high at early evening and noon, but it is low at night and early in the morning.[9,10] Researchers have reported that besides motor performance changes during the day, there may be changes in muscle metabolism, body temperature, body fluids and blood concentrations of hormones.[11,12] Circadian rhythms arising from endogenous markers are found in the suprachiasmatic nucleus of the anterior hypothalamus in most mammals.[13] The nerve and humoral outputs in the suprachiasmatic nucleus communicate with the hypothalamus and other centers in the endocrine system, and centers transmit a large number of behavioral and physiological rhythms.[14] Chronobiology requires circadian rhythm display to reproduce circadian measurements resulting from behavioral and environmental factors, for example energy intake, activity, posture, sleep, ambient heat and light.[15] The results of the observations are summarized as follows; the body temperature,[16] the mood,[17] the duration of the reaction[14] and cognitive function[18] reported that numerous behaviors and biological functions affect athletic performance.

In the literature, there is no study examining the circadian rhythm of kick boxers after HIFT. In addition, in kickboxing, which is high-intensity intermittent sport, one of the modalities for the development of athletes can be high-intensity functional exercise. Although there are no studies in the literature that specifically include the importance of high-intensity functional exercise in kickboxers, there are studies involving different performance parameters in different athletes. High Intensity Functional Training (HIFT) is a training methodology that includes

multimodal exercises performed at high heart rates or high VO_2 levels.[19] High-intensity functional training (HIFT) is an exercise method that can be adapted to any fitness level and emphasizes functional, multi-joint movements that create more muscle than traditional exercise activities. HIFT, a partially new method of exercise, is often compared to high-intensity interval training (HIIT), but the two of them are different. HIIT training is characterized by relatively short repetitive vigorous activities consisting of periods of rest or low-intensity training sessions for recovery. HIFT, on the other hand, constantly uses a variety of functional exercise and various activity durations, with or without rest.[20–22]

The effect of functional exercises performed at different times of the day in kickboxers has not been examined. Performance values to be obtained in terms of training design are important. In addition, the fact that the study group consisted of men and the investigation of acute performance values can be reported as a limitation of the research. The aim of this study is to examine the acute effect of high-intensity functional exercises on circadian rhythm and anaerobic performance parameters. The hypothesis of the study was stated that the measured anaerobic performance parameters are better in the evening hours.

MATERIAL VE METODS

Participants

Fifteen male athletes between the ages of 18-25, who exercised regularly for three days a week, and did kickboxing for at least 3 years (age, 20.67± 1.23 years; height, 173.60± 3.18 cm; 69, 20±2.67 kg; BMI 23.03±.49). The power analysis program G*Power (version 3.1.9.3, Germany) was used to obtain the research group. As a result (confidence interval = .95, alpha value = .05 and beta value = .80 and effect size value = .35), it was reported that at least 15 volunteers should be included in the study.[23] Accordingly, the minimum sample size was found to be 15 kickboxing athletes. Before starting the study, kickboxers were informed in detail about the content, purpose and methodological model of the research. An Informed Consent Form was signed by the athletes who stated that they volunteered to participate in the training. Athletes who volunteered for the study signed an Informed Consent Form. The study was approved by the ethics committee of the Institute's Clinical Research Ethics Committee (register no. 2021/2624). Before the study, participants were asked to sleep at least 8 hours before each test session, and to come on a full stomach, provided that they had food at least two hours before the morning and early evening session. In addition, the participants were given necessary information about maintaining their usual kickbox training, not doing high-intensity exercise, and not using substances such as alcohol and caffeine.[24]

Experimental Procedures

Prior to data collection, all participants attended a familiarization phase session in which they performed all HIFT programs and test parameters. The participants included in the study were created in such a way that they could perform HIFT programs on a single group. Body weights were measured with an electronic scale (Tanita SC-330S, Amsterdam, Netherlands) with an accuracy of 0.1 kilograms (kg). During the measurement, the height of the participants was measured with a stadiometer (Seca Ltd., Bonn, Germany) with precision of 0.01 meters (m).[25] Body mass index and body fat ratios of all volunteers were measured and recorded with an electronic scale (Tanita SC-330S, Amsterdam, Netherlands).[25] The vertical jump and T-line agility performance of the participants was measured after HIFT in three different time periods of the day (starting at 9.00 a.m, 1.00 p.m and 4.00 p.m) with at least three days between each other. Vertical jump values were recorded by cm and T line agility tests values were recorded by seconds (Smart Jump; Fusion Sport,

Australia). Three trials were performed for each measurement, and the highest value of the three trials was used for each variable.[26,27] The reason why these time periods of the day were chosen for the study was related to the fact that the kickbox competitions follow a course from morning (eliminations) to early evening (finals).

