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The Effects of Extensive Interval and Continuous Run Trainings on Aerobic Anaerobic Power

Mehmet Altin

Selcuk University, Faculty of Sport Sciences, Recreation Department, Konya, Turkey
E-mail: <mealtin@selcuk.edu.tr>

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ABSTRACT This paper aimed to determine the effects of the continuous run and extensive interval run trainings on aerobics and anaerobic power. Total 47 male students including 16 athletes in the Extensive Interval Running Group (EIRG), 15 athletes in the Continuous Run Group (CRG) and 16 athletes in the Control Group (CG) were included. The training program was totally applied to EIRG and CRG for 3 days per week during 8 weeks by determining aerobics with the Shuttle Run Test and anaerobic power with the Wingate test before the trainings, these measurements were recorded after the training process. In this paper; considering the first and second measurement values of EIRG and the second measurements, there were significant differences between the CG and CRG averages. Hereby, it can be said that CRG trainings, leads to increase in maxVO_2 level more, EIRG trainings represent more development in anaerobic power as well as maxVO_2.

INTRODUCTION

In training sciences, the popularity and importance of aerobic power, anaerobic power and performance concepts have been on agenda for current researches. Everyone interested in sport science are mostly in search of new training methods to develop athletes' performance and sedentary people' health parameters (Issurin 2010). Maybe the miraculous innovations by technology have started a new period for developing, testing athletes' conditional features with various methods, techniques and tools-measurements. According to Bompa (2003), physical activities cause anatomical, physiological, biochemical and psychological changes and the quality of activities vary with time, distance, repetition, number, volume, density. Therefore, the basic determinant of the effects of sportive activities is that activities must be performed depending on a certain system and program. Favorable aerobic capacity is the greatest determinant of life quality in individuals. If there is a balance between O_2 (Oxygen) taken and O_2 to be taken in physical activities, the relevant activities represent aerobics. Aerobic capacity is defined as the capacity for adapting to work. When major striated muscle groups use energy from the aerobic metabolism, the value of aerobic capacity per unit means aerobic power (Yildiz 2012).

Anaerobic capacity is defined, as work capacity occurring when skeletal muscles use anaerobic energy transfer systems during maximal and supramaximal physical activities (Jonathan and Euan 1997). The value of anaerobic capacity per unit, is called anaerobic power. Assessing anaerobic power in sports, such as, weight-lifting, discus throw, 100 m speed runs and plays such as, basketball and football, including, activities such as, rapid exits, is significant in evaluating anaerobic performance (Yildiz 2012). Özkan et al. (2010) described anaerobic performance as a term important for sport branches which are fulfilled in short time and need explosive strength, and stated that athletes' performance is affected by individual and environmental factors.

Jonathan and Euan (1997) paid attention to the fact that anaerobic activity is an activity which carries characteristics of work load above anaerobic threshold representing explosive strength and shows itself as tiredness. Anaerobic activity cannot be maintained for a long time hence, it is hardly ever possible to measure anaerobic power; that is, anaerobic capacity, completely, directly and objectively. Measurements can

Address for correspondence:
Selcuk University, Faculty of Sport Sciences,
Recreation Department, Konya-Turkey
Telephone: +90 332 2234786
Fax: +90 332 2411606
Mobile:+90 538 076 98 18

be done through tests and indirect methods, that are partly reflecting anaerobic power (Foss and Keteyian 1998).

