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THE EFFECT OF HIGH INTENSITY INTERVAL TRAINING PERFORMED AT DIFFERENT TIMES OF DAY ON SOME PERFORMANCE PARAMETERS

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ABSTRACT

Athletes frequently employ high-intensity interval training (HIIT) to improve their performance. However, it is believed that it is critical to find the most efficient time period for performing training. The purpose of this study is to assess the effect of HIIT performed at different times of the day on various performance measures. Twelve male volunteers between the ages of 18 and 25, who had been exercising three days a week for at least three years and were studying at the faculty of sports sciences, participated in the study (age, 20,67± 1,07 years; body height, 174,25± 2,34 cm; 67,58± 3,02 kg; BMI 22,34±0.89). Ten minutes warm-up + ten minutes HIIT were used in the research protocols. Additionally, two measurements were taken for the HIIT program, at various times of the day (09.00-11.00 a.m in the morning; 05.00- 07.00 p.m in the evening). Following each measurement, the volunteers' 30-meter sprint and T-line agility were assessed. Researchers found a statistically significant difference in the T-Test and 30 m sprint test performance between volunteers who completed the morning and evening HIIT programs ($p < 0.05$). T-Test and 30 m sprint test performances were seen greater in the evening hours. Based on the performance times of the T-Test and 30 m sprint test following the HIIT protocols performed in the morning, it was found that the HIIT protocol performed in the evening was more effective.

Keywords: Circadian rhythm, HIIT, Performance

GÜNÜN FARKLI ZAMANLARINDA YAPILAN YÜKSEK YOĞUNLUKLU ARALIKLI EGZERSİZİN BAZI PERFORMANS PARAMETRELERİNE ETKİSİ

ÖZET

Sporcular performanslarını iyileştirmek için sıklıkla yüksek yoğunluklu interval antrenmanı (HIIT) kullanırlar. Ancak, antrenmanın gerçekleştirilmesi için en verimli zaman diliminin bulunmasının kritik olduğuna inanılmaktadır. Bu çalışmanın amacı, günün farklı zamanlarında gerçekleştirilen HIIT'in çeşitli performans ölçümleri üzerindeki etkisini değerlendirmektir. Araştırmaya spor bilimleri fakültesinde öğrenim görmekte olan ve en az üç yıldır haftada üç gün spor yapan 18-25 yaşları arasında 12 erkek gönüllü (yaş, 20,67± 1,07 yıl; boy, 174,25± 2,34 cm; 67,58± 3,02 kg; VKİ 22,34±0,89) katıldı. Araştırma protokollerinde on dakika ısınma + on dakika HIIT kullanıldı. Ayrıca HIIT programı için günün çeşitli saatlerinde (sabah 09.00-11.00; akşam 17.00- 19.00) iki ölçüm yapılmıştır. Her ölçümün ardından gönüllülerin 30 metrelik sprint ve T-line çevikliği değerlendirildi. Araştırmacılar, sabah ve akşam HIIT programlarını tamamlayan gönüllüler arasında T-Testi ve 30 m sprint testi performansında istatistiksel olarak anlamlı bir fark buldu ($p < 0,05$). T-Test ve 30 m sprint testi performansları akşam saatlerinde daha fazla görüldü. Sabah yapılan HIIT protokollerini takiben yapılan T-Test ve 30 m sprint testinin performans sürelerine göre karşılaştırıldığında HIIT protokolünün akşamları daha etkili sonucu ortaya çıktı.

Anahtar Kelimeler: Sirkadiyen ritim, Yüksek yoğunluklu interval antrenman, Performans

