Turkish Journal of Sport and Exercise /Türk Spor ve Egzersiz Dergisi
http://dergipark.gov.tr/tsed
Year: 2020 - Volume: 22 - Issue: 1 - Pages: 19-23
DOI: 10.15314/tsed.678929

ISSN: 2147-5652

The Effect of Bicycle Training Program on Aerobic and Anaerobic Performance

Şükran ARIKAN[1A], Serkan REVAN[1B]

[1]*Selcuk University, Faculty of Sport Sciences, Konya, TURKEY*

Address Correspondence to S, Arıkan, e-mail: sarikan@selcuk.edu.tr

(Received): 23.01.2020 / (Accepted): 24.03.2020

A:Orcid ID: 0000-0002-2625-0898- B: 0000-0002-9056-3514

Abstract

The aim of this study is to determine the effect of cycling exercise program applied to young adults for eight weeks on aerobic and anaerobic performance. Fourteen volunteer, non-smokers, moderately active men aged between 19-23 participated in the study. The aerobic performance of the participants before and after the training program was determined by 20-meter shuttle running test and their anaerobic performance was determined by Wingate anaerobic power test. The training program consisted of 40-60 minutes cycle ergometer exercise performed 3 times weekly for 8 weeks at a work load corresponding to 60-80% of the maximal heart rate. The pre-post data were compared using the Wilcoxon paired signed ranks test. According to the findings of the study, there was no significant difference in body weight, body mass index, minimum strength and fatigue index values ($p>0,05$), while there was a significant difference in the maximum oxygen uptake (VO_2 max), peak power and average power values in the pre-test and post-test scores ($p<0,05$). As a result, it can be said that regular cycling exercise program improves aerobic and anaerobic performance positively.

Key words: Wingate anaerobic power test, aerobic power, bicycle training program.

INTRODUCTION

Scientific evidence showing the beneficial effects of exercise is indisputable, and the benefits of exercise are far greater than the risks of exercise in most adults. To improve and maintain physical fitness and health, a regular training program that includes cardiorespiratory, resistance, flexibility and neuromotor exercise training, beyond daily life activities is required for most adults (8). Endurance training that improves oxygen delivery from the atmosphere to the mitochondria and enables adaptations of the cardiovascular and neuromuscular systems, which allows for tighter regulation of muscle metabolism, improves peak oxygen consumption, increases the capillary density of the working muscle, increases blood volume and reduces heart rate during exercise at the same absolute intensity (14,15). Sport-specific training programs are designed to optimize the skills of the players, and must comply with the physiological and energetic demands of a particular sport. For most sports, adenosine triphosphate-phosphocreatine (ATP-PC), glycolytic and oxidative phosphorylation systems play an important roles. The first two energy systems are the main source of ATP during high-intensity exercise, while the mitochondrial system plays an important role in the recovery period (36).

It is stated that designing high intensity exercise programs can be an important success factor and high intensity training programs are especially critical for improving cardiac function. Although high-intensity exercise appears to lead to greater beneficial adaptations in the cardiovascular system, it is still unknown whether this type of training is safe in larger patient groups than in low-to-moderate training, and whether it affects the complication rates in patients more positively (34). For a certain level of energy expenditure, the high intensity training program causes more subcutaneous fat loss compared to the moderate intensity training program. From a clinical point of view, the most suitable program for individuals at risk of health problems or obese people who are unable to exercise is a low-intensity exercise program with a progressive increase in duration and frequency of sessions (29). Although high-intensity training is stated to be more effective in increasing relative peak oxygen consumption and providing higher cardiovascular benefits than continuous endurance exercises, both training methods support health (13).

Regular training results in an increase in the anaerobic performance of athletes. This improvement in anaerobic performance is the increase in the efficiency of the ATP-PC and lactic acid system. Therefore, the energy resources and ability of the athlete to use these resources are important factors for a good athletic performance (23). Continuous endurance training increases performance during functions based on aerobic energy metabolism, while high intensity interval studies provide more effective use of aerobic and anaerobic energy systems. Studies have indicated that these training increases oxygen uptake and activities of mitochondrial enzymes that produce energy in skeletal muscles (2). The aim of this study is to determine the effect of cycling exercise program applied to young adults for eight weeks on aerobic and anaerobic performance.