Training methods and load techniques, which aim to push at the basic motoric characteristics over the top, have been substituted with modern trainings and load techniques with more diversities and alternatives owing to the contributions of rapidly progressing technology and scientific developments. As trial period, it is obligatory to keep on endurance exercises for 8-12 weeks, these exercises are repeated three times in a week with each performance period involving 45-50 minutes (ACSM 2014). Endurance is of great importance in performing and maintaining lots of sportive activities. Continuous and interval runs, repetitions and competition methods, are often used in the development of endurance. Sevim (2002) wrote about the characteristics of interval training, that working and resting or high and low loaded stages change systematically, adding that resting can be regarded as active or passive. Muratli et al. (2011) suggested that common interval trainings can be performed by repetitions in a distance of 800 meter; these distance intervals involve 100, 200, 400 and 800 meter respectively. The biggest advantage of interval training is to do more work with less tiredness. At the end of muscle activity, resting interval is carried out against tiredness. Furthermore, any person can work more productively since body heat does not become high so quickly (Fox et al. 1988). Gibala (2007) informed that intensive interval activities applied for a few weeks atleast increased oxygen intake and activities of mitochondrial enzymes representing energy in skeletal muscles. Positive effects of interval trainings on human health and performance have been presented as research issues now. Sevim (2002) dealt with interval training in two titles including extensive (common) and intensive (intensive). The working density is low, but continuous in common interval training whereas working density is high, load time is less and resting time is long in intensive interval training (Sevim 2002). Even if the concepts of interval and intermittent mean discontinuous activities in the literature (Bompa 1998; Fox et al. 1988), the word "intermittent" mostly represents activities lasting less than 1 minute while the word "interval" mostly represents activities lasting between 2-6 minutes (Shephard and Astrand 1993). Interval trainings applied in high forms were regarded to be the most effective training method which improves aerobic and anaerobic capacity, cardiovascular system and metabolic functions (Buchheit and Laursen 2013). Dündar (2000) explained that continuous runs organized in an athlete's pulse, heart beats of 130-160 at unchanged pace or volume, last 30 minutes in young athletes and, between 60 minutes and 120 minutes in adult athletes. Meanwhile, the volume of trainings is said to be fifty to seventy percent in accordance with the continuous runs method. Moreover, load time is high in interval training, resting between loads is short-term, as productive rests (30-40 seconds, around 1-2.5 minutes). Çevik et al. (1996) informed that, interval and continuous run trainings are very effective methods in the development of aerobic power and capacity.

Even though, technology and science advance in a continuous way, the researches about the effects of training systems, on any organism remains study and research issues, without losing their actuality. As in the past, studies which focus on the determination of limitations of human organisms today, and in next period, will be kept on with their popularity.

Objective

This study was done in order to determine the effects of extensive interval and continuous run trainings on aerobic and anaerobic power.

MATERIAL AND METHODS

Scope and Sample

The research scope included the athlete students who went on their education in university, the sampling group involved total 47 male athletes who studied at various departments in Selcuk University, had amateur licenses in individual/team sports and had 5 years of sport background at least. The subjects were divided into three groups including DKG, EIKG and CG.

Load Methods and Volume

In determination of load volume, Polar FT4 Quick Guide heart rate monitor was used. Average heart rate and maximum heart rate measures, were recorded during exercises. Sport men were required to run at the pre-determined load vol-

ume during exercises. Activities were performed for both groups at the temperature rate of 18-23 C° between the hours 06:30-08:30 spending between 1-2 hours per day, repeating same procedures for 3 days in each week. The groups were admonished to care about their nutrition, their health controls were taken before the research and they signed the consent report showing that they participated in the study voluntarily.

For the first two weeks, activities were required at lower volume and general aerobic strength-supporting quality, in order to adapt to EIRG and CRG trainings and control heart beats (Table 1).CRG activities were done at fifty to seventy percent volume in pulse interval (130-160) determined in accordance with the Karvonen method with the load time at medium long level (Table 3). Continuous runs were performed at a distance of 10-15 km on soft ground in a forest on average.

Fisher and Jensen (1990) mentioned about the necessity of the principles of density, time, repetition, numbers and time of sets, type and weekly training number, while preparing an interval training program. As a basic rule for interval training, Sevim (2002) reported that activities must be stopped, when the heart rate reached 180-200, another activity must be started when it reduced to 120-130. In the same study, as a general principle in common interval training, it was stated that runs must be done with the maximum performance capacity of sixty to eighty percent heart rate was expected to reduce to 125-130, between repetitions in high level sportmen, heart rate was expected to reduce to 110-120 in new starters and young people (Sevim 2002).

Table 1: Adaptation training program applied in study groups

Extensive Interval Training Group (EIRG)				*Continuous Run Training Group (CRG)*			
(3 days in a week- Monday/Wednesday/Friday)							
Weeks	*Volume (%)- Time (min)*	*Characteristics*	*Aim*	*Weeks*	*Volume (%)- Time (min)*	*Characteristics*	*Aim*
1	50/ 50-60'	Low pace runs	Adaptation	1	50/ 50-60'	Low pace runs	Adaptation
2	50 / 60-70'	Low pace runs	Adaptation	2	50 / 60-70'	Low pace runs	Adaptation