High Intensity Functional Training (HIFT)

Before HIFT session, participants conducted a 6 min light intensity aerobic run (only 30-40 % HR). After warm up volunteers rested for 30 seconds after completing the program that included 30 seconds of high-intensity anaerobic exercise (eg, jumps and combinations of jumps). They then completed the exercise paired with 30 seconds of bodyweight/free weight resistance exercise (eg, combinations of push-ups or push-ups) and rested for 30 seconds. Then they did the same session again. After the end of the HIFT session, a 3-minute rest period was performed. A HIFT session followed by a rest took 7 minutes in total. The HIFT program was carried out in 2 sessions in totaly 14 minutes. The methodology was inspired by Ben-Zeev et al. (2020).[28] The Karvonen formula was used to calculate the heart rate reserves in order to determine the HIFT heart rate (HR) intensity of the kickbox athletes individually before each test session.[29] Polar h10 was used to monitor heart rate during HIFT session. Participants performed HIFT protocols at 09.00 a.m, 01.00 p.m, and 05.00 p.m, with a 72-hour break between each time zone.

Statistical Analysis

The data determined in the study were analyzed using the SPSS (25.0) program. In statistical data analysis, firstly, the 'Shapiro Wilks' test was performed to determine whether the study was normally distributed. Mauchly Test was used for homogeneity of variances and Greenhouse-Geisser correction factor was used to correct for variances. All variables in the study showed normal distribution. “Repeated Measurements Anova” was used to determine the effect of different times of day on vertical jump, T line agility, average power, and peak power. The significance level was chosen as $p<0.05$.

RESULTS AND DISCUSSION

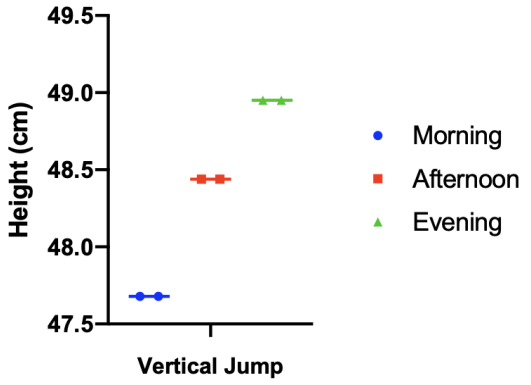

Figure 1. Vertical Jump Performance of Different Time of Day After HIFT

Figure 1 shows the difference between the vertical jump test performance values of kickboxers after morning, afternoon and evening protocols. The vertical jump measured in the evening (48.95±2.50) was better than the vertical jump height observed after the vertical jump measured at afternoon (48.44±2.60) and morning (47.68±2.75), respectively. In addition, a statistically significant difference was found between vertical jump heights [F(1,145)= 129.54 p=.000, partial eta square:,902] after morning, afternoon and evening protocols ($p<.05$).

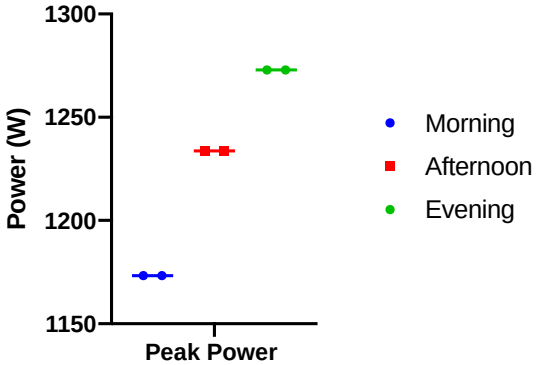

Figure 2. Peak Power Values of Different Time of Day After HIFT

Figure 2 shows the difference between peak power values measured after the vertical jump test determined after morning, afternoon and evening protocols of kickboxers. The peak power value observed after vertical jump measured in the evening (1272.93±188.94) was better than afternoon (1233.67±196.02) and morning (1173.33±205.95) hours respectively. In addition, a statistically significant difference was found between peak power values measured after morning, afternoon and evening protocols [F(1,275)= 122.89 p=.000, partial eta square:,898] (p<.05).

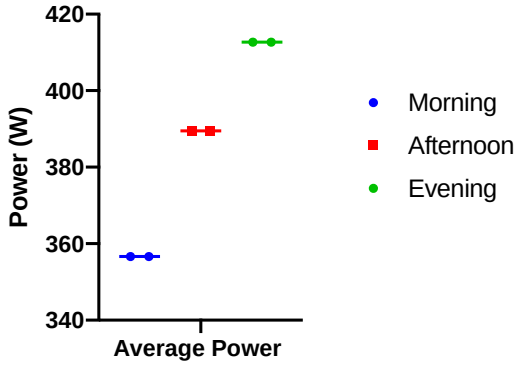

Figure 3. Average Power Values of Different Time of Day After HIFT

Figure 3 shows the difference between the average power values of kickboxers measured after vertical jump test after morning, afternoon and evening protocols. It was observed that the average power value observed after the vertical jump test, which was measured in the evening (412.67±106.29), was better than that in the afternoon (389.53±109.86) and (356.60±115.30) in the morning, respectively. In addition, it was determined that there was a statistically significant difference between the average power values measured after the morning, noon and evening protocols [F(1,139)= 124.23 p=.000, partial eta square:,899] (p<.05).