MATERIAL & METHOD

Subjects: Fourteen volunteer, non-smokers, moderately active men aged between 19-23 participated in the study. The study was carried out in accordance with the Helsinki Human Rights Declaration and the informed consent was obtained from the participants. Performance evaluation tests were carried out on different days, two days before the training program and two days after the end of the program.

Determination of aerobic performance: The aerobic performance of the individuals participating in the study was determined by 20-meter shuttle running test (16). It is a test that starts with 8.5 km/h and the running speed increases by 0.5 km/ h per minute. The participants were asked to cover 20 m per signal. The test was terminated when the participant failed to overlap the two signals or when he left the test. At the end of the test, the tours completed by individuals were counted and the estimated VO_2 max value of the subject was found in ml/kg/min from the evaluation table.

Determination of anaerobic performance: Anaerobic performance of individuals was determined by Wingate anaerobic power test. This test is a supramaximal test involving pedaling at maximum speed against a constant load based on body weight for 30 seconds. The test was carried out on a computer linked mechanical bicycle ergometer (Monark 894-E). The seat length was adjusted for each participant, and after 5 minutes 50 watt 50 rpm warming up on the bicycle ergometer, the weight corresponding to 7.5% of the body weight was placed on the pan. When the participant was ready, he was asked to cycle maximally, when the speed of 150 rpm was reached, the weight was automatically reduced and he was asked to maintain the pedal speed for 30 seconds. Subjects were verbally motivated during the test. Peak power (= maximum anaerobic power, the highest mechanical power obtained in any five-second time frame generated during the test), average power (= maximum anaerobic capacity, average power generated during the test) and minimum power (=lowest mechanical power achieved during any five-second time period generated during the test) was calculated by the software program on the computer. The fatigue index was calculated by the following formula: ([highest peak power − lowest peak power] × 100)/highest peak power (23,24).

Training Program: The training program consisted of 40-60 minutes cycle ergometer exercise performed 3 times weekly for 8 weeks at a work load corresponding to 60-80% of the maximal heart rate. The target heart rate of the subjects were monitored with a polar pulse control monitor in each training. Stationary and non-resistance exercise bikes were used in training.

Table1. Training program

Weeks	Duration (min)	Intensity (%)	Frequency (day/week)
1	40	60-65	3
2	45	60-65	3
3	45	65-70	3
4	50	65-70	3
5	50	70-75	3
6	55	70-75	3
7	55	75-80	3
8	60	75-80	3

Statistical Analysis

Mean and standard deviation values of the participants were calculated. Whether the data is normally distributed or not is determined by Kolmogorov Smirnov Test. As a result of the test, it was determined that the data did not show normal distribution and the pre-post data were compared using the Wilcoxon paired signed ranks test, which is one of the non-parametric tests, was used.

© 2020 Faculty of Sport Sciences, Selcuk University

RESULTS

The average and standard deviation values of some variables of the participants whose average age is 21 ± 1.24 years and height average is 176.7 ± 6.62 cm are given in Table 2.

Table 2. Changes of some variables before and after the training program of the subjects participating in the study.

Variables	Pre-test Mean+SD	Post-test Mean+SD	p
Body weight (kg)	66,91±8,17	66,45±7,70	0,344
BMI (kg/m²)	21,49±2,77	21,32±2,58	0,281
VO_{2max} (ml/kg/dk)	44,40±5,55	45,75±6,40	0,048*
Peak power (W/kg)	10,65±0,62	11,30±0,93	0,013*
Average power (W/kg)	7,78±0,39	8,21±0,44	0,006*
Minimum power (W/kg)	4,80±0,36	5,09±0,46	0,079
Fatigue index (%)	54,81±4,06	54,63±5,83	0,778

*p<0,05, SD: Standard deviation, BMI: Body mass index

VO_{2max}: Maximum oxygen consumption

According to Table 2, while there was no significant difference in body weight, body mass index, minimum power and fatigue index values (p> 0.05), there was a significant difference in the pre-test and post-test scores of VO_2 max, peak power and average power values (p <0.05) has been determined.

DISCUSSION & CONCLUSION

The most important finding of this study is that the bicycle exercise program applied for 8 weeks increases maximal aerobic and anaerobic power. In addition, body weight, body mass index, minimum power and fatigue index values were not affected by the training program.