Table 2: Extensive interval training program

Extensive interval activities (3 days in a week- Monday/Wednesday/Friday)				
Weeks	*Volume (%) and time*	*Warm-up*	*Main stage*	*Finish*
3	60-65 / 60-70'	10-15' Low pace runs and aerobic drills	400x2 - 800x2 (2 series) Inter-series active resting	10-15' cool dawn
4	60-65 / 70-80'	10-15' Low pace runs and aerobic drills	400x3 - 800x3 (2 series) Inter-series active resting	10-15' cool dawn
5	65-70 / 80-90'	10-15' Irregular runs and skipping-ropes, drills with barrier sticks	400x2 600x2 800x2 (2 series) Inter-series active resting	10-15' cool dawn
6	65-70 / 80-90'	10-15' Irregular runs and skipping-ropes, drills with health ball	400x2 600x2 800x2 (2 series) Inter-series active resting	10-15' cool dawn
7	70-75 / 90-100'	10' Warm-up with play form, 5' preparation of missing parts	200x3 400x3 800x3 (2 series) Inter-series active resting	10-15' cool dawn
8	70-75 / 90-100'	10' 1500 m Athletic runs 5' paired run drills	200x3 400x3 800x3 (2 series) Inter-series active resting	10-15' cool dawn
9	75-80 / 100-110'	10-15' Low pace runs and various run drills	200 x2 400x2 800x2 (3 series) Inter-series active resting	10-15' cool dawn
10	75-80 / 100-110'	10-15' Irregular runs and skipping-ropes, drills with barrier sticks	200 x2 400x2 800x2 (3 series) Inter-series active resting	10-15' cool dawn

'= minutes (min)

Table 3: Continuous runs training program

Continuous runs (3 days in a week- Monday/Wednesday/Friday)

Weeks	*Volume (%) and time*	*Warm-up*	*Main stage*	*Finish*
3	50-55 / 80'	5-10' Low pace runs and aerobic drills	60'	10-15'cool dawn
4	50-55 / 90'	5-10' Low pace runs and run drills	70'	10-15'cool dawn
5	55-60 / 105'	10-15' Irregular runs and skipping-ropes, drills with barrier sticks	75'	10-15'cool dawn
6	55-60 / 110'	10-15' Irregular runs and skipping-ropes, drills with health ball	80'	10-15'cool dawn
7	60-65/ 115'	10' Warm-up with play form, 5' Preparation of missing parts	85'	10-15'cool dawn
8	60-65/ 120'	10' 1500 m Low pace runs 5' paired run drills	90'	10-15'cool dawn
9	65-70/120'	10-15' Low pace runs and various run drills	2x40'	10-15'cool dawn
10	65-70/120'	10-15' Irregular runs and skipping-ropes, drills with barrier sticks	2x45'	10-15'cool dawn

'= minutes

According to Fisher and Jensen (1990), the repetition number in the study depends on the length of activity interval. As activity interval becomes shorter, repetition number increases. In short-term, highly intensive intervals, resting time is 2-3 times of activity interval. In longer, medium level activity intervals, resting time may be as activity interval (1:1) or shorter (1:0.5). Generally, athletes must do trainings 5-7 times in a week, while, non-athletes must do them 3-4 times. When doing activities, all issues mentioned above have been considered and fundamentals and principles have been adapted.

With the extensive interval training method, the load duration was kept in medium-long level by using sixty to eighty percent load volume. Activities were carried out on athleticism soil track of Selcuk University, heart rate was considered to be 150-170 (Table 2). After starting activities, 6 students from the study group, 3 students from the control group were excluded from the research, since they did not obey the nutrition principles and show necessary importance to activities.

Applied Tests

Although, there are many tests measuring aerobic power, Shuttle Run test is the mostly known and used one among these. MaxVO_2 is the most valid measurement method of aerobic energy system, functional strength capacity (Tiryaki 2002). This test developed by Leger and Lampart (1982) is regarded to be one of the best tests, which can be used for determining approximate maximal oxygen usage (Kamar 2008).

Shuttle-Run (20 meter) Test

The objective of this test, is to estimate max-VO_2 value and it is the most valid method of aerobic energy system, functional strength capacity (Tiryaki 2002).Before starting the test, the subjects are motivated to have higher performance and they were pre-informed about the test. People do not need to do warm-up before starting the test, because 20 m shuttle run test is a test with multiple steps, its first steps are of warm-up pace (Tamer 2000). The shuttle-run test was performed by 2 expert trainers in accordance with the procedures and maxVO_2 values were recorded as ml/kg-dk.