INTRODUCTION

In HIIT, short bursts of high intensity exercise (i.e., exercise that results in ≥85% maximum heart rate) alternate with rest or low intensity exercise to create a cyclic pattern of stress on the body (Gibala et al., 2012; Gray et al., 2016). Recent research suggests it could replace traditional cardiorespiratory exercise as a more time-efficient option (Alves et al., 2014). HIIT is a broad term that refers to brief to moderate bursts of repetitive exercise performed at a level above the anaerobic threshold (Laursen and Jenkins, 2002). The objective of HIIT is to continually emphasize the physiological systems involved in a particular type of endurance exercise more than is necessary during the activity (Daniels and Scardina, 1984). There are several widely utilized high-intensity interval training (HIIT) protocols in the literature; however, variations in interval and recovery time have been established to meet various research aims (Gibala and McGee, 2008; Weston et al., 2014). HIIT is a more effective strategy for eliciting a number of physiological health advantages, such as enhanced cardiorespiratory fitness, better insulin sensitivity, and reduced appears to be an application, when compared to traditional exercise (e.g., aerobic exercise, resistance training) (Costa et al., 2018; Costigan et al., 2015). For instance, a lower exercise volume and a shorter duration of exercise HIIT protocols were utilized to test the premise that HIIT is a time-efficient technique for reaching health benefits, and it was discovered that 30 minutes twice a week of HIIT improved overall health (Gibala and McGee, 2008). The study showed that after seven weeks of HIIT, the participants' maximum oxygen uptake and maximum aerobic speed could be enhanced significantly by 8.2 percent (Baquet et al., 2002). Additionally, it has been demonstrated that performing short-term HIIT training three times per week for five weeks results in a net increase in endurance levels (Sperlich et al., 2011).

The term "circadian rhythm" refers to the cyclical variations that occur in relation to a solar day on a regular basis and at regular intervals (Reilly et al., 2000). Due to the cyclical changes that occur, performance of persons and athletes varies according to their exposure to hot and humid environmental circumstances at various times of the day, changes in body temperature, and sports branch (Hammouda et al., 2011; Hammouda et al., 2013; Kline et al., 2007). Nutrition, sleep, individual chronotype variances, and rest are all elements that can alter daily variation, particularly during different times of the day (Youngstedt and O’Connor, 1999). Daily changes in athletes' maximum performance, encompassing both individual and team sports, are fairly considerable (Knaier et al., 2019). Diurnal variation has been shown to be useful in a variety of variables affecting athletic performance, and it has been found that diurnal variation produces a variety of consequences (Bessot et al., 2006; Racinais et al., 2005). The literature confirms that there are variances in short-term athletic performance at various times of the day (Gauthier et al., 2001; Guette et al., 2005) and that this effect has an effect on athletes' performance levels (Bessot et al., 2006). According to the studies, the best short-term performance is achieved with the lowest values in the morning and the highest values in the afternoon (Sedliak et al., 2008; Souissi et al., 2010; Souissi et al., 2004).

It is well-known that athletes frequently use high-intensity interval training (HIIT), which is supposed to improve performance. However, the time period during which it is most effective is a subject of performance curiosity. The purpose of this study was to investigate the effect of high-intensity interval training (HIIT) at various times of the day on a variety of performance metrics. The study's hypotheses were as follows: 'HIIT has a greater beneficial effect on performance indicators during the evening hours.'

Athletes are commonly recognized to participate in high-intensity interval training (HIIT), which is thought to improve performance and is frequently practiced. Performance-wise, however, it is a mystery as to when it will be most effective. The purpose of this study was to assess the effect of high-intensity interval training (HIIT) applied at various times of the day on a variety of performance metrics. It was found that the study's hypotheses were as follows: 'HIIT has a higher beneficial effect on performance indicators in the nighttime hours.'

MATERIAL AND METHODS

Participants

Twelve male volunteers between the ages of 18 and 25, who had exercised consistently three days a week for at least three years and were studying at the faculty of sports sciences, participated in the study (age, 20.67±1.07 years; body height, 174.25±2.34 cm; body weight, 67.58±3.02 kg; BMI, 22.34±0.89). The study group was determined using the power analysis application G*Power (version 3.1.9.3, Germany). As a result of the power analysis (confidence interval=0.95, alpha=0.05, beta=0.80, and effect size=0.60), it was concluded that at least 12 volunteers should be included in the study. The athletes had to meet the following criteria to be included in the study: (a) have been doing sports for at least 3 years; (b) have no history of disability that would affect the study's outcome; (c) ensure regular participation in the study; and (d) follow the researchers' commands throughout the study. All athletes were given all of the essential information regarding the study's requirements and risks, and they signed an informed consent form indicating that they volunteered to participate. The athletes were instructed to maintain their usual level of physical activity and abstain from intense activities for 24 hours prior to the study. Additionally, they were forbidden to use stimulants (e.g. caffeine) or depressants (e.g. alcohol) before to the study. Before starting the study, necessary approval was received from Malatya Turgut Özal University Non-Interventional Clinical Research Ethics Committee (Ethics Committee Protocol Number 2022/21).