The results indicated a specific enzymatic response to each of endurance training despite a similar increase in VO_2 max (7). High intensity aerobic endurance training is significantly more effective than moderate and low intensity training in improving VO_2 max in healthy young adults. Changes in VO_2 max are compatible with changes in the stroke volume, indicating a close connection between the two (10,12). In a different study, significant differences were found between the 85% and 75% groups and the control group as a result of cycling exercises performed at different intensities in young men (65%, 75% or 85% of maximum heart rate, 3 days a week). No significant difference was found between the 65% group and the control, or between the 75% and 85% group. Researchers have concluded that in order to reveal significant changes in VO_2 max, it is necessary to work at least 75% of the maximum heart rate (4). Contrary to these studies, Meyer et al (18) reported that low and medium intensity walking and jogging training for 12 weeks increased VO_2 max similarly. Studies comparing both interval and continuous training regimes have demonstrated similar adaptations for increases in VO_2 max in the two types of training programs (5,6,20,22). In a different study, it was stated that the continuous running method was more effective than the interval running method in reducing body weight, and both methods showed similar positive effects in reducing body fat percentage and improving aerobic capacity (25). Yüksel et al (35) found that after the training program, which is applied regularly for three weeks a week for eight weeks, the continuous running method affects body weight, body fat percentage and aerobic power values, while interval training does not affect body weight, body fat percentage and anaerobic power values. Contrary to these studies, it has been reported that the gains in Vo_2 max are higher in the interval training group than in the continuous training group (9,19). Similarly, interval training programs were found to be more effective than low-intensity continuous training in cardiac patients (26,30,33). However, twelve weeks of high-intensity interval training is an effective training stimulant to improve cardiovascular fitness and glucose tolerance, but less effective than prolonged training in the treatment of hyperlipidemia and obesity. Also, unlike strength training, the twelve-week interval training program has no effect on muscle mass or skeletal health (21). Green et al (11) observed increases in VO_2 max at the end of the first 3 weeks after prolonged submaximal cycling exercises, and increased more in VO_2 peak at the end of 9 weeks. The researchers also reported that the prolonged submaximal training program increased the potential for β-oxidation, oxidative

© 2020 Faculty of Sport Sciences, Selcuk University

phosphorylation and glucose phosphorylation. In our current study, continuous cycling exercise training significantly increased VO_2max. Unlike these studies, Williams et al (32) reported that neither the eight-week sprint interval running program nor the continuous cycling ergometer program significantly improved the maximal or submaximal indicators of aerobic performance in prepubertal boys.

Anaerobic capacity depends on training background and can be increased by 10% with a proper training program for 6 weeks. In addition, there is a close relationship between a high anaerobic capacity and a high anaerobic energy release (17). Low-volume high-intensity interval training provides moderate improvement in the aerobic power of active non-athletic and sedentary people. The meta-analysed effects of high intensity interval training on Wingate peak and mean power were unclear (31). As performance in Wingate anaerobic test is dependent on phosphagenic, glycolytic and, partially, oxidative metabolism, these data indicate that at least one of these energetic systems had improved after interval training. Twenty-seven minutes of cycling at 80% VO_2 max applied with 3 sessions per week for 6 weeks provided sufficient stimulus to significantly improve markers of anaerobic and aerobic performance in recreationally active college-aged men (36). Similarly, VO_2 max and anaerobic power variables increased statistically significantly in young male basketball players in interval training, continuous running and technical training groups (1). Burgomaster et al (3) reported that VO_2 max increased significantly in the sprint interval (6 weeks, 3 times a week, 6x30 sec wingate) and in the continuous cycling group (6 weeks, 5 days a week, 40-60 min per day, 65% VO_2 max intensity cycling). They stated that the peak power that occurred during the Wingate test increased in both groups and the average power values increased only in the interval group. In our current study, as a result of continuous cycling exercise training, maximum anaerobic power (peak power) and capacity (average power) values increased significantly. Contrary to these studies, Tabata et al (27) stated that moderate intensity endurance training performed for six weeks does not affect anaerobic capacity while developing aerobic capacity, but six-week high intensity interval training can improve both anaerobic and aerobic energy systems, possibly by applying intense stimuli to both systems. Tanisho and Hirakawa (28) found that after cycling exercise training performed 3 times a week for 15 weeks in male college students, VO_2 max significantly increased in both continuous (20-25 min) and interval (10x10 sec, 20 sec rest) groups. In addition, although maximal anaerobic power increased in both groups, it was found statistically significant in the interval group. The contradictions between the researches on this subject can be explained by the different types of training programs, duration, intensity and measurement methods, as well as that the subjects participating in the research consisted of different groups.