Wingate Test

Wingate test which is used to determine anaerobic performance, is regarded to be a valid and reliable test in literature (Tharp et al. 1985; Bar-Or 1987; Kamar 2008; Tamer 2000; Özkan et al. 2010). Wingate test is performed, using the cycling ergometer; it is based on the principle of resistance to load determined in accordance with a person's Body Weight (BW) (Bar-Or 1994; Green 1995). Wingate Anaerobic power test (WAnT) is one of the tests, which give information about both lactic acid and alactic acid compounds, and determine anaerobic characteristics (Ingulf and Burgers 1990;Inbar and Bar-Or 1986). The time for the test which is, taken for measuring alactic acid and lactic acid anaerobic capacities is 30 seconds, and the subject cycles in this time as soon as possible. Ergometer re-

sistance is adjusted in the first 2-3 seconds after starting the test, and at the same time, hour and electronic pedal meter are activated. Pedal numbers are recorded for every 5 seconds. At the end of the test, alactic acid capacity is estimated as maximal power observed for 5 seconds (watt/kg BW), lactic acid capacity is regarded as total performance in 30 seconds (joule or joule/kg BW) (Tamer 2000).In this study, the measurements were done in accordance with the procedures of Wingate test and the results were recorded as ml/kg/dk.

Statistical Analysis

Normality and variance homogeneity of the data were tested; the paired samples t, test for differences in measurements, the One Way Anova for resources of differences in the groups and the Tukey test for differences were used.

FINDINGS

Any significant differences were not seen in the relevant participants' age and height changes before the study as shown inTable 4.

There were no differences between the groups in the first measurement values of BW (Body Weight), BMI (Body Mass Index), BFP (Body Fat Percentage), Total Skinfold, $MaxVO_2$ and Anaerobic power. Considering the first and second measurement values of BW, statistically significant differences were found in CRG averages as seen in Table 5 ($P<0.05$).

When the BMI values were examined, significant differences were observed in the first and second measurement values of CRG, in the second measurements of CG and other two groups ($P<0.05$). When the BFP values were taken, significant differences were also found in the first and second measurement values of CRG, in the second measurements of CG and other two groups ($P<0.05$). Seeing the Total Skinfold values, significant differences were determined in the first and second measurements of EIRG and CRG groups, in the second measurements of CRG and other groups ($P<0.05$).

Looking at the $MaxVO_2$ values, there were significant differences in the first and second measurements of EIRG and CRG and in the second measurement values of EIRG, CRG and CG averages ($P<0.05$). When examining the anaerobic power values, there were no differences in the CG and CRG measurements and between the groups; when considering the first and second measurement values of EIRG and the second measurements, there were significant differences between the CG and CRG averages.

Table 4: Age and height parameters of groups

Parameters	*EIRG (n=16)*	*CRG (n=15)*	*CG (n=16)*
Age (years)	23.01 ± 2.97	23.6 ± 3.1	24.2 ± 3.12
Height (cm)	175 ± 6.34	177 ± 6.83	176 ± 7.12

Table 5: Physical parameters of groups

Parameters	*Measurement*	*E IRG* $x \pm SD$	*CRG* $x \pm SD$	*CG* $x \pm SD$
BW (kg)	1st	74.32 ± 8.42	74.3 ± 7.24	72.3 ± 8.43
	2st	72.28 ± 7.46	70.12 ± 6.34*	71.31 ± 6.48
BMI (kg/m^2)	1st	22.83 ± 3.1	23.41 ± 3.42	24.3 ± 4.1
	2st	21.12 ± 2.93b	21.12 ± 2.98*b	24.1 ± 3.92a
BFP (%)	1st	12.92 ± 2.68	13.28 ± 2.63*	13.84 ± 3.21
	2st	11.83 ± 2.78b	11.33 ± 2.41b	13.76 ± 3.38a
Total Skinfold	1st	67.32 ±15.34*	65.24 ±17.38*	64.41 ±14.32
	2st	63.21 ±14.18b	59.21 ±14.41a	63.28 ±13.48b
$MaxVO_2$ (ml/kg/min)	1st	50.8 ± 5.3*	51.38 ± 6.21*	50.49 ± 5.98
	2st	53.4 ± 6.2b	59.27 ± 6.51a	51.27 ± 6.21b
Anaerobic Power(ml/kg/min)	1st	49.32 ± 5.12	49.05 ± 3.66	48.04 ± 4.36
	2st	54.15 ± 4.33*a	50.85 ± 5.48b	49.01 ± 4.31b

BW: Body weight; $MaxVO_2$: Maximal oxygen consumption; BMI: Body mass index; BFP: Body fat percentage
*P<0.05 Inter-Measurements Difference a,b,cInter-Groups Difference
*(Paired-Simples T Test) a,b,c (One-Way Anowa)

DISCUSSION

In this paper, any statistical differences were not seen in the first measurement values of VA, VKI, VYY, Total Sikinfold, MaxVO_2 and Anaerobic power between the groups. Aerobic focused trainings, which were followed three times in a week during 2 weeks, were considered to facilitate athletes' adaptation to running programs.