Experimental procedures

All subjects completed the familiarization phase prior to data collection by attending a session in which they practiced all HIIT exercises and test conditions. The study recruited volunteers to conduct HIIT activities in a single group. Additionally, during the practice session, participants were informed that the study will be completed in two different time periods: in the morning (09.00-11.00) and in the evening (17.00-19.00). The body weights were determined using an electronic scale (Tanita SC-330S, Amsterdam, Netherlands) with a 0.1-kilogram accuracy (kg). The participants' heights were determined during the measurement using a stadiometer (Seca Ltd., Bonn, Germany) with an accuracy of 0.01 meters (m) (American College of Sports Medicine., 2018). Using an electronic scale, the body mass index and body fat ratios of all subjects were determined and recorded (Tanita SC-330S, Amsterdam, Netherlands) (American College of Sports Medicine., 2018). After HIIT, the participants' 30 m sprint and T-line agility performance were assessed at two different durations throughout the day (starting at 9.00 a.m and 17.00). Three trials were performed for each measurement, and the highest value of the three trials was used for each variable (Fox, 1998; Pauole et al., 2000). After the T-test and 30 m speed test tracks were prepared, a two-door photocell electronic chronometer system measuring with 0.01 second precision was placed at the start and finish lines of the tracks. Three trials were taken for each variable (a rest interval of 1 min after each trial for the T-test and 30 s after each trial for the 30 m sprint test), and the highest value of the three trials was utilized for analysis.

High intensity functional training (HIIT)

Before HIIT session, participants conducted a 10 min light tempo aerobic run (only 30- 40 % HR). After warm up, the participants performed following complementary protocols: (1) 30 s of work with a maximum HR intensity of 85-90% followed by 120 s of rest (HIIT) (1:4 (30:120 sn)). HIIT exercises consisted of squat jump, walk down-shoulder tap, jackknife crunch, and burpee mountain climbing movements; they were determined by the researcher and the consultant based on published interval training practices. This sequence of exercises was repeated one time for a total of 10 min training session and was conducted. For a total of 20 minutes, the experimental procedure included a combination of HIIT and pre-warm up exercises. The Karvonen formula was used to calculate the heart rate reserves in order to determine the HIIT heart rate (HR) intensity of the subjects individually before each test session

(Karvonen, 1957). During the HIIT session, heart rate was monitored via a Polar h10. Participants conducted HIIT protocols at commencing at 9.00 a.m and 05.00 p.m.

Statistical analysis

Due to the study's small sample size of less than 50 volunteers, the Shapiro Wilk's test was used to determine the normality of the data. To determine the significance of the difference between the arithmetic means of two related groups, the Paired Samples T-test was performed. All statistical analyses were conducted using the IBM Statistics package program (SPSS, version 25.0, Armony, NY). The mean and standard deviation (x̄±ss) of the data were used, and the level of significance was set to $p<0.05$.

RESULTS

The difference in T-Test performance times between morning and evening sessions is indicated in Figure 1. T-Test performance time was reported to be faster after the evening (11.54±.20) protocol than following the morning (12.38±0.34) protocol. Additionally, a statistically significant difference in T-Test performance times was observed (t=6,963 p=0.000) following morning and evening treatments ($p<0.05$).

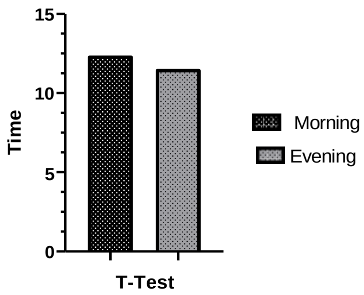

Figure 1. T-Test Values determined by the volunteers' morning and evening routines

The difference in performance timings for the 30 m sprint test following morning and evening protocols for the volunteers participating in the study is represented in Figure 2. It was reported that the performance time for the 30 m sprint test after the evening (4.49±0.07) routine was improved to the performance time for the 30 m sprint test after the morning (4.55±0.09) protocol. Additionally, a statistically significant difference in performance durations for the 30 m sprint test was determined (t=8,124, p=.000) between the morning and evening routines ($p<0.05$).