Our study has some limitations. The first is that the training program is limited to eight weeks. The second is that aerobic performance is determined only by the field method.

As a result, it can be said that the eight week continuous cycling exercise program increases both aerobic power and anaerobic power and capacity.

REFERENCES

1. Al Abdilh W, Savas S. Genç erkek basketbolculara farklı tipte uygulanan dayanıklılık antrenmanlarına fizyolojik tepkiler. Gazi J Physical Edu Sport Sci, 2017,22(1-4): 11-24.
2. Altınkök M. Yüksek şiddetli interval antrenman uygulamalarının etki alanlarının incelenmesi. IJSER, 2015, 1(2):463-475.
3. Burgomaster KA, Howarth KR, Phillips SM, Rakobowchuk M, Macdonald MJ, McGee SL, Gibala MJ. Similar metabolic adaptations during exercise after low volume sprint interval and traditional endurance training in humans. J Physiol, 2008, 586(1):151-60.
4. Burke EJ, Franks BD. Changes in VO2max resulting from bicycle training at different intensities holding total mechanical work constant. Res, 1975,46:31-7.
5. Cocks M, Shaw CS, Shepherd SO, Fisher JP, Ranasinghe AM, Barker TA, Tipton KD, Wagenmakers AJ. Sprint interval and endurance training are equally effective in increasing muscle microvascular density and eNOS content in sedentary males.J Physiol, 2013, 591(3):641-56.
6. Daussin FN, Zoll J, Dufour SP, Ponsot E, Lonsdorfer-Wolf E, Doutreleau S, Mettauer B, Piquard F, Geny B, Richard R. Effect of interval versus continuous training on cardiorespiratory and mitochondrial functions: relationship to aerobic performance improvements in sedentary subjects. Am J Physiol Regul Integr Comp Physiol, 2008, 295(1):R264-72.
7. Fournier M, Ricci J, Taylor AW, Ferguson RJ, Montpetit RR, Chaitman BR. Skeletal muscle adaptation in adolescent boys: sprint and endurance training and detraining. Med Sci Sports Exerc, 1982,14(6):453-6.
8. Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, Nieman DC, Swain DP. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently

© 2020 Faculty of Sport Sciences, Selcuk University

healthy adults: guidance for prescribing exercise. Med Sci Sports Exerc, 2011, 43(7):1334-59.