In literature, the researchers suggested that regular exercises and interval run programs provided weight control and made positive effects on health (Gökdemir et al. 2007; Alp et al. 2015; Gleeson 2007; Trap et al. 2008; Baynaz et al. 2017; Sajedi 2016; Halson et al. 2003; Altinkök 2015; Koç et al. 2007). These researches are parallel with the relevant findings of this paper. Keeping performance and reaching at the high level require to move easily and in flexible ways in compliance with joint movements by athletes. So body mass index and body fat percentage are necessary parameters to be kept under control and in certain scales.

When the first and second measurement values of body weight were studied, statistically significant differences were seen in the CRG averages ($P<0.05$). And there were significant differences in the BMI averages, the first and second measurement values of CRG, the second measurements of CG and other two groups ($P<0.05$). When studying Total Skinfold values, there were significant differences between the first and second measurements of EIRG and CRG, the second measurements of CRG and other groups ($P<0.05$). Revan et al. (2008) in their researches focused the effects of continuous and interval runs on body composition; body mass index, body fat percentage, total skinfold and maxVO_2 values. Statistical differences were reported in continuous run and interval run groups. Yüksel et al. (2007) suggested that the continuous run method was effective on body weight, body fat percentage and aerobic power values whereas interval trainings were not effective on body weight, body fat percentage and anaerobic power values. Revan et al.'s (2008) and Yüksel et al.'s (2007) researches are in harmonisation with these relevant findings. Furthermore, there were meaningful differences between the first and second measurement values of CRG, the second measurements of CG and other two groups when examining the BFP values ($P<0.05$). Stamford (1983) stated that body fat percentage reduced due to a high level of calorie burn as a result of trainings. Trapp et al. (2008) found reduction in body weight and body fat percentage in the group in which the intensive interval activity was applied. Koç (2010) reported that reductions associated with body weight and body fat percentage values were meaningful in male handball players performing aerobic training program. The literature showed that there is a negative correlation between body fat percentage and weight, owing to endurance trainings for 3 days in 8 weeks (Ribeiro et al. 2004; Revan et al. 2008; Hawley 2002). Within this study, changes in BW, BFP, BMI and Total skinfold values comply with the studies mentioned above.

Continuous and low density-interval trainings for 10 weeks provide benefits for maxVO_2 values like continuous runs (Overend et al. 1992; Morris et al. 2002). Some researches suggest that interval training method had more positive effects on vascular system in accordance with different training methods and techniques (Billat et al. 2001; Milanovic et al. 2015; Ramos et al. 2015). Berger et al.'s (2006) study named 'The Effect of Interval Trainings on Oxygen Usage Capacity' indicated that maxVO_2 values have statistically meaningful changes in the extensive interval training groups that is, extensive interval activities lead to increase in maxVO_2. Revan et al. (2008) observed statistically significant difference in maxVO_2 values of the groups doing continuous and interval runs. This study also showed, that there were significant differences in the first and second measurements of EIRG and CRG, the second measurement values of EIRG and CRG, the CG averages when examining maxVO_2 values ($P<0.05$). Most literature reviews show that interval running programs made positive effects on maxVO_2 value (Krustrup et al. 2003; Hazell et al. 2010; McMillan et al. 2005; Slothet al. 2013; Milanovic et al. 2015; Demiriz et al. 2015). These findings note that increases and correlations in maxVO_2 values of both running groups were parallel with each other.