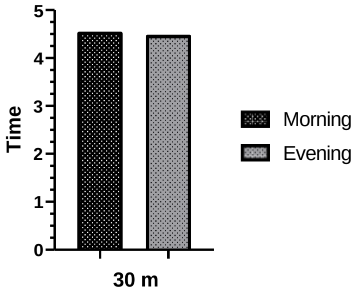

Figure 2. The values of the 30 m sprint test following the volunteers' morning and evening routines

DISCUSSION

The purpose of this study was to determine the effect of high-intensity interval training (HIIT) on specific performance indicators at various times of the day. Our hypothesis was that HIIT would result in evening improvements in T line agility and 30-meter sprint performance. The majority of the findings corroborated our hypothesis. Indeed, HIIT activities performed in the evening were found to be more successful in improving T line agility and 30 m sprint performance than those performed in the morning. Additionally, it was revealed that a statistically significant difference existed between T line agility test performance (t= 6.963 p=0.000) and 30 m sprint performance (t=8124 p=0.000) on different days following HIIT, with the difference favoring the evening (p< 0.05).

Numerous research have been conducted to examine the impact of HIIT exercises on various performance indicators; these studies are summarized below. Kilit and Arslan (2019) compared the psychophysiological reactions, performance responses, and technical scores of young tennis players after six weeks of high-intensity interval training (HIIT) vs. six weeks of on-court tennis training (OTT). They discovered that both training protocols significantly improved jump and sprint performance from pre- to post-testing (p< 0.05, d values ranging from 0.40 to 1.10). When compared to the HIIT group, the OTT group demonstrated significantly greater performance responses in terms of agility test performance and technical scores (p< 0.05, d = ranging from 0.77 to 0.88 [moderate effect]) (Kilit & Arslan, 2019). Arslan et al., (2020) compared the effects of 5-week running-based HIIT vs. small-sided game training on young soccer players' physical performance, psychophysiological reactions, and technical skills. A 1000-m run test, zigzag agility, repeated sprint ability, 30–15 intermittent fitness test, and speed dribbling ability test were done before and after the 5-week training sessions. Their results showed that SSG exercise improved agility and technical test performance more than HIIT (p≤ 0.05, d=ranging from 0.92 to 1.99). However, the HIIT group exhibited significantly better performance in the 1000-m run and repeated sprint tests (p

≤ 0.05, d=ranging from 0.90 to 2.06) (Arslan et al., 2020). Monks et al., (2017) wanted to determine how HIIT affected the performance of Taekwondo athletes. Thirty-three collegiate Taekwondo athletes were randomly allocated to one of two groups: HIIT (N=16) or HICR (N=17). The HIIT group engaged in high-intensity sprints with active rest periods, whereas the HICR group engaged in continuous high-intensity running. During the intervention, the T-test and sit-ups scores of the HIIT and HICR groups improved (Monks et al., 2017). Seo et al., (2019) investigate the effect of high-intensity interval training (HIIT) using a variety of work-to-rest ratios on athletes' athletic performance. 47 male Taekwondo athletes (aged 15–18 years) were randomly allocated to one of three HIIT groups or the control group. Each group completed six and eight bouts of HIIT: 1) 1:2 (30:60 s), 2) 1:4 (30:120 s), and 3) 1:8 (30:240 s) groups, respectively, while the control group completed only Taekwondo training. Each HIIT group met for ten sessions over a four-week period. Pre- and post-tests of athletic performance included the VO2max, Wingate anaerobic, vertical jump, and agility T-test. After ten sessions of HIIT with the 1:4 group over a four-week period, it was determined that the program was efficient for increasing both aerobic and anaerobic capacity (Seo et al., 2019). The purpose of Váczi et al., (2013) was to examine the effects of a short-term in-season plyometric training program on power, agility, and knee extensor strength. The study's findings show that plyometric training involving high-impact unilateral and bilateral exercises improved lower limb power and maximal knee extensor strength significantly, but had a smaller effect on soccer-specific agility (Váczi et al., 2013).

Gokkurt and Kivrak's (2021) objective was to investigate the effect of eight weeks of high-intensity interval training on speed, agility, and acceleration in under-nineteen (U19) soccer players. By comparing the pre-and post-test values for the speed and acceleration properties of the experimental group's soccer players, it was determined that their post-test values were significantly higher ($p<0.05$). The experimental group improved by pro-rata 0.008, but the control group improved by pro-rata 0.004 ($p<0.05$) (Gökkurt & Kıvrak, 2021). The purpose of Suppiah et al., (2020) was to determine the effect of high-intensity functional interval training on aerobic fitness, agility, and sprint performance in young badminton players. The results indicate that there was a significant difference in 20 m Multistage Fitness and Four Corner Agility between the experimental group (EG) and the control group (CG); F (1,14) = 4.663, ($p<0.05$) and F (1.14) = 5.443, ($p<0.05$), respectively (Suppiah et al., 2020). According to the findings of these research published in the literature, HIIT activities increase certain performance indicators. Obtaining data on the effect of HIIT activities at various times of the day on performance may help close a significant gap in the literature. The following studies examined the effects of exercises conducted at various times of the day on various performance measures. Maaouia et al., (2020) aims to investigate the impact of various methods of stretching on the diurnal variations in agility performance. Twenty elite teenage soccer players conducted the T-test agility protocol at two different times of the day (morning: 07:00–8:30 and evening: 17:00–18:30), with a minimum of two days between testing sessions. They revealed that performance improvement following dynamic stretching (DS) was much faster in the evening than in the morning, with a higher improvement at 17:00 h than at 7:00 h. The results indicate that the administration of DS has an effect on the typical diurnal variations in agility performance, whether in the morning or evening, and benefits in compensating for the physiological decline in morning value (Maaouia et al., 2020). Chittibabu's objective was to determine the diurnal variation in male handball players' motor fitness and core temperature. Ten male handball players were evaluated using a 30-meter run, a T-test, a vertical jump test, and a tympanic temperature measurement. There was no diurnal effect on speed ($F = 0.542$, $p> 0.05$), agility ($F = 0.991$, $p > 0.05$), or explosive power ($F = 0.812$, $p > 0.05$) in this investigation. However, the core temperature varied during the day ($F = 15.49$, $p < 0.05$), reaching a maximum at 17:00 hours (Chittibabu, 2014). Rai and Tiwari's (2015) objective was to examine diurnal variation in selected components of motor fitness in male university volleyball players. Thirty male volleyball players were assessed twice (once in the morning (between 7:00 and 9:00 a.m.) and once in the evening (between 5:00 and 7:00 p.m.). The standing broad range jump test is used to assess participants' explosive strength, the 30-yard dash test is used to assess their speed ability, and the Illinois agility test is used to assess their agility. The findings indicate that there is no significant effect of time of day (diurnal variations) on speed ability (tcal=0.06 ttab=1.671) or agility (tcal=0.71 ttab=1.671). The mean speed in the morning and evening was 4.31 seconds and 18.20 seconds, respectively, while the mean agility was 17.83 seconds (Rai and Tiwari, 2015). According to the literature, performance outcomes measured in the evening are superior to those measured in the afternoon and morning, which is consistent with our study.

CONCLUSION

In conclusion, this research revealed that HIIT exercise protocols performed in the evening (5:00-19.00) were more effective than those performed in the morning at enhancing agility and 30 m sprint performance (09.00-11.00). When organizing exercise routines, diurnal variation might be taken into account. There are some limitations to this study. This study did not use participants of different sexes, and the results were not assessed by assessing the volunteers' body and muscle temperatures. The study can be repeated by increasing the number of samples collected from male and female athletes of various ages and sports. Furthermore, performance indicators may be examined at different times of the day, and training plans can be designed based on individual awareness, taking into consideration the participants' circadian rhythms. Increasing the quantity of research analyzing the effects of different times of day on various parameters may result in more precise recommendations regarding planning participants.

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