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Effect of Functional Threshold Trainings Applied to Junior Elite Cyclists on Power and Strength Parameters

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Ethical Statement: It is declared that scientific and ethical principles have been followed while carrying out and writing this study and that all the sources used have been properly cited.

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Abstract

The aim of the study is to examine the effect of functional threshold power training applied to young elite cyclists on power and strength parameters. 24 young elite level cyclists participated voluntarily. In our study, it was divided into two groups as Functional threshold training group (FTTG) and Traditional training group (TTG). Functional threshold training group n:12 (age 17 years, height 1,73±8,5 m., body weight 64,87±10.4 kg. and sports age 4,6±1.3), Traditional training group) n:12 (age 17 years, height 1,73±8,81 m., body weight 58,8±9,1 kg. and sports age 4,1 years). 30 sec Anaerobic power test, 20 min FTP test, 40 km. endurance and strength tests were applied to both groups as pre-post test. The obtained data were compared using the within-group Paired T test and the between-group Independent T test in the IBM SPSS Statistics 24.0 program. Traditional training group; Anaerobic power, 20 min FTP aerobics power, 40 km. endurance and strength pre-post test values improved. Functional threshold training group; Anaerobic power, 20 min FTP aerobic power, 40 km. endurance and strength pre-post test values were found to be more effective training development $p<0.05$. In spite of the performance improvement in both groups of athletes participating in the study, FTP training group showed more progress. Based on the data we obtained, cycling and strength training can be an example for trainers and sports scientists working on cycling.

Keywords: Ftp, aerobic, anaerobic, cycling

Özet

Genç Elit Bisikletçilere Uygulanan Fonksiyonel Eşik Güç Antrenmanlarının Güç ve Kuvvet Parametreleri Üzerine Etkisi

Bu çalışmanın amacı genç elit bisikletçilere uygulanan fonksiyonel eşik güç antrenmanlarının güç ve kuvvet parametreleri üzerine etkisinin incelenmesidir. Araştırmaya genç elit düzeydeki 24 bisiklet sporcusu gönüllü olarak katılmıştır. Araştırmamızda Fonksiyonel eşik antrenman grubu (FAG) ve Geleneksel antrenman grubu (GAG) olmak üzere iki gruba ayrılmıştır. Fonksiyonel eşik antrenman grubu n:12 (yaş 17 yıl, boy 1,73±8,5 m., vücut ağırlığı 64,87±10,4 kg. ve spor yaşları 4,6±1,3), Geleneksel antrenman grubu n:12 (yaş 17 yıl, boy 1,73±8,81 m., vücut

ağırlığı 58,8±9,1 kg. ve spor yaşları 4,1 yıl) olarak belirlenmiştir. Her iki gruba da ön-son test olmak üzere 30 sn. anaerobik güç testi, 20 dk. FTP testi, 40 km. dayanıklılık ve kuvvet testleri uygulanmıştır. Elde edilen veriler IBM SPSS Statistics 24.0 programında Grup içi paired t testi ve gruplar arası independent t testi kullanılarak karşılaştırılmıştır. Geleneksel antrenman grubu anaerobik güç, 20 dk. FTP, 40 km. dayanıklılık ve kuvvet ön-son test değerlerinde gelişme bulunurken Fonksiyonel eşik antrenman grubu anaerobik güç, 20 dk. FTP aerobik güç, 40 km. dayanıklılık ve kuvvet ön-son test değerlerinde daha etkili antrenman gelişimi $p<0,05$ olduğu bulunmuştur. Araştırmaya katılan her iki sporcu grubunda da performans gelişimi olmasına rağmen , FTP antrenman grubunda daha fazla gelişim olmuştur. Elde ettiğimiz verilere dayanarak bisiklet ve kuvvet antrenmanı şekillerinin bisiklet sporu ile çalışan antrenör ve spor bilimcilere örnek olabilir.