This study showed no significant differences in the CG and CRG measurements and between the groups, when looking at anaerobic power values; but significant differences between the CG and CRG averages, when considering the first and second measurements of EIRG. Baynaz et al. (2017) suggested that improvements in anaerobic power values were statistically significant in sedentary females doing in-

terval trainings. Hazell et al. (2010) presented that interval sprint trainings had positive effects on anaerobic power. Altinkök (2015) stated that there were statistically significant changes in anaerobic values of the trial group within their study aimed at the influence area of highly intensive interval trainings. Helgerud et al. (2007) studied the effects of different load volumes on endurance parameters and mentioned about meaningful differences in anaerobic capacity of intensive interval training group rather than other groups. Fox et al. (1988) compared interval trainings with the method of continuous runs and suggested that there were less lactic acid accumulation in interval training and thus, tiredness level became lower and some parts of ATP-CP storages in muscles were renewed in resting period. Demiriz et al. (2015) informed that there were increases in maxVO_2values of Extensive Interval Group at $p<0.05$, in anaerobic threshold values at $p<0.01$, owing to the interval trainings with various resting intervals. Any increase in EIRG aerobic and anaerobic power are parallel with the studies mentioned above. Some researches indicate that interval trainings increased aerobic adaptation in accordance with the method of frequent runs much more (Daussin et al. 2007; Ribeiro et al. 2004).

CONCLUSION

In EIRG and CRG total skinfold and maxVO_2 values, increases were observed after the training process and these differences were regarded to be statistically significant. Also, CRG values were statistically higher than EIRG values. Rather than extensive interval training programs, regular runs influence anaerobic power much more.

More decreases were observed in BMI, BW and BFP values of CRG rather than other groups. The reason of these changes is related with organizing regular run programs in aerobic environment and leaving more positive effects on body mass index and body fat percentage.

BMI, BW, BFP, MaxVO_2, Anaerobic Power values of CG were found to be lower than EIRG and CRG values and these differences were regarded to be statistically significant. Since the control group was not included in regular training period regarding the trial groups, any decrease in performance values can be seen as a natural result. A statistically significant and high difference was observed in the first and second measurements of EIRG anaerobic power rather than CRG values. Extensive interval trainings were more effective on anaerobic power than continuous run trainings.

As a result of all these evaluations, it can be concluded that Continuous Runs and Extensive Interval Runs are valid training methods to increase maxVO_2 capacity; and that, continuous run trainings for body mass index and body fat percentage and extensive interval runs for development of anaerobic capacity can be more effective.

RECOMMENDATIONS

In addition to continuous and interval run trainings, the effects of other training methods and techniques must be researched and analyzed in order to maintain BW,BMI, BFP control.

For improving aerobic and anaerobic capacity from the determinants of life quality, modern training methods and techniques must be given with their effects without losing any time.

Training methods and techniques were considered to be highly effective by analyzing changes in accordance with various population and age groups.Herein, this paper will shed light for the next studies.

REFERENCES

Alp M, Kilinç F, Suna G 2015. Hazirlik sezonunda hentbolculara uygulanan antrenmanlarin bazi antropometrik ve biyomotorik özellikler üzerine etkisinin incelenmesi. *SSTB*, 17: s47-s59.

Altinkök M 2015. Yüksek Siddetliinterval antrenman uygulamasinin etki alaninin incelenmesi. *IJER*, 1(2): 2149-2159.

American College of Sports Medicine (ACSM) 2014. *Information on High Intensity Interval Training*. ACSM's Consumer Information Committee.

Bar-Or O 1994. *Testing of Anaerobic Performance by the Wingate Anaerobic Test*. Bloomington: GRS Tech Publication.

Bar-Or O 1987.The wingate anaerobic test: An update on methodology, reliability and validity. *Sports Med*, 4: 381-394.

Baynaz K, Acar K, Çinibulak E, Atasoy T, Mor A, Pehlivan B, Arslanoglu E 2017. The effect of high intensity interval training on flexibility and anaerobic power. *JHS*, 14(4): 4088-4096.

Berger NJ, Tolfrey K, Williams AG, Jones AM 2006. Influence of continuous and interval training on oxygen uptake on-kinetics. *Med Sci Sports Exerc*, 38(3): 504-512.

Billat VL, Slawinski J, Bocquet V, Chassaing P, Demarle A, Koralsztein JP 2001. Very short (15s±15s)

interval training around the critical velocity allows middle-aged runners to maintain VO_2 max for 14 minutes. *Int J Sports Med,* 22(3): 201-208.

Bompa OT 2003. *Dönemleme Antrenman Kurami ve Yöntemi*. 2 Baski. Ankara: Dumat Ofset, pp. 365-372.

Bompa TO 1998. *Antrenman Kurami ve Yöntemi*. Çev. Ilknur K and Burcu T. Bagirgan Yayinevi. Ankara.