9. Gorostiaga EM, Walter CB, Foster C, Hickson RC. Uniqueness of interval and continuous training at the same maintained exercise intensity. Eur J Appl Physiol Occup Physiol, 1991, 63(2):101-7.
10. Gormley SE, Swain DP, High R, Spina RJ, Dowling EA, Kotipalli US, Gandrakota R. Effect of intensity of aerobic training on VO2max. Med Sci Sports Exerc. 2008, 40(7):1336-43.
11. Green H, Dahly A, Shoemaker K, Goreham C, Bombardier E, Ball-Burnett M. Serial effects of high-resistance and prolonged endurance training on Na+-K+ pump concentration and enzymatic activities in human vastus lateralis. Acta Physiol Scand, 1999, 165(2):177-84.
12. Helgerud J, Høydal K, Wang E, Karlsen T, Berg P, Bjerkaas M, Simonsen T, Helgesen C, Hjorth N, Bach R, Hoff J. Aerobic high-intensity intervals improve VO2max more than moderate training. Med Sci Sports Exerc, 2007, 39(4):665-71.
13. Hottenrott K, Ludyga S, Schulze S. Effects of high intensity training and continuous endurance training on aerobic capacity and body composition in recreationally active runners. J Sports Sci Med, 2012,11(3):483-8.
14. Jones AM, Carter H. The effect of endurance training on parameters of aerobic fitness. Sports Med. 2000, 29(6):373-86.
15. Kubukeli ZN, Noakes TD, Dennis SC. Training techniques to improve endurance exercise performances. Sports Med, 2002, 32(8):489-509.
16. Leger LA, Lambert J. A maximal multistage 20-m shuttle run test to predict VO2max. Eur J Appl Physiol Occup Physiol.1982, 49(1):1-12.
17. Medbo, JI and Burgers S. Effect of training on the anaerobic capacity. Med. Sci. Sports Exerc, 1990, 22(4):501-507.
18. Meyer T, Auracher M, Heeg K, Urhausen A, Kindermann W. Effectiveness of low-intensity endurance training. Int J Sports Med, 2007, 28(1):33-9.
19. Milanović Z, Sporiš G, Weston M. Effectiveness of High-Intensity Interval Training (HIT) and Continuous Endurance Training for VO2max Improvements: A Systematic Review and Meta-Analysis of Controlled Trials.Sports Med 2015,45(10):1469-81.
20. McKay BR, Paterson DH, Kowalchuk JM. Effect of short-term high-intensity interval training vs. continuous training on O2 uptake kinetics, muscle deoxygenation, and exercise performance. J Appl Physiol (1985). 2009;107(1):128-38.
21. Nybo L, Sundstrup E, Jakobsen MD, Mohr M, Hornstrup T, Simonsen L, Bülow J, Randers MB, Nielsen JJ, Aagaard P, Krustrup P. High-intensity training versus traditional exercise interventions for promoting health. Med Sci Sports Exerc, 2010, 42(10):1951-8.
22. Overend TJ, Paterson DH, Cunningham DA. The effect of interval and continuous training on the aerobic parameters. Can J Sport Sci, 1992,17(2):129-34.
23. Özkan A, Köklü Y, Ersöz G. Wingate anaerobik güç testi. Uluslararası İnsan Bilimleri Dergisi, 2010a, 7(1): 207-224.
24. Özkan A, Köklü Y, Ersöz G. Anaerobik Performans ve Ölçüm Yöntemleri. Gazi Kitabevi, 2010b.
25. Revan S, Balcı ŞS, Pepe H, Aydoğmuş M. Sürekli ve İnterval Koşu Antrenmanlarının Vücut Kompozisyonu ve Aerobik Kapasite Üzerine Etkileri, Spormetre Beden Eğitimi ve Spor Bilimleri Dergisi, 2008,5(4):193-197.
26. Rognmo O, Hetland E, Helgerud J, Hoff J, Slordahl SA. High intensity aerobic interval exercise is superior to moderate intensity exercise for increasing aerobic capacity in patients with coronary artery disease. Eur J Cardiovasc Prev Rehabil, 2004,11:216-22.
27. Tabata I, Nishimura K, Kouzaki M, Hirai Y, Ogita F, Miyachi M, Yamamoto K. Effects of moderate-intensity endurance and high-intensity intermittent training on anaerobic capacity and VO2max. Med Sci Sports Exerc, 1996,28(10):1327-30.
28. Tanisho K, Hirakawa K. Training effects on endurance capacity in maximal intermittent exercise: comparison between continuous and interval training. J Strength Cond Res, 2009, 23(8):2405-10.
29. Tremblay A, Simoneau JA, Bouchard C. Impact of exercise intensity on body fatness and skeletal muscle metabolism.Metabolism, 1994, 43(7):814-8.
30. Warburton DER, McKenzie DC, Haykowsky MJ, et al. Effectiveness of high-intensity interval training for the rehabilitation of patients with coronary artery disease. Am J Cardiol, 2005,95:1080-4.
31. Weston M, Taylor KL, Batterham AM, Hopkins WG. Effects of low-volume high-intensity interval training (HIT) on fitness in adults: a meta-analysis of controlled and non-controlled trials. Sports Med, 2014,44(7):1005-17.
32. Williams CA, Armstrong N, Powell J. Aerobic responses of prepubertal boys to two modes of training. Br J Sports Med, 2000,34(3):168-73.
33. Wisloff U, Stoylen A, Loennechen JP, et al. Superior cardiovascular effect of aerobic interval training versus moderate continuous training in heart failure patients. Circulation, 2007,115:3086-94.
34. Wisloff U, Ellingsen Ø, Kemi OJ. High-intensity interval training to maximize cardiac benefits of exercise training? Exerc Sport Sci Rev, 2009, 37(3):139-46.
35. Yüksel O, Koç H, Özdilek Ç, Gökdemir K. Sürekli ve İnterval Antrenman Programlarının Üniversite Öğrencilerinin Aerobik ve Anaerobik Gücüne Etkisi. Sağlık Bilimleri Dergisi (Journal of Health Sciences), 2007,16(3): 133-139.
36. Ziemann E, Grzywacz T, Łuszczyk M, Laskowski R, Olek RA, Gibson AL. Aerobic and anaerobic changes with high-intensity interval training in active college aged men. J Strength Cond Res, 2011,25(4):1104-12.

© 2020 Faculty of Sport Sciences, Selcuk University