Comparison of Interval and Continuous Aerobic Training on Quality of Life and Exercise Capacity in Patients with Coronary Artery Disease

Gulay Yalcin, fatma mutluay

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Gulay Yalcin[1] DrPH; fatma mutluay[2] Prof Dr

[1]mudanya university bursa TR
[2]yalova university yalova TR

Corresponding Author:
Gulay Yalcin DrPH
mudanya university
cagrisan str. no:2 bursa/turkey
bursa
TR

Abstract

Background: According to the World Health Organization (WHO), coronary artery disease (CAD), which is in the group of non-communicable diseases, is one of the most important causes of mortality in developed and developing countries, and its prevalence is increasing (1,2). It is seen that 45% of all deaths in our country are from cardiovascular diseases (CVD), and 36% (including 32% from CAD) are from heart diseases (3). Cardiac rehabilitation (CR) includes individually planned, supervised exercise interventions, medical assessments, risk profiling, education and counseling, and pharmacological and non-pharmacological interventions for cardiac patients. It is defined as a comprehensive and long-term program aiming to maximize the quality of life of cardiac patients in terms of physical, physiological, psychological, social, and work efficiency (4). The basic building block of the cardiac rehabilitation program, which is also used in treating coronary artery diseases, is aerobic exercise (5,6). Aerobic exercise can be performed intervally or continuously (7). Continuous exercise training is the more well-known type of exercise that continues at a constant value. In interval exercise training, in contrast to continuous exercise training, exercise is followed by intervals of exercise and recovery periods. Both types of exercise are recommended in cardiac rehabilitation by the European Society of Cardiology and the European Association for Cardiovascular Prevention and Rehabilitation (8). In the literature, aerobic exercise training has been frequently used in treating coronary artery disease; however, studies examining the effect of aerobic exercise types on this disease have yet to be included. With the idea that patients may better tolerate interval training, our aim in this study was to investigate whether the application of a personalized exercise program in the form of interval and continuous aerobic training is superior to each other in increasing the exercise capacity and quality of life of the patient.

Objective: This research compares the effects of interval and continuous aerobic training on people's quality of life and exercise capacity.

Methods: The participants are diagnosed with coronary artery disease, aged between 40- 80, and have no mental or physical disability to join in the research. The participants'' demographic info and clinical stories were recorded. We used the symptom-limited and six-minute walking tests (6DWT) to evaluate exercise capacity. We evaluate the quality of life by using Short Form-36 (SF-36). All evaluation tests are done before and after training. Participants were randomly divided into two groups: interval aerobic training (IAE) and continuous aerobic training (CAE). The training lasted three times a week for six weeks.

Results: In both groups, significant changes were found in evaluation test scores after the rehabilitation program (p<0,05). However, only the IAE group had significant statistical differences compared to the CAE group regarding test time and 6DYT scores. After training, the CAE group showed significant statistical change in every SF-36 parameter, while the IAE group showed significant values except energy/fatigue (p<0,05). The IAE group has statistically significant changes compared to the CAE group on the parameters: physical function, role limitations due to physical function, role limitations due to emotional function, and general health (p<0,05).

Conclusions: Although both training methods benefitted cardiac rehabilitation, interval aerobic training was superior in some assessment parameters and was better tolerated than continuous aerobic training. For this reason, it was concluded that increasing patients' exertion capacity would be more helpful. Clinical Trial: clinical trails number of the article study retrieved from NCT06525233.

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COMPARISON OF THE EFFECT OF INTERVAL AEROBIC TRAINING AND CONTINUOUS TRAINING ON CORONARY ARTERY DISEASE

Abstract

Purpose: This research compares the effects of interval and continuous aerobic training on people's quality of life and exercise capacity.

Methods: The participants are diagnosed with coronary artery disease, aged between 40- 80, and have no mental or physical disability to join in the research. The participants'' demographic info and clinical stories were recorded. We used the symptom-limited and six-minute walking tests (6DWT) to evaluate exercise capacity. We evaluate the quality of life by using Short Form-36 (SF-36). All evaluation tests are done before and after training. Participants were randomly divided into two groups: interval aerobic training (IAE) and continuous aerobic training (CAE). The training lasted three times a week for six weeks.

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Conclusion: Although both training methods benefitted cardiac rehabilitation, interval aerobic training was superior in some assessment parameters and was better tolerated than continuous aerobic training. For this reason, it was concluded that increasing patients' exertion capacity would be more helpful.

Keywords: Aerobic Exercise, Bicycle Ergometry Test, Cardiac Rehabilitation

INTRODUCTION

According to the World Health Organization (WHO), coronary artery disease (CAD), which is in the group of non-communicable diseases, is one of the most important causes of mortality in developed and developing countries, and its prevalence is increasing (1,2). It is seen that 45% of all deaths in our country are from cardiovascular diseases (CVD), and 36% (including 32% from CAD) are from heart diseases (3).

Cardiac rehabilitation (CR) includes individually planned, supervised exercise interventions, medical assessments, risk profiling, education and counseling, and pharmacological and non-pharmacological interventions for cardiac patients. It is defined as a comprehensive and long-term program aiming to maximize the quality of life of cardiac patients in terms of physical, physiological, psychological, social, and work efficiency (4). The basic building block of the cardiac rehabilitation program, which is also used in treating coronary artery diseases, is aerobic exercise (5,6). Aerobic exercise can be performed intervally or continuously (7). Continuous exercise training is the more well-known type of exercise that continues at a constant value. In interval exercise training, in contrast to continuous exercise training, exercise is followed by intervals of exercise and recovery periods. Both types of exercise are recommended in cardiac rehabilitation by the European Society of Cardiology and the European Association for Cardiovascular Prevention and Rehabilitation (8).

In the literature, aerobic exercise training has been frequently used in treating coronary artery disease; however, studies examining the effect of aerobic exercise types on this disease have yet to be included. With the idea that patients may better tolerate interval training, our aim in this study was to investigate whether the application of a personalized exercise program in the form of interval and continuous aerobic training is superior to each other in increasing the exercise capacity and quality of life of the patient.

METHOD

Participants

This study included 40 volunteers diagnosed with coronary artery disease by a specialist physician, aged between 40-80 years, with an ejection fraction above 55%. Participants were randomized according to the order of arrival and divided into two groups. The participants were informed about the study's purpose, duration, and the methods to be used during the treatment. They signed the "Informed Voluntary Consent Form" prepared by the Ethics Committee standards, and permission for publication approval was obtained for the photographs to be used. Approval was obtained at the Istanbul Medipol University Non-Interventional Clinical Research Ethics Committee meeting numbered 10840098-604, with file number 526. Also clinical trails number of the article study retrieved from NCT06525233.

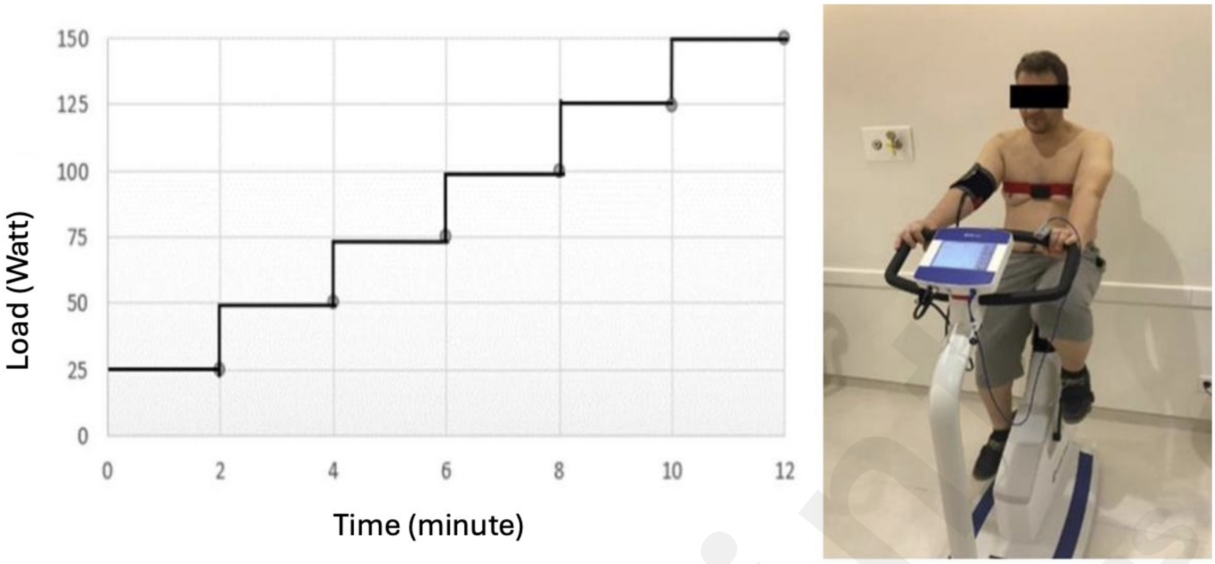
Evaluation Methods

A Demographic Information Form was prepared to record personal information such as name, surname, age, gender, educational status, occupation, marital status, and clinical conditions such as myocardial infarction, surgery and disease duration, hypertension, and diabetes. Symptom-limited cardiopulmonary exercise and 6-minute walk tests were performed to assess exercise capacity. The Short Form 36 (SF-36) questionnaire assessed the quality of life.

Exercise Tolerance Test

An exercise test was performed with a bicycle ergometer (Custo-med, Germany) by monitoring 3-lead ECG, blood pressure, heart rate, and O_2 saturation. The 'Ladder Type Protocol' with increasing workload was selected as the test protocol (9) (Figure 1). Before the exercise test, the patients rested for 15 minutes, and resting pulse rate and blood pressure were measured. The test was started with 25 watts on a bicycle in an upright position, and the test was increased to 25 watts every 2 minutes. At the end of each 2-minute increase, blood pressure, heart rate, dyspnea, and leg pain complaints were evaluated with the 'Modified Borg Scale.' The patient was asked to keep the bicycle's speed in the range of 50-60 rpm, and the test was terminated when the physiotherapist decided that the patient could not continue monitoring. The maximum load the patient reached at the test's end was recorded in watts (Appendix 4). In addition to the patient's request and physiotherapist's decision, the test was terminated when the following criteria were met: ST depression ≥ 3 mm, ST elevation ≥ 1 mm, decreased blood pressure (more than 20 mmHg), widespread symptomatic angina pectoris, severe dyspnea, cyanosis, persistent ventricular tachycardia (more than 30 s) and technical problems (related to PC, monitor or ECG device).

Figure 1. Exercise Tolerance Test Protocol and Intervention



6 Minutes Walk Test

The test was performed in a 30-meter-long quiet corridor with a sign at the beginning of each meter. Patients were asked to walk the longest possible distance they could walk in their rhythm for 6 minutes, and the distance they walked was recorded in meters. Patients rested for 10 minutes before the test. Oxygen saturation, heart rate, and blood pressure were recorded before and after the test, and dyspnea and fatigue were scored using the modified Borg scale (10,11).

Short Form 36

The Short Form 36, a quality of life scale developed by the Rand Corporation in 1992, was translated into Turkish, and validity and reliability studies were conducted. SF-36 is a self-assessment scale. The scale consists of 36 items, measuring eight different concepts. These are physical function, social function, pain, energy/vitality, role limitation due to emotional problems, role limitation due to physical problems, mental health, and general perception of health (12). This scale was read to the patients face-to-face and completed by them.

Aerobic Exercise Training

In our study, aerobic exercise training was given at intervals to one group and continuously to the other group for six weeks, three days a week, for 18 sessions. The training in both groups consisted of a 5-minute warm-up, 20-minute loading, and a 5-minute cooling period. The exercise session of both groups consisted of two consecutive components in combination (13):

1. Aerobic training: Warm-up / Load / Cool-down

2. Strengthening

The warm-up and cool-down phases consisted of low-intensity cardiovascular endurance activity. The warm-up phase was performed for 5 min with a linear increase from zero resistance to the targeted load, while the cool-down phase was performed for 5 min with a linear curve from the targeted loading intensity to zero resistance.

The loading phase was performed continuously at the same load for 20 min in the continuous group and 3 min loading and 1 min rest periods in the interval group (Figure 2) (Figure 3). In the interval group, cycling was continued at low intensity (5 watts) without stopping during the rest period.

Strengthening phase: Finally, to eliminate the leg pain factor in aerobic training, quadriceps muscle strengthening training with 2 kg weight was performed with 30 repetitions in each session in both groups.

Figure *2*. Continuous Aerobic Exercise Training Model

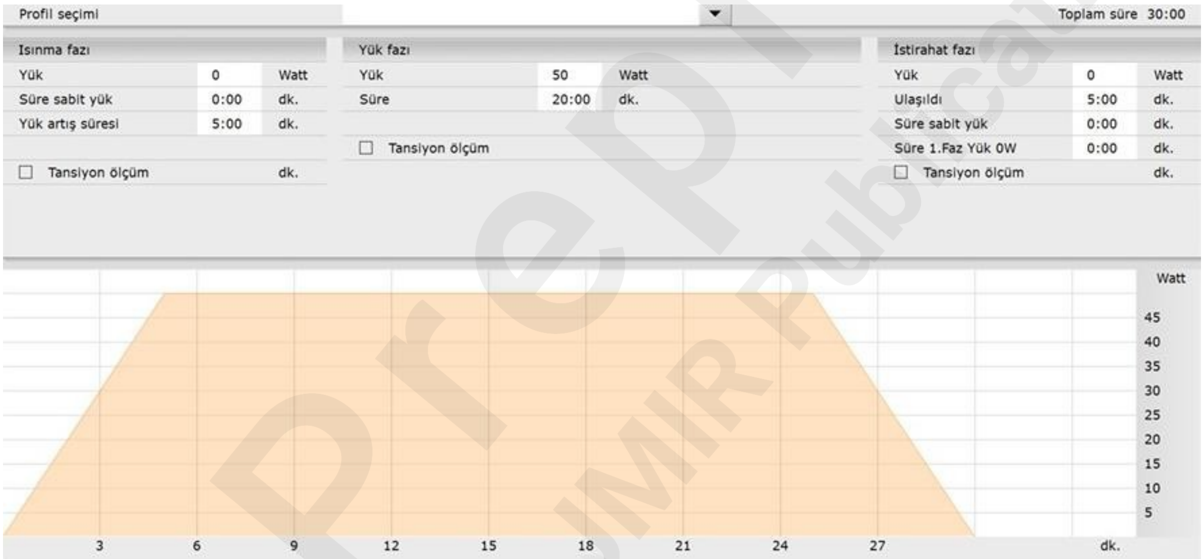
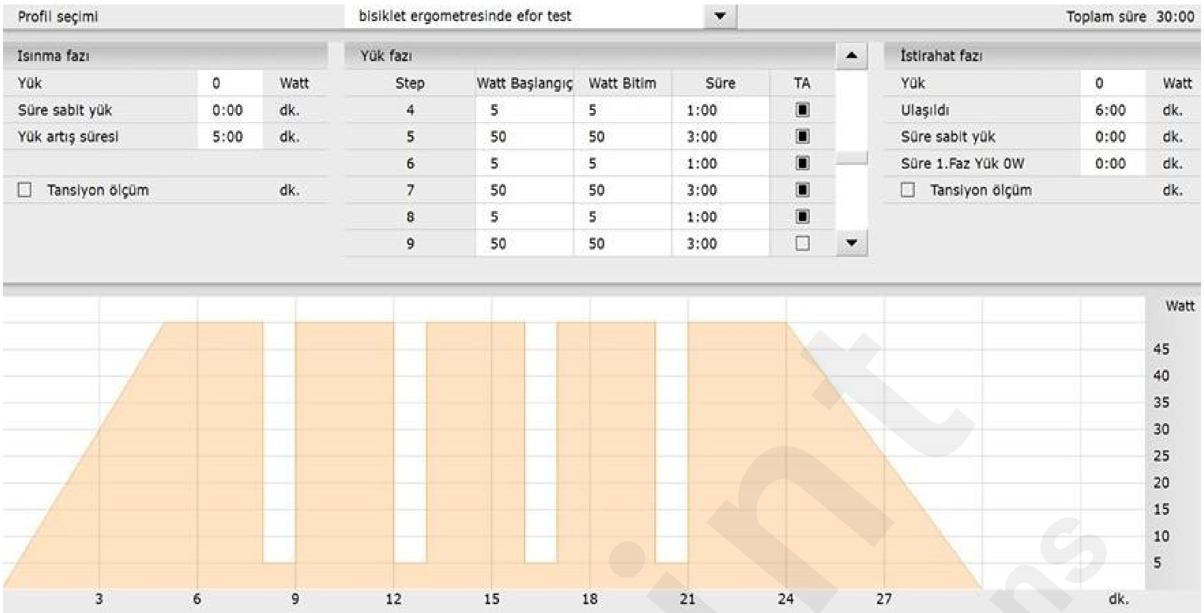


Figure 3. Interval Aerobic Exercise Training Model



Exercise Prescription

Exercise intensity was determined individually by calculating 75% of the maximum workload of the pre-training effort test capacities. As the program progressed, exercise duration was kept constant. The software automatically increased the workload to achieve the target heart rate range. The target heart rate was calculated to be at 85-90% of the heart rate reserve. The following formula was used to calculate the target heart rate range:

$$\mathbf{HR_{(TARGET)} = HR_{(REZERVE)} \times Aerobic\ Violence + HR_{(REST)}}$$

$HR_{(REZERVE)} = HR_{(MAX)} - HR_{(REST)}$

$HR_{(MAX)} = 220 - Age$

During the training, an aerobic program was performed with an upright bicycle, which was shared by the participants. The length of the bicycle was adjusted individually for each individual to cause minimal knee flexion in the patient with the pedal down.

Statistical Analysis

The data were statistically analyzed with SPSS (Statistical Package for Social Sciences) version 20.0. 'The Shapiro-Wilk test was used to determine the conformity of the data to normal distribution. P <0.05 (two-way) values were considered statistically significant in all analyses. In order to compare the pre-and post-exercise values of the groups, "Paired Sample T Test" was used for parametric data (normal distribution), and "Wilcoxon Rank Test" was used for non-parametric data (non-normal distribution). Intergroup evaluations were made with the "Independent Sample T Test" for parametric data and the "Mann-Whitney U Test" for non-parametric data. Statistical analysis of categorical data between groups was calculated with the "Chi-Square test."

RESULTS

The 58 patients in the study groups were randomly divided into two groups according to the order of arrival. One person was excluded from the study due to orthopedic disability, nine due to age criteria, and one due to comorbidity. Since two people in the continuous aerobic exercise group of 22 volunteers and four in the interval aerobic exercise group of 24 volunteers discontinued the treatment, our study was completed with 40 volunteers (Figure 4).

Figure 4. Flow Diagram of the Study

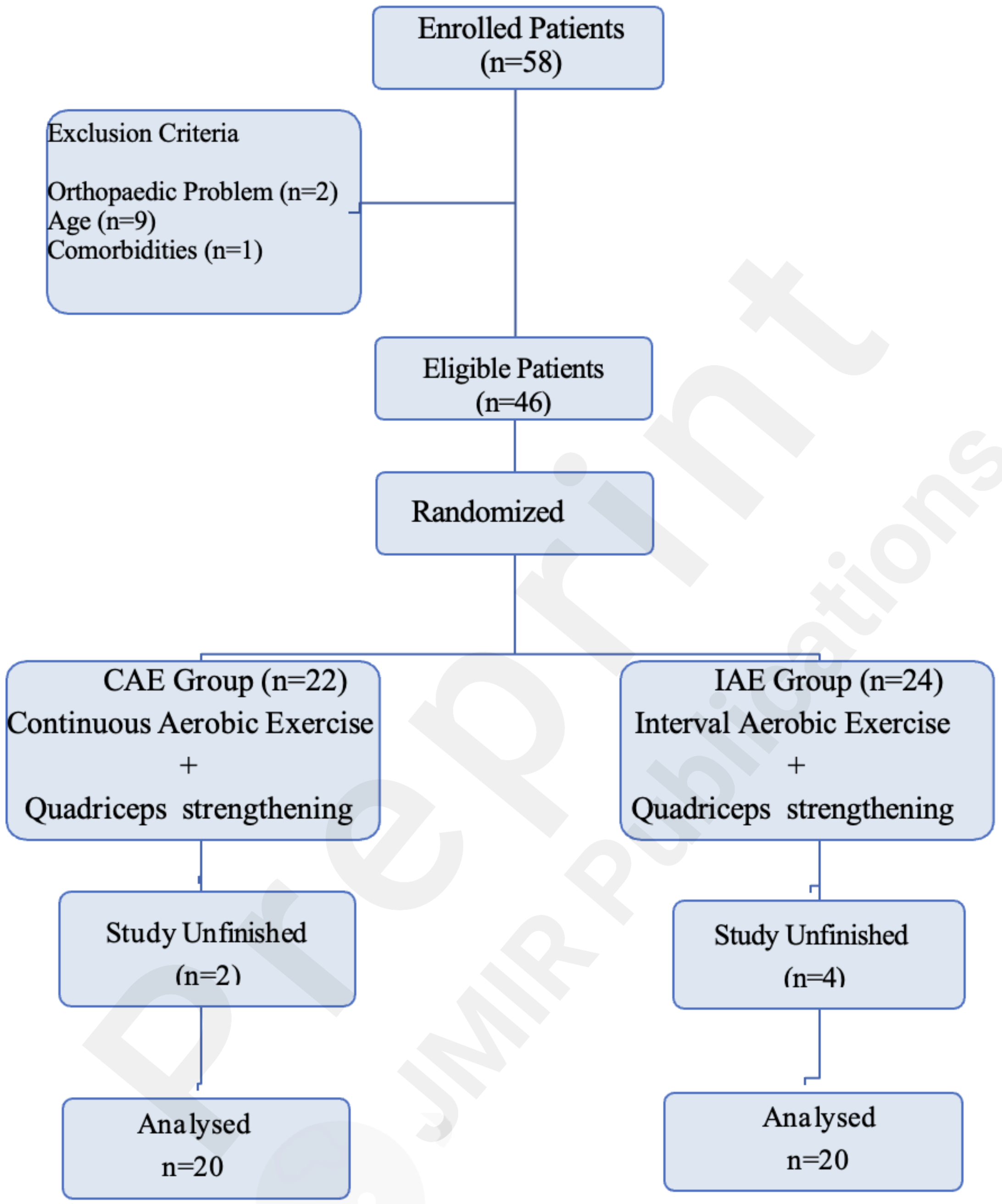


Table 1 shows the evaluation of the patients in terms of demographic characteristics, and no statistical difference was found between the groups (p>0.05).

Table 1. Demographic and Clinical Characteristics of Participants by Groups

		CAE (n=20) Mean±sd (Min-Max)	**IAE (n=20) Mean±sd (Min-Max)**	**Between Groups Analysis (P)**
Age (year)		67,25±8,66 (51-78)	64,95±10,15 (44-79)	0,741
BMI (kg/m^2)		26,23±3,11 20,12-31,54)	27,92±2,92 (21,44-33,04)	0,062
Gender	Female	12 (%60)	5 (%25)	0,472
	Male	8 (%40)	15 (%75)	
Education	Primary	4 (%23,5)	0 (%0)	0,082
	Middle	7 (%41,1)	7 (%41,1)	
	High	4 (%23,5)	5 (%29,4)	
	University	2 (%11,7)	5 (%29,4)	
Occupation	Housewife	7 (%35)	4 (%20)	0,426
	Staff	1 (%5)	7 (%35)	
	Retired	12 (%60)	9 (%45)	
Marital Status	Married	20 (%100)	19 (%95)	0,117
	Single	0 (%0)	0 (%0)	
	Divorced	0 (%0)	1 (%5)	
Disease duration (year)		12,25±6,76 (4-26)	9,2±4,60 (4-19)	0,52
MI presence		2(%10)	8(%40)	0,23
Operation presence		5(%25)	10(%50)	0,43
Hypertension		13(%65)	11(%55)	0,32
Diabetes		4(%20)	4(%20)	0,50

**p<0,05; CAE:Continuous Aerobic Exercise; IAE:Interval Aerobic Exercise; BMI: Body Mass Index; SD:Standard deviation*

No statistically significant difference was found when baseline exercise capacity, symptom values at the end of the test, and baseline values of SF-36 parameters were compared. (p>0,05). There was no statistically significant difference between the baseline values of the two groups (p>0.05). 6 DYT, the mean of all subjects was 348.0±92.12 meters. This value was found to be lower than the healthy population (women: 500 m; men: 580 m) but not low enough to have a poor prognosis (< 300 m) (Table 2).

Table 2. Comparison of the initial values of the participants

	IAE Mean±sd (Min-Max)	CAE Mean±sd (Min-Max)	**Between Groups Analysis (P)**
Exercise test (Watt)	74,99±31,71 (25-150)	67,10±21,15 (28-112,5)	0,35
Test Duration (min)	6,16±2,65 (2-12)	5,48±1,81 (2,25-9,00)	0,35
Heart Rate (pulse/min)	118±20,57 (83-174)	115,7±17,95 (83-150)	0,70
Systolic Blood Pressure (mmHg)	198,1±19,96 (105-260)	196,3±26,81 (102-265)	0,66
Diastolic Blood Pressure (mmHg)	109,91±10,82 (60-123)	104,23±12,91 (65-118)	0,72
Dyspnea (0-10)	3,15±2,36 (0-9)	3,65±2,27 (0-8)	0,50
Leg Pain (0-10)	4,65±1,78 (1-7)	4,5±1,43 (1-7)	0,77
6 Minutes Walking Test (m)	343,50±46,86 (272,25-471,75)	352,50±67,89 (295,25-407,25)	0,78

**p<0,05; CAE:Continuous Aerobic Exercise; IAE:Interval Aerobic Exercise; SD:Standard Deviation*

The comparison of the evaluation results before and after exercise training is shown in Table 3. After the training, the change in workload, test duration, and 6DYT values obtained from ETT in both groups was statistically significant ($p<0.05$).

Table *3.* Change in Exercise Capacity of Patients at Baseline and After Training

	Before Exercise	After Exercise	Intragroup Changes (Mean±SD)	Intragroup Analysis (P)	Between Groups Analysis (P)
Exercise Tolerance Test (W)					
IAE	74,99±31,71	101,75±34,53	26,76±2,82	**<0,001***	0,158
CAE	67,10±21,15	86,43±28,86	19,33±7,71	**<0,001***	
Test Duration (min)					
IAE	6,16±2,65	8,33±2,80	2,17±1,11	**<0,001***	**0,025***
CAE	5,48±1,81	6,89±2,15	1,41±0,97	**<0,001***	
Heart Rate (pulse/min)					
IAE	118±20,57	120,6±19,38	2,60±10,07	0,26	0,170
CAE	115,7±17,95	113,65±18,09	2,05±11,09	0,42	
Systolic Blood Pressure (mmHg)					
IAE	198,1±19,96	205,35±21,84	6,93±16,34	0,28	0,521
CAE	196,3±26,81	199,95±15,32	2,91±9,13	0,11	
Diastolic Blood Pressure (mmHg)					
IAE	109,91±10,82	104,30±21,74	5,05±19,82	0,32	0,615
CAE	104,23±12,91	103,25±31,81	1,01±21,72	0,46	
Dyspnea (0-10)					
IAE	3,15±2,36	3,65±2,67	0,5±2,56	0,39	1,000
CAE	3,65±2,27	4,15±2,36	0,5±2,62	0,40	
Leg Pain (0-10)					
IAE	4,65±1,78	5,0±2,69	0,35±2,03	0,45	0,78
CAE	4,5±1,43	4,65±2,23	0,15±2,43	0,79	
6 Minutes Walking Test (m)					
IAE	343,50±146,8	397,0±161,49	55,45±31,14	**<0,001***	**0,026***
CAE	352,50±67,89	402,0±75,51	48,5±27,32	**<0,001***	

**p<0,05; CAE:Continuous Aerobic Exercise; IAE:Interval Aerobic Exercise; SD:Standard Deviation*

When the differences in both groups were compared, it was found that the change in the IAE group was statistically significant (p<0.05) compared to the CAE group in the test duration and 6-minute walk test results. In contrast, the two groups were not superior to each other in the ETT results (p>0.05). In addition, it was observed that only the interval training group reached 54 meters, which is the value expressing minimal clinical significance before and after training in the 6-minute walk test.

Table 4. Change in SF-36 Parameters of Patients at Baseline and After Training

	Before Exercise	**After Exercise**	**Intragroup Changes (Mean±SD)**	**Intragroup Analysis (P)**	**Between Groups Analysis (P)**
Physical Function					
IAE	42,5±18,75	72,5±20,29	29,0±12,78	**<0,001***	**<0,001***
CAE	40,0±17,95	50,0±20,66	10,0±11,65	**0,001***	
Physical Role Difficulty					
IAE	50,0±27,95	75,0±24,33	25,0±22,76	**<0,001***	**0,024***
CAE	50,0±28,41	75,0±24,97	24,5±21,61	**0,004***	
Emotional Role Difficulty					
IAE	33,0±29,95	100,0±25,22	66,0±38,88	**<0,001***	**0,006***
CAE	33,0±25,77	67,0±23,34	33,0±20,07	**0,003***	
Energy/Vitality					
IAE	62,5±10,16	65,0±8,66	2,5±7,30	0,36	0,429
CAE	55,0±10,33	57,5±7,71	2,3±6,15	**0.04***	
Mental Health					
IAE	68,0±7,21	68,0±7,48	0,9±7,16	**0,04***	0,609
CAE	60,0±9,14	64,0±8,35	3,9±6,03	**0.03***	
Social Function					
IAE	50,0±17,40	63,0±13,07	12,5±12,21	**0,002***	0,214
CAE	50,0±12,25	63,0±10,94	13,0±9,30	**<0,001***	
Pain					
IAE	45,0±19,29	56,5±16,87	11,5±14,46	**0,009***	0,307
CAE	40,0±9,62	45,0±14,41	4,6±9,79	**0,001***	
General Health Perception					
IAE	35,0±11,86	55,0±12,88	19,5±16,29	**<0,001***	**0,001***
CAE	35,0±11,73	42,5±10,91	7,1±10,21	**<0,001***	

**p<0,05; CAE:Continuous Aerobic Exercise; IAE:Interval Aerobic Exercise; SD:Standard Deviation*

When the quality of life results were examined, the difference between the groups was not statistically significant (p>0.05) in energy/vitality, mental health, social functioning, and pain in interval aerobic exercise compared to continuous aerobic exercise. In contrast, interval aerobic exercise was statistically significant

($p<0.05$) compared to continuous aerobic exercise in physical function, physical role difficulty, emotional role difficulty, and general health perception.

DISCUSSION

Our study investigated the effect of two methods of aerobic training in patients diagnosed with coronary artery disease. As a result of the program being applied continuously to one group and at intervals to another, both groups observed significant improvements in exercise capacity and quality of life. Regarding quality of life, significant improvements were found in all parameters in the continuous training group except the energy/vitality parameter in the interval training group. When the intergroup difference analysis was analyzed, it was observed that there was a more significant improvement in the interval training group in the duration of effort test and walking test results and many sub-parameters of quality of life (physical function, physical role difficulties, emotional role difficulties, general health perception). These results confirmed our hypothesis to a great extent.

Age is the most important non-modifiable risk factor for coronary artery disease. Our patients' mean age was 66.10±8.66 years, which is in the risk range for CAD. A history of hypertension, which is one of the critical risk factors, was detected in a total of 24 subjects, and 57.5% of the study population was male. With these determined values, it is seen that our study population is confirming in terms of the risk of coronary artery disease. No significant difference was found between demographic, clinical, and other evaluation tests in both groups. Therefore, it is thought that both groups benefited from exercise training similarly.

Today, cardiac rehabilitation is recognized as an essential component of treating myocardial infarction, cardiac surgery, and other cardiovascular diseases. The aim is not only treatment and correction of complaints but also to provide the patient with the best level of life that can coexist with the existing disease (14). It has been reported that people who exercise regularly during the rehabilitation process will feel better, their mental health will improve as well as their physical health, their sense of self-confidence will increase, and accordingly, motivation and success rate will increase (15). Consistent with the literature, the results of our study suggest that our patients had a significant increase in effort capacity and quality of life.

In a meta-analysis study by Liying et al. in 2022, the effects of high-intensity interval and moderate-intensity continuous exercise on cardiopulmonary function were examined in patients with coronary artery disease (16). In this analysis, which included nineteen randomized controlled trials, the primary outcomes included peak oxygen uptake and anaerobic threshold. Secondary outcomes included left ventricular ejection fraction, exercise duration, respiratory exchange ratio, resting heart rate, peak heart rate (PHR), and oxygen pulse. Included in the analysis were 511 patients in the experimental group with high-intensity interval exercise and 525 patients in the control group with moderate-intensity continuous exercise. Seven studies examining exercise duration showed that high-intensity interval exercise was statistically significant in increasing exercise duration compared to moderate-intensity continuous exercise training. In our study, exercise duration increased statistically significantly in both groups, but the groups were not statistically superior to each other. When the results of 12 studies evaluating the maximum heart rate in exercise were analyzed, it was found that high-intensity exercise training significantly affected PHR compared to moderate-intensity exercise training. When we look at our study's maximum heart rate value, no significant change was found in either group. When we evaluate this situation, the results are expected to differ in this direction because the number of cases in the study is much less compared to the population included in the meta-analysis study.

In a study by Jaureguizar et al. comparing the effects of interval and continuous training in patients with coronary artery disease, 72 patients were trained for eight weeks, three days a week. The effects of training on functional capacity and quality of life were investigated (17). In the group trained with loading at the same intensity with a bicycle ergometer, interval training showed a 21% increase in oxygen consumption, while continuous training showed a 14% change. 6 In walking distance at the end of 6 DYT, interval training showed an increase of 49.6±6.3 m, while continuous training showed an increase of 29.6±12.0 m. İnterval training showed more significant changes in both parameters, and no superiority of the two groups was found in the quality-of-life analysis. In our study, exercise test results were evaluated as the workload achieved and although there was an increase in both groups, no superiority was found between the two groups (IAE=35%; CAE=29%). 6 The values obtained as a result of DCT were higher in both groups than the values in this study (IAE=55.45±31.14; CAE=48.5±27.32); however, when the two groups were compared, the results were similar to the study and in favor of interval training. In quality of life results, results favoring interval training were obtained in our study. It is thought that the number of cases and duration of training may be adequate in the evaluation of the results of the two studies.

Cardiovascular disorders and related mortality decrease with increased exercise capacity. There is a strong link between aerobic exercise and exercise capacity; however, the relationship between exercise capacity according to exercise type has yet to be fully discovered (18). In a study conducted by Conraads et al. in 2015 with 200 coronary artery disease patients, the superiority of interval and continuous aerobic training was investigated (19). Oxygen consumption was considered the primary outcome in the training, which was applied three days a week for 12 weeks, and other cardiovascular risk factors and quality of life outcomes were investigated. The interval training group was trained at 90-95% maximum heart rate, and the continuous training group was trained at 70-75% maximum heart rate on a bicycle ergometer. İnterval training was performed for 38 min as 10 min warm-up followed by 4 min loading and 3 min rest, and continuous training was performed for 47 min as 5 min warm-up, 5 min cool down, and 37 min loading. Risk factors were questioned, and quality of life was analyzed using physical and mental component parameters. Peak oxygen consumption increased significantly in both groups, and they had no superiority. In addition, there was a significant improvement in quality of life and other cardiovascular risk factors after aerobic training, but no significant difference was found between the two groups. In our study, there was a change in both groups after training. However, although the interval training group could not show a more significant increase in the workload reached at the end of ETT, it was superior to continuous training in 6 DYT and exercise test completion time. It is thought that the training duration and exercise intensity applied in the same way to both groups in our study may have been effective in these results. Our study examined all sub-parameters in the quality of life assessment, and interval training was superior in some parameters. It is thought that this difference may be due to personal factors. Risk factors were not questioned in our study, and this was determined as a deficiency in analyzing the study's effect.

A 2022 systematic review and meta-analysis examined the effect of different intensity exercises on rehabilitating patients with cardiovascular disease (20). This review included ten randomized controlled trials involving 520 patients with at least three weeks of high-intensity interval exercise (HIIT) and moderate-intensity continuous exercise (MCT) programs. There were no age restrictions in these studies, and all cardiovascular diseases, such as acute (chronic) coronary heart disease, angina, arrhythmia, heart failure, hypertension, hyperlipidemia, and atherosclerosis, were included. Peak oxygen consumption (VO2peak), peak heart rate (HRpeak), maximum respiratory exchange rate (maximum RER), and quality of life values were analyzed before and after the intervention. The HRpeak and quality of life values showed that the HRpeak of the patients after HIIT training was higher than after MCT training. In our study, although higher values were seen in HRpeak after interval training, this change was not statistically significant; however, significant changes were found in the interval training group in quality of life values, similar to the meta-analysis.

Pattyn et al. compared the results of interval and continuous aerobic training in coronary artery disease patients. In the meta-analysis study including 206 patients, subjects who were trained for at least four weeks were included in the study, and it was found that peak oxygen consumption increased in both groups and interval training was more effective; however, continuous training was found to be superior in reducing body mass index (21). In our study, it was found that both groups showed improvement in increasing exercise capacity compared to the baseline values, but no superiority was found in terms of the workload reached as a result of ETT; however, the prolongation of the ETT period by revealing symptoms in the IAE group in a longer time after training showed superiority to the CAE group. This may be due to the small sample size. At the same time, since body mass index findings were not recorded after the training in our study, no comment can be made in evaluating the effectiveness of the training in this respect. In the updated results of the same study in 2018, 1080 people were included in the analysis. In this study, interval training was superior in increasing peak oxygen consumption, although improvements were observed after training in both groups; however, no superiority was found in other cardiorespiratory findings and quality of life results (22). In our study, the superiority of the interval training group was observed in the parameters of physical function, physical role difficulty, emotional role difficulty, and general health perception. When we evaluate the results this way, the meta-analysis study mainly focused on peak oxygen consumption. The quality of life results were given as total scores, not sub-parameters, since different questionnaires were used. Our study showed that our exercise test was symptom-limited and that peak oxygen consumption could not be measured due to a lack of equipment. In addition, the difference in the duration of training in both studies may affect the results. Personal factors play a much more significant role when evaluating the quality of life results.

Continuous and interval aerobic training improves cardiovascular fitness, and total workload is tolerated more in interval training than in continuous training (3). In a study conducted by Rognmo et al., the effects of high-intensity interval training and moderate-intensity continuous training were compared. Training was given at 90-95% of maximum heart rate as high intensity and 70-75% moderate intensity. In groups of 21 patients randomized, training was given on a walking belt three days a week for ten weeks. As a result, it was found that the interval aerobic program applied with high intensity was superior in increasing exercise capacity (17.9%-7.9%) (23). In our study, the training in both groups was applied with high intensity (85-90% of maximum heart rate) with symptom limitation according to the ETT results. In this training, improvements in terms of exercise capacity were in the direction of interval training (35%-29%).

Studies show that similar training programs were performed in different disease groups. In 2024, a meta-analysis study examined the effect of moderate-intensity continuous training versus high-intensity interval training on aerobic and functional capacity in patients with heart failure (25). Thirteen randomized controlled trials were analyzed, including patients over 18 years with an ejection fraction below 40%. Moderate-intensity continuous aerobic training was performed between 50-75% of maximum heart rate; high-intensity interval aerobic training was performed with a bicycle or treadmill at 85-95% of maximum heart rate. Exercise durations ranged from 3.5 weeks to 6 months. Outcomes were evaluated using ejection fraction, peak oxygen uptake, 6 DYT, and Minnesota quality of life questionnaires. HIIT significantly improved peak oxygen uptake left ventricular ejection fraction, the six-minute walk test, and the Minnesota Living with Heart Failure Questionnaire in patients with heart failure with reduced ejection fraction. In addition, HIIT was found to be more effective in improving peak oxygen uptake among patients with lower body mass index. Our study found results favoring interval training in 6DYT and quality of life results to support the meta-analysis study. Body mass index values were not examined as a result of our study, and no comparison could be made in this direction, which is considered a deficiency of our study.

In another study (24) conducted with patients who underwent coronary artery bypass surgery, interval and continuous aerobic exercise training was performed with bicycle ergometry for 12 weeks, three days a week, with heart rate control in patients under 70. When the results were analyzed, the increase in peak oxygen consumption was statistically significant in the interval group compared to the continuous group. The increase in MacNew's quality of life score was higher in the interval group, but there was no statistically significant difference between the two groups. In another study (26) conducted with patients undergoing bypass operation, interval, and continuous training were compared, and no statistically significant difference was found between the two groups. In our study, the increase in exercise capacity was statistically significant in the interval group in the walking test and test duration results. However, there was no statistical significance in the ETT workload result. The difference in the diagnoses and cardiovascular deformities of the studied groups is thought to be the main reason for this situation.

In conclusion, according to our study, continuous or interval application of aerobic exercise programs in individuals diagnosed with CAD can improve exercise tolerance and patients' quality of life. However, it was observed that interval aerobic training was superior in increasing submaximal exercise capacity and duration of exertion, increased the perception of health felt by the patients, and was more easily tolerated.

Limitations

The most important limitation of our study is that the exercise test used for measuring maximal aerobic capacity could be measured with symptom limitations due to the need for more equipment. This situation may cause the test results to be affected by the person factor and may affect the objectivity. The other limitation is that the long-term permanence of the training given could not be determined due to the lack of long-term follow-up of the study. In addition, not questioning all risk factors at the beginning of the study and not evaluating the body mass index at the end of the study are among the limitations.

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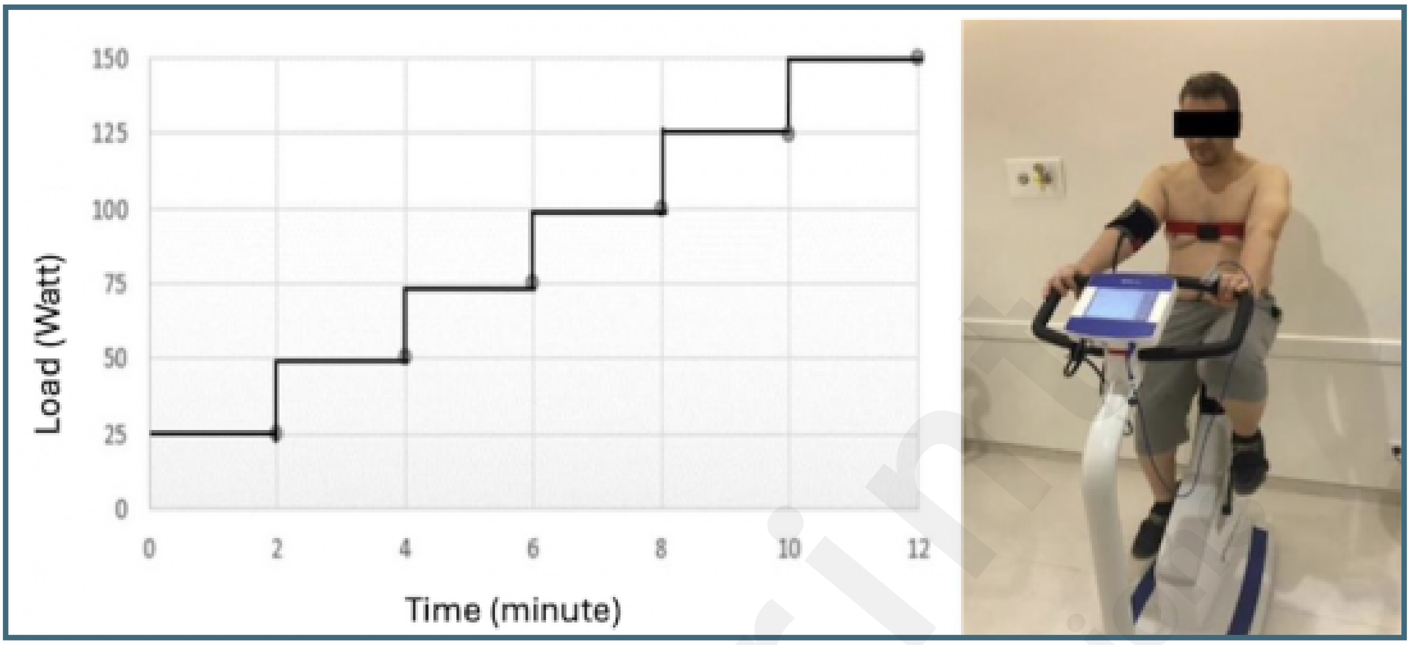
Supplementary Files

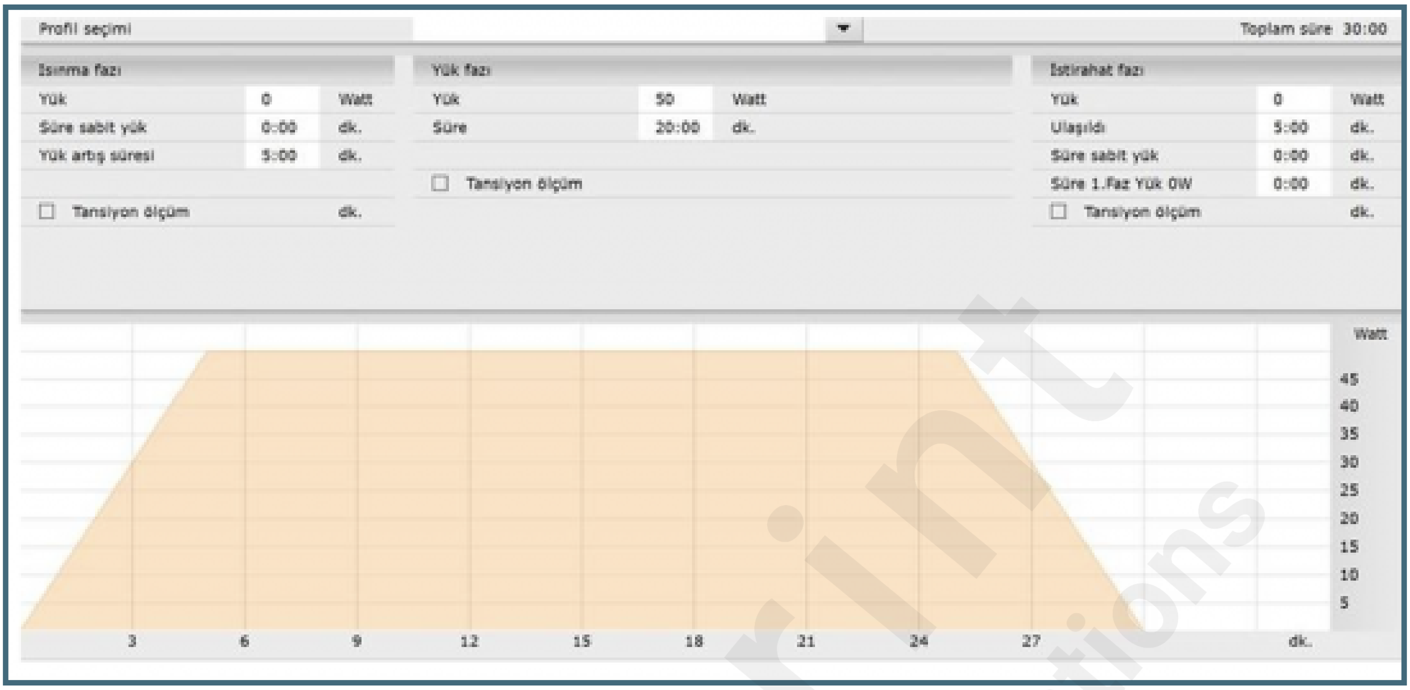