Buchheit M, Laursen PB 2013. High-intensity interval training solutions to the programming puzzle. *Part I, Med,* 43(5): 313-338.

Çevik C, Günay M, Tamer K, Sezen M, Onay M 1996. Farkliaerobik nitelikli antrenmanlarin serum enzimler, serum elektrolitler, üre, kreatin, total protein, fosfor ve ürik asit üzerindeki etkileri ve iliski düzeylerinin belirlenmesi. *Gazi Journal of Physical Education and Sport Sciences,* 1(2): s37-s46.

Daussin FN, Ponsot E, Dufour SP, L-Wolf E, Doutreleau S, Geny B, Piquard F, Richard R 2007. Improvement of VO_2max by cardiac output and oxygen extraction adaptation during intermittent versus continuous endurance training. *Eur J Appl Physiol,* 101(3): 377-383.

Demiriz M, Erdemir I, Kayhan RF 2015. Farkli dinlenme araliklarinda yapilan anaerobik interval antrenmanin, aerobik kapasite, anaerobik esik ve kan parametreleri üzerine etkileri. *USEABD,* 1(1): 1-8.

Dündar U 2000. *Antrenman Teorisi*. 5 Baski. Ankara: Bagirgan Yayinevi.

Fisher AG, Jensen CR 1990. *Scientific Basis of Athletic Conditioning.* 3rd Edition. Philadelphia: Lea and Febiger, pp.161-169.

Foss ML, Keteyian SJ 1998. *Fox's Physiological Basis for Exercise and Sport.* 6th Edition. Boston: WCB/ McGraw-Hill.

Fox EL, Bowers RW, Foss LM 1988. *The Physiological Basis of Physiol Education and Athletics*. Philadelphia: Sounders College Publishing, pp. 62-82.

Gibala MJ 2007. High-intensity interval training: New insights. *Sports Science Exchange,* 20(2): 1-5.

Gleeson M 2007. Immune function in sport and exercise. *J Appl Physiol,* 103: 693-699.

Gökdemir K, Koç H, Yüksel O 2007. Effects of aerobic training program on respiration circulation and body fat ratio of university students. *Egzersiz Çevrimiçi Dergisi,* 1(1): 45-49.

Green S 1995. Measurement of anaerobic work capacities in humans. *Sports Med,* 19: 32-42.

Halson SL, Lnacaster GI, Jeukendrup AE, Gleeson M 2003. Immunological responses to overreaching in cyclists. *Med Sci Sports Exerc,* 35(5): 854-886.

Hawley JA 2002. Adaptations of skeletal muscle to prolonged, intense endurance training. *Clin Exp Pharmacol Physiol,* 29: 218-222.

Hazell TJ, Mac Pherson REK, Gravelle BMR, Lemon PWR 2010. 10 or 30-s sprint interval training bouts enhance both aerobic and anaerobic performance. *Eur J Appl Physiol,* 110(1): 153-160.

Helgerud J, Høydal K, Wang E, Karlsen T, Berg P, Bjerkaas M, Simonsen T, Helgesen C, Hjorth N, Bach R, Hoff J 2007. Aerobic high-intensity intervals improve VO_2max more than moderate training. *Med Sci Sports Exerc,* 39(4): 665-671.

Inbar O, Bar-Or O 1986. Anaerobic characteristics in male children and adolescents. *Medicine and Science in Sport Exercise,* 18: 264-269.

Ingulf J, Burgers S 1990. *Effects of Training on the Anaerobic Capacity*. Norway: Department of Physiology, National Institute of Occupational Health.

Issurin VB 2010. New horizons for the methodology and physiology of training periodization. *Sport Med,* 40(3): 189-206.

Jonathan M, Euan A 1997. A perspective on exercise, lactate, and the anaerobic threshold. *Chest Exercise and the Heart,* 111: 787-795.

Kamar A 2008. *Sporda Yetenek Beceri Ve Performans Testleri.* 2 Baski. Ankara: Nobel Yayimevi, pp. 150-179.

Koç H 2010. Influence of aerobic training program on some respiratory and circulatory parameters in male handball players. *TJSE,* 12(3): 185-190.

Koç H, Tamer K, Çoksevim B 2007. Effects of continuous and interval running programs on creatin and urea plasma levels. *Journal of Health Sciences,* 16(1): 17-22.

Krustrup P, Mohr M, Amstrup T, Rysgaard T, Johansen J, Steensberg A, Pedersen PK, Bangs J 2003. The yo-yo intermittent recovery test: Physiological response, reliability, and validity. *Med and Sci in Sports and Exerc,* 35(4): 697-705.