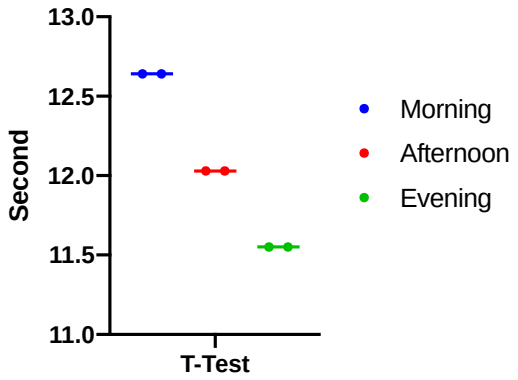

Figure 4. T-line Agility Test (T-Test) Values of Different Time of Day After HIFT

Figure 4 shows the difference in T-line agility times of kickboxers after morning, afternoon and evening protocols. It was observed that T-line agility time observed after evening (11.55±.31) protocol was better than T-line agility times observed after afternoon (12.03±.40) and morning (12.64±.31) protocols, respectively. In addition, a statistically significant difference was found between T-line agility times [F(1,925)= 39,227 p=.000, partial eta square:,737] after morning, afternoon and evening protocols (p<.05).

The purpose of the current study was to compare the acute effect of high-intensity functional exercises on circadian rhythm and anaerobic performance parameters in kickboxers. Vertical jump, average power, anaerobic power and T-line agility values were analyzed as performance parameters. Because kickboxing is a sport in which the anaerobic energy system is used extensively.[4] Vertical jump, average power, anaerobic power and t line agility values was found better in the evening hours after HIFT.

When the literature was examined, no study was found in which the effect of HIFT exercises at different times was determined, and the vertical jump, T-line agility, average and peak power performance values of the kickboxing participant group were examined. However, there are many studies in the literature examining HIFT exercises. Brisebois et al. (2018) reported that as a result of their study, resting heart rate decreased, resting diastolic blood pressure decreased, and resting systolic blood pressure

did not change. It has also been reported that absolute VO_2max and relative VO_2max are improved. In addition, it has been reported that lean body mass increased, but fat mass did not change.[30] Crawford et al. (2018) initially determined that measures of physiological fitness (for example, aerobic capacity) were significantly correlated with physical work capacity. It has also been reported that the change in physiological measures cannot predict the change in physical working capacity caused by HIFT.[31] Feito et al. (2018) reported that HIFT protocols performed for 16 weeks resulted in improved results in strength, metabolic conditioning performance, and body composition.[19] Sobrero et al. (2017) aimed to determine the change in health and performance measures in women who participated in HIFT or traditional cycle training (TCT) after a six-week exercise program. Recreationally active female participants were randomly assigned to a HIFT group. The exercise participants trained three days a week for six weeks with their certified trainer. Researchers observed body composition (BC), aerobic and anaerobic capacity, muscle strength, endurance, flexibility, strength and agility. As a result of the research, they found that HIFT programs can have beneficial effects on body composition (BC), health and fitness variables such as musculoskeletal strength and performance, compared to TCT programs.[32] The results of the literature and the results of our research are similar. In this context, it is claimed that HIFT modalities may be the recommended exercise modality due to their potential to increase the level of physical parameters tested. In addition, it is important that the individual differences, current fitness levels and training histories of the volunteers participating in the studies with different results from our study may be different. Considering the studies in the literature examining the effects of circadian rhythm on different performance parameters, Souissi et al. (2004) showed that oral temperature, peak power (Ppeak), mean power (Pmean), and maximal power (Pmax) varied simultaneously throughout the day. In line with these results, it shows that there is a circadian rhythm in anaerobic performance during cycle tests. By recording the oral temperature, it allows to determine the time of occurrence of the maximum and minimum values in the circadian rhythm of anaerobic performance.[7] Kline et al. (2007) revealed an important pattern in swimming performance according to the environmental and circadian times of the day. Performance has been reported to peak 5-7 hours before Tmin and is worst from 1 hour before to 1 hour after Tmin. Average swimming performance has been reported as 169.5 s.[9] López-Samanes et al. (2017), morning and afternoon service speed/accuracy (SVA), counter motion vertical jump (CMJ), agility T-test (AGIL) and 10-m sprint (10-m RUN) tests showed that test performances significantly improved in the morning. He reported that he was atrophied during the test. However, it revealed that isometric grip strength (IS) was not affected by the time of day.[33] The results of the literature and the results of our research are similar in terms of the negative effect of morning performance on agility and vertical jump performance. In addition, it should be kept in mind that the circadian differences, current fitness levels, changes in sleep levels and training histories of the volunteers participating in the studies with different results from our study may be different

CONCLUSION AND RECOMMENDATIONS

HIFT performed by the kickboxers were effective in optimising their vertical jump, average power, peak power and T-line agility performance expecially in the evening hours. Some positive responses to anerobic parameters revealed the kickboxers' individuality and confirmed the idea that HIFT procedures should be considered as an individualised approach to optimising and improving vertical jump, average power, peak power and T-line agility performance in the evening hours. In the results of the study, the biological rhythms of kickboxers, such as being lark sleepers or owl sleepers, were

ignored. In addition, the effects on different participant groups and different performance parameters should be investigated in future studies.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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