Anahtar Kelimeler: Ftp, aerobik, anaerobik, bisiklet

INTRODUCTION

The skills and capabilities developed by people as a result of their struggles against nature and each other in order to survive constitute the foundations of sports. Throughout history, sports have always existed (1). Sports in its current sense has been making progress in different areas since the half of the 19th century. A remarkable progress appears in health science as from this period. It helps people improve their body posture through physical activities. In addition, thanks to sports, the cardiovascular system, muscles and joints work efficiently and make people feel good socio-mentally (20).

As one of the sports developing up to now, cycling started with the first bicycle race held in France in 1868. The winner of this race was the British athlete, James Moore. Upon the foundation of the French Cycling Federation in 1881, the first foundations of the popularity of the cycling branch were laid. Thanks to the races held in many parts of Europe as of 1890, the cycling branch became one of the most popular sports branches with its developing components and its debut in the 1896 Athens Olympics. Cycling, which has progressed with the modern Olympics, has played an important role in talent selection, performance enhancement, technology and scientific studies, as well as entertainment and races (2,3).

Functional threshold (FTP) test has been one of the most developed scientific studies today. FTP test, which constitutes the subject of our study where the person's threshold values are determined based on the person's power output during 20 minutes on the bike with a smart power meter, and it is defined as the highest average power output. It is claimed that the FTP estimated in the power outputs of the 8 and 20-minute tests during field-based tests represents the power output at the lactate threshold. It is a test that helps tailor training programs based on the values obtained as a result of FTP. Thanks to this test, the athletes can be trained preparing training periodization based on the threshold ranges as customized for characteristics that are desired to be progressed (7).

At this point, it is possible to say that it will make a significant contribution to sports sciences and performance; in addition, it can guide many sports scientists and coaches studying on this subject to increase athlete success. This study aims to determine the effect of functional threshold training (FTP) applied to young elite cyclists on power and strength parameters.

METHOD

Physical Characteristics of the Cyclists Participating in the Study

24 licensed elite cyclists participated in the study. Cyclists are divided into two groups: Functional Training Group (FTG n:12) and Traditional Training Group (TTG n:12). The training includes an 8-week training period. Permission of Akdeniz University, Clinical Research Ethics Committee was obtained for this study. Ethics Committee Code 2012-KAEK-20, Decision No: 1178.

Height and Body Weight Measurement

Participants were measured barefoot while wearing plain cycling jerseys. Height measurement was made barefoot with a Seca 220 brand device. Body weight was measured with a Miras RSP-0120 brand electronic scale.

Anaerobic Power Test (WanT)

Anaerobic power test aims to measure the explosive power of cyclists. The test takes 30 seconds and data is automatically recorded during the test. The cyclist's heart rate was automatically recorded throughout the test period. The application of the test is as follows: When the cyclist feels ready after warming up, he/she starts pedaling and rotates the pedals with his maximum strength for 30 seconds (16).

Functional Threshold Power Test (FTP)

Functional Threshold Power Test serves to measure the cyclist's functional threshold power value. The application of the test is as follows: A 15-minute warm-up protocol was performed by the cyclist on trainer. When the cyclist felt ready, he started the test and applied his maximum effort he could throughout the test for 20 minutes. Cooling was done for ten minutes at the end of test (4). Morgan et al. (2018) conducted a study on the time trial performance of road cyclists in relation to FTP (14).

Aerobic Power Test 40 Kilometers (Km) Time Trial Test

This test was applied to measure the aerobic endurance of the participants. The test was carried out in an open environment on Tacx brand rollers, with participants' own bicycles, cycling jerseys and lock-pedal shoes (SPD). Before the test, participants were given general information about the test and were asked to complete the 40 km distance in the shortest time. Roller is a mechanism that allows three rollers to rotate with each other. Participants can train in stable position, thanks to this equipment. The speed, duration and pulse averages of the participants were measured with a Garmin device (19).

Strength Measurements

Maximal Strength Tests (1RM); The cyclist was placed in a technically appropriate position on the designated fitness equipment. In order to determine the maximum amount of weight the cyclists could lift; two trials were performed and the maximum weight lifted was recorded in kilograms. means by which maximum repetitions are determined; Leg Press (kg), Calf Raise (kg), Squat (kg), Upper Rowing (kg), Crunch Machine (kg) (9).

Training Program

In the study, the Functional training group performed FTP training and strength training three days a week, in addition to normal cycling training 6 days a week. The traditional training group did cycling training six days a week. Athletes in this group were not given additional FTP and strength training. Athletes in both groups implemented training programs for eight weeks. Training intensity was gradually increased by 5% in the first five weeks. In the 5^{th} week, the intensity rate was reduced to the 1st week level for recovery purposes. It was gradually increased again in the 6^{th}, 7^{th} and 8^{th} weeks.

Table 1. Functional Threshold Training Group Program

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Strength Training 5 Device %50/10x/2 Sets Leg Press Calf Raise Squat Upper Rowing Crunch Machine		Strength Training 5 Device %50/10x/2 Sets Leg Press Calf Raise Squat Upper Rowing Crunch Machine		Strength Training 5 Device %50/10x/2 Sets Leg Press Calf Raise Squat Upper Rowing Crunch Machine		
			Afternoon			
Road training Aim Endurance Zone 2 Warm-up Phase 20 min Zone 1-2 Main Phase Zone 2 50-60 km 90-100 cadence Cooling Phase 20 min Zone 1	Road training Aim Tempo Zone 3 Warm-up Phase 20 min Zone 1-2 Main Phase Zone 3 80-90 km 90-100 cadence (6 X 70% - 1 min) Cooling Phase 20 min Zone 1	Road training Aim Endurance Zone 2 Warm-up Phase 20 min Zone 1-2 Main Phase 50-60 km Zone 2 90-100 cadence Cooling Phase 20 min Zone 1	Road training Aim Tempo Zone 3 Warm-up Phase 20 min Zone 1-2 Main Phase 80-90 km Zone 3 90-100 cadence (6 X 70% - 1 min) Cooling Phase 20 min Zone 1	Road training Aim Endurance Zone 2 Warm-up Phase 20 min Zone 1-2 Main Phase 50-60 km Zone 2 90-100 cadence Cooling Phase 20 min Zone 1	Road training Aim Endurance Zone 3 Warm-up Phase 20 min Zone 1-2 Main Phase 100-110 km Zone 3 95-110 cadence Cooling Phase 20 min Zone 1	Active Rest

Table 2. Traditional Training Group Program

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Road training Aim Endurance Zone 2 Warm-up Phase 20 min Zone 1-2 Main Phase Zone 2 50-60 km 90-100 cadence Cooling Phase 20 min Zone 1	Road training Aim Tempo Zone 2-3 Warm-up Phase 20 min Zone 1-2 Main Phase Zone 2-3 80-90 km 90-100 cadence Cooling Phase 20 min Zone 1	Road training Aim Endurance Zone 2 Warm-up Phase 20 min Zone 1-2 Main Phase Zone 2 50-60 km 90-100 cadence Cooling Phase 20 min Zone 1	Road training Aim Tempo Zone 2-3 Warm-up Phase 20 min Zone 1-2 Main Phase Zone 2-3 80-90 km 90-100 cadence Cooling Phase 20 min Zone 1	Road training Aim Endurance Zone 2 Warm-up Phase 20 min Zone 1-2 Main Phase Zone 2 50-60 km 95-110 cadence Cooling Phase 20 min Zone 1	Road training Aim Tempo Zone 2-3 Warm-up Phase 20 min Zone 1-2 Main Phase Zone 2-3 100-110 km 95-110 cadence Cooling Phase 20 min Zone 1	Active Rest

Statistical analysis

Descriptive statistics of the data obtained through this study (peak power, normalized power outputs, average power outputs and functional power threshold values) were given as mean (Mean), standard deviation (SD), minimum (Min) and maximum (Max) values. To ensure homogeneity of the data, subjects with extreme values were removed. Kolmogorow-Smirnow and Levene's Test of Homogeneity were applied respectively to check normal distribution before proceeding with statistical procedures and to control homogeneous distribution. Since the data were seen to be normally distributed, intragroup comparison Paired t test and intergroup independent t test were used in paired comparisons to compare the data obtained from this study. IBM SPSS Statistics 24.0 package program was used in statistical analysis.

FINDINGS

Comparison of 30 sec Anaerobic Power Pretest Values of the Traditional Cycling Training Group and the Functional Threshold Power Training Group participating in the research is given in Table 1.

Table 3. Comparison of 30 sec Anaerobic Power Pretest Values of the Traditional Cycling Training Group and the Functional Threshold Power Training Group participating in the research

	Groups	n	$\bar{X}$	SD	p
Average Heart Rate (beats/min)	TTG	12	180,5	11,8	0,56
	FTTG	12	177,4	13,4	
Average Heart Rate (beats/min)	TTG	12	192,3	11,6	0,21
	FTTG	12	185,4	14,6	
Average Power (watt)	TTG	12	472,3	104,3	0,77
	FTTG	12	564,6	137,2	
Maximum Power (watt)	TTG	12	666,6	154,2	0,73
	FTTG	12	787,1	159,3	

Considering the 30-second anaerobic power pre-test data between the traditional cycling training group and the functional threshold power training group participating in the research; there was no statistically significant difference in the average heart rate, maximum heart rate, average power and maximum power data ($p>0.05$).

Table 4. Comparison of 20 min FTP Pretest Values of the Traditional Cycling Training Group and the Functional Threshold Strength Training Group participating in the research

	Groups	n	$\bar{X}$	SD	p
Average Heart Rate 20 min. (beats/min)	TTG	12	181,3	9,7	0,62
	FTTG	12	179,1	12,1	
Maximum Nabız 20 min. (beats/min)	TTG	12	201,3	7,8	0,13
	FTTG	12	195,3	10,8	
Average Power 20 min. (watt)	TTG	12	171,0	37,4	0,85
	FTTG	12	174,4	47,9	
Maximum Power 20 min. (watt)	TTG	12	436,3	174,9	0,10
	FTTG	12	555,6	164,8	
Relative Power 20 min. (watt/kg)	TTG	12	2,8	0,44	0,99
	FTTG	12	2,8	0,56	

Considering the 20-minute FTP pre-test data between the traditional cycling training group and the functional threshold strength training group participating in the research, there was no statistically significant difference in the data of average heart rate, maximum heart rate, average power, maximum power, and watts produced per kg ($p>0.05$).

Table 5. Comparison of 40 Km Pre-Test Values of the Traditional Cycling Training Group and the Functional Threshold Strength Training Group participating in the research

	Groups	n	$\bar{X}$	SD	p
Time (min)	TTG	12	59,3	14,8	0,38
	FTTG	12	54,4	11,4	
Average Speed 40 Km. (km/hour)	TTG	12	40,5	8,36	0,75
	FTTG	12	42,1	9,6	
Average Power 40 Km. (watt)	TTG	12	145,4	32,0	0,39
	FTTG	12	156,8	31,7	
Maximum Power 40 Km. (watt)	TTG	12	484,0	149,2	0,20
	FTTG	12	395,6	175,4	
Average Heart Rate 40 Km. (beats/min)	TTG	12	174,67	8,7	0,09
	FTTG	12	181,3	9,6	
Maximum Heart Rate 40 Km. (beats/min)	TTG	12	191,9	5,9	0,01
	FTTG	12	202,4	11,6	

Considering the 40 km pre-test data between the traditional cycling training group and the functional threshold strength training group participating in the research; no statistically significant difference ($p>0.05$) was found in time, average speed, average power, maximum power, average heart rate, maximum pulse data. However, a statistically significant difference was found in maximum heart rate data ($p<0.05$).

Table 6. Comparison of Strength Pretest Values of the Traditional Cycling Training Group and the Functional Threshold Strength Training Group participating in the research

	Groups	n	$\bar{X}$	SD	p
Leg Press (kg)	**TTG**	**12**	**105,0**	**48,9**	**0,72**
	FTTG	**12**	**111,7**	**42,0**	
Calf Raise (kg)	**TTG**	**12**	**97,9**	**28,4**	**0,67**
	FTTG	**12**	**102,9**	**27,3**	
Squat (kg)	**TTG**	**12**	**82,9**	**16,0**	**0,20**
	FTTG	**12**	**90,8**	**12,9**	
Latt Pull Down (kg)	**TTG**	**12**	**85,0**	**23,9**	**0,43**
	FTTG	**12**	**92,1**	**19,2**	
Abdominal (kg)	**TTG**	**12**	**61,7**	**8,34**	**0,07**
	FTTG	**12**	**67,5**	**6,57**	

Considering the intergroup strength pre-test data of the traditional cycling training group and functional threshold strength training group participating in the research; there was no statistically significant difference in leg press, calf raise, squat, lat pull down and abdominal data ($p>0.05$).

Table 7. Comparison of 30-second Anaerobic Power Posttest Values of the Traditional Cycling Training Group and the Functional Threshold Power Training Group Participating in the research

	Groups	n	$\bar{X}$	SD	p
Average Heart Rate Last (beats/min)	TTG	12	177,0	13,9	0,05
	FTTG	12	166,5	10,0	
Maximum Heart Rate Last (beats/min)	TTG	12	193,3	11,3	0,00
	FTTG	12	177,1	12,6	
Average Power Last (watt)	TTG	12	520,5	122,2	0,04
	FTTG	12	643,0	144,9	
Maximum Power Last (watt)	TTG	12	721,8	147,7	0,02
	FTTG	12	909,4	210,3	

Considering the 30-second anaerobic power post-test data between the traditional cycling training group and the functional threshold power training group participating in the research; a statistically

significant difference was found in the average heart rate, maximum heart rate, average power and maximum power data in favor of FTTG ($p<0.05$).

Table 8. Comparison of 20-minute FTP Post-Test Values of the Traditional Cycling Training Group and the Functional Threshold Strength Training Group Participating in the research

	Groups	n	$\bar{X}$	SD	p
Average Heart Rate 20 min. Last (beats/min)	TTG	12	175,3	15,4	0,49
	FTTG	12	171,0	14,0	
Maximum Heart Rate 20 min. Last (beats/min)	TTG	12	191,8	13,2	0,39
	FTTG	12	187,2	12,6	
Average Power 20 min. Last (watt)	TTG	12	182,7	48,5	0,04
	FTTG	12	224,8	45,5	
Maximum Power 20 min. Last (watt)	TTG	12	463,5	125,4	0,00
	FTTG	12	675,2	177,4	
Relative Power 20 min. Last (watt/kg)	TTG	12	2,9	0,5	0,03
	FTTG	12	3,3	0,4	

Considering the 20-minute FTP post-test data between the traditional cycling training group and the functional threshold strength training group participating in the research; whereas no statistically significant difference was found in the average heart rate and maximum heart rate data ($p>0.05$), a statistically significant difference was found in the average power, maximum power, watts per kg data in favor of FTTG ($p<0.05$).

Table 9. Comparison of 40 Km Post-Test Values of the Traditional Cycling Training Group and the Functional Threshold Strength Training Group participating in the research

	Groups	n	$\bar{X}$	SD	p
Time Last (min)	TTG	12	54,9	9,6	0,25
	FTTG	12	46,3	7,9	
Average Speed 40 Km. Last. (km/hour)	TTG	12	43,8	8,3	0,43
	FTTG	12	49,8	7,4	
Average Power 40 Km. Last (watt)	TTG	12	158,1	37,3	0,00
	FTTG	12	199,6	24,8	
Maximum Power 40 Km. Last (watt)	TTG	12	554,7	102,4	0,03
	FTTG	12	662,3	129,6	
Average Heart Rate 40 Km. Last (beats/min)	TTG	12	174,8	10,4	0,19
	FTTG	12	166,4	18,7	
Maximum Heart Rate 40 Km. Last (beats/min)	TTG	12	190,3	8,0	0,14
	FTTG	12	195,4	8,3	

Considering the 40 km post-test data between the traditional cycling training group and the functional threshold strength training group participating in the research; while no statistically significant difference was found in time, average speed, average heart rate, maximum heart rate data ($p>0.05$), a statistically significant difference was found in average power and maximum power data in favor of FTTG ($p<0.05$).

Table 10. Comparison of Strength Posttest Values of the Traditional Cycling Training Group and the Functional Threshold Strength Training Group participating in the research

	Groups	n	$\bar{X}$	SD	p
Leg Press Last (kg)	TTG	12	110,0	48,5	0,04
	FTTG	12	147,1	34,9	
Calf Raise Last (kg)	TTG	12	101,6	28,8	0,00
	FTTG	12	139,2	22,5	
Squat Last (kg)	TTG	12	87,5	15,6	0,00
	FTTG	12	131,6	9,8	
Lat Pull Down Last (kg)	TTG	12	88,8	23,7	0,02
	FTTG	12	110,0	16,2	
Abdominal Last (kg)	TTG	12	66,3	8,8	0,00
	FTTG	12	80,4	7,5	

When the intergroup strength posttest data of the traditional cycling training group and functional threshold strength training group participating in the research were examined; a statistically significant difference was found in leg press, calf raise, squat, lat pulldown and abdominal data in favor of FTTG ($p<0.05$).

DISCUSSION AND CONCLUSION

This study aims to examine the effects of functional threshold training on power and strength parameters in young elite cyclists. 24 cyclists having high-level performance between the ages of 16 and 18 participated in the research. In the eight-week study program; The functional threshold strength training group applied cycling six days a week and strength training three days a week, while the traditional training group applied only the current normal cycling training program.

Rylands et al. (17) conducted a study on the effect of gear ratio and peak power ratio on eight male elite BMX cyclists. In the study, peak power was found to be 1380±56 at 41/16 gear ratio, 1436±129 at 43/16 gear ratio, and 1658±201 at 45/16 gear ratio. Inoue et al. (8) used a bicycle ergometer for the anaerobic power cycling test in their study on ten mountain bike athletes participating in a mountain bike race and recorded the race times of the ten athletes participating in the competitions. The cyclists then underwent a 30-second anaerobic power test and a 5X anaerobic power test. Cyclists' wingate peak power was found to be 1,006.06±150.0 watts and wingate average power was 831.2±94.0 watts. As a result of the study, it was determined that the peak power and average power values in the anaerobic cycling test were significantly correlated with the race times. In their study with 11 male and nine female athletes, Kilpatrick and Greeley (2014) divided the athletes into two groups and investigated the effects of 30-second and 60-second intervals on performance. The first group underwent 16 sets of 30-second 1:1 load: rest interval training. The same 60-second interval protocol applied to the first group was applied to the second group. As a result of this study, it was found that there was an increase in the performance values of both groups, but there was a greater performance increase in the first group that applied a 30-second interval (10). In the current study, a significant difference was found in the post-test average power watt values and maximum power watt values of the Functional threshold training group and Traditional training group anaerobic power test applied for eight weeks between the two groups in favor of the functional threshold training group. It can be thought that the reason for this is the functional threshold training and strength training applied to the FTTG.

In the study conducted on 13 elite mountain bike athletes in 2018, Özen (2018) applied a 20-minute FTP test to the participants in his study on anthropometric measurements, physiological performance tests, and field performance tests in order to determine the performance values of the athletes. According to the results of this study, there is a significant difference between the test values (15). In the study conducted by Aslan (2), applied on 19 mountain bike athletes in the 6-week Tabata training model, the average power pre-test values of the cyclists were found to be 889 watts and the post-test values were 965 watts. The study is parallel to our study, as the values of the group applying the Tabata training model increased significantly more and there was a significantly greater difference in the values in favor of the functional threshold training group in our study.

In their study in 2018, Koçak (2018) applied the high-intensity interval integrated training method on 10 elite mountain bike athletes with an average age of 15.70 years in a 6-week period. As a result of the study, $V\dot{O}_2max$, maximum minute power and average power values increased. In addition, according to the anaerobic power test results, there was an increase in peak power and average power data, while there was a significant positive increase in leg strength and mountain bike track times (11). 11 volunteer mountain bikers with an average age of 35 years and an average weight of 80 kg participated in the study conducted by Miller et al. (13). In the study conducted by the participants in the study in the form of FTP and intermittent loading on the mountain bike performance time, a positive increase was seen in the FTP and intermittent loading exercises on the mountain bike race time performance and provided a significant improvement in terms of time. Denham et al. (2017) in their study on 11 people, a significant increase was found in the results of anaerobic power values depending on FTP for everyone who participated in the study, as a result of the pre- and post-tests of 6-week 30-second sprint training (6). These results are similar to other studies due to the significant increase in FTP values and increase in performance values.

Taylor et al. (1997) conducted a study to examine the effect of interval training on eight cyclists with good training levels. They applied interval training in a total of 12 sessions for six weeks, two repetitions per week. They applied 6-8 repetitions of loading, consisting of five minutes of loading with 80% of the peak power value and one minute of active rest. They applied a 40 km time trial test to measure the performance of the cyclists participating in the study. It was found that the time to complete the study in the tests performed at the beginning and at the end of the six weeks was shortened (19). In their study, Laursen et al. (2005) investigated the effects of high-intensity interval training on performance on 38 cyclists. They divided the cyclists participating in the study into four different groups and had them perform different load training for four weeks. While there was a significant increase in the first three groups in the 40 km time trial tests after the training period, there was no significant difference in the traditional training group (12). In (2019), Aslan divided 19 senior cyclists between the ages of 14-18, competing in the Kütahya cycling team, into two groups and applied two different training programs. One of the groups trained with traditional cycling training for six weeks, and the other group trained with the Tabata training model for sixweeks. In the results of anaerobic, aerobic, leg-waist strength and 40 km time trial tests performed at the beginning and end of 6 weeks, there was a positive improvement in performance values in both groups who did traditional cycling training and those who did Tabata training model, but there was a greater improvement in the performance values in the Tabata training group. There was a statistical increase in performance (2). According to these results, the traditional training group and the functional threshold strength training group in the current study show parallelism in terms of positive development of 40 km time trial test results and reduction in finishing times.

Tecer (2018) conducted a study to examine the effects of high-intensity bicycle exercise training (HIBET) and stationary bicycle exercise training (SBET) on knee joint isokinetic muscle strength, muscular endurance and aerobic capacity on 54 healthy sedentary women between the ages of 18-35. The women participating in the study were divided into two separate groups: standard cycling exercise for n:27 people and high-intensity cycling exercise for n:27 people, which they chose voluntarily. As a result of the study, it was revealed that the aerobic capacity and knee joint muscular strength and endurance increased in both groups, but the group doing high-intensity bicycle exercise training was more effective in terms of both strength and muscular endurance. In this study, it was determined that the strength values of the group doing high-intensity cycling exercise increased more (18). Crawford et al. (1979) conducted a study on 27 cyclists with a 12-minute supine bicycle exercise, showing a positive increase in isometric and isokinetic strength exercises (5). It shows parallelism in the current study due to the increase in force values.

In the study conducted by Boyraz (2018) on 14 elite mountain bikers, after 6 weeks of It was observed that there was a statistically significant improvement as a result of upper extremity maximum anaerobic power, anaerobic capacity, fatigue index, 1TM-rowing, machine crunches, leg opening, leg bending, calf raise, chest push, leg push tests (3). According to the results obtained, the strength values of the study group increased more and are parallel to the current study, as there was a greater increase in strength in the functional threshold training group.

In the light of the data we obtained, the training of the cyclist group doing traditional training at the beginning of the season and during the season was seen to be effective in some parameters and it produces an

expected result. However, since the traditional training group follows a training method based solely on cycling, passing a certain distance and repetitions at a certain intensity, it is seen that especially the lower extremities, cardiovascular and aerobic systems are improved. It has been observed that the combination of Strength and FTP training is more effective in performance improvement. In particular, the fact that strength training in addition to FTP training increases the performance of cyclists can be an example for coaches and sports scientists who will study for the matter concerned. This study was conducted in the young athletes which constitutes the limitation of the study. Therefore, future research can analyze the same variables in elite athletes and/or masters.

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