Leger LA, Lambert J 1982. A maximal multistage 20 meter shuttle run test to predict VO_2max. *Eur J Appl Physiol Occup Physiol,* 49(1): 1-12.

McMillan K, Helgerud J, Macdonald R, Hoff J 2005. Physiological adaptations to soccer specific endurance training in professional youth soccer players. *Br J Sports Med,* 39: 273-277.

Milanovic Z, Sporis G, Weston M 2015. Effectiveness of high-intensity interval training (HIT) and continuous endurance training for VO_2max improvements: A systematic review and meta-analysis of controlled trials. *Sports Med,* 45(10): 1469-1481.

Morris N, Gass G, Thompson M, Bennett G, Basic D, Morton H 2002. Rate and amplitude of adaptation to intermittent and continuous exercise in older men. *Med Sci Sports Exerc,* 34(3): 471-477.

Muratli S, Kalyoncu O, Sahin G 2011. *Antrenman ve Müsabaka.* 3 Baski. Istanbul: Kalyoncu Spor Danismanlik Ltd, pp. 213-215.

Overend TJ, Paterson DH, Cunningham DA 1992. The effect of interval and continuous training on the aerobic parameters. *Can J Sport Sci,* 17(2): 129-134.

Özkan A, Köklü Y, Ersöz G 2010. Wingate anaerobik güç testi. *Uluslararasi Insan Bilimleri Dergisi,*7(1): 207-224.

Ramos JS, Dalleck LC, Tjonna AE, Beetham KS, Coombes JS 2015. The impact of high-intensity interval training versus moderate-intensity continuous training on vascular function: A systematic review and meta-analysis. *Sports Med,* 45(5): 679-692.

Revan S, Balci, SS, Pepe H, Aydogmus M 2008. Sürekli ve interval kosu antrenmanlarinin vücut kompozisyonu ve aerobik kapasite üzerine etkileri. *Spormetre Beden Egitimi ve Spor Bilimleri Dergisi,* VI(4): 193-197.

Ribeiro BL, de Mello MA, Gobatto C 2004. Continuous and intermittent exercise: Effects of training and detraining on body fat in obese rats. *Arch Latinoam Nutr,* 54(1): 58-65.

Sajedi H 2016. *Genel Hazirlik Döneminde Yapilacak 6 Haftalik Glutamin Yüklemesinin Elit Hentbolcularin Aerobik, Anaerobik Güç ve Kuvvet Parametrelerine Etkisi*. Doktora Tezi, Yayimlanmamis. Erzurum, Turkey: SBE, Atatürk Üniversitesi.

Sevim Y 2002. *Antrenman Bilgisi*. Ankara: Nobel Yayin Daðitim.

Shephard RJ, Astrand PO 1993. *Endurance in Sport.* London: Blackwell Scientific Pub, pp. 9-15.

Sloth M, Sloth D, Overgaard K, Dalgas U 2013. Effects of sprint interval training on VO_2max and aerobic exercise performance: A systematic review and meta-analysis. *Scand J Med Sci Sports,* 23(6): 341-352.

Stamford B 1983. The results of aerobic exercise. *Phys Sportsmed,* 1(9): 145.

Tamer K 2000. *Sporda Fiziksel-Fizyolojik Performansin Ölçülmesi ve Degerlendirilmesi*. Ankara: Baggirgan Yayimevi, pp. 48-165.

Tharp GD, Newhouse RK, Uffelman L, Thorland WG, Johnson GO 1985. Comparison of sprint and run times with performance on the Wingate anaerobic test. *Res Q Exerc Sport,* 56: 73-76.

Tiryaki G 2002. *Egzersiz ve Spor Fizyolojisi*. Ankara: Ata Ofset Matbaacilik,

Trapp EG, Chisholm DJ, Freund J, Boutcher SH 2008. The effects of high-intensity intermittent exercise training on fat loss and fasting insulin levels of young women. *Int J Obes,* 32(4): 684-691.

Yildiz SA 2012. What is the meaning of aerobic and anaerobic capacity? *Solunum Dergisi,* 14(Suppl): 1-8.

Yüksel O, Koç H, Özdilek Ç, Gökdemir K 2007. The effect of continuous and interval training programs on anaerobic and anaerobic power of the university students. *Journal of Health Sciences,* 16(3): 133-139.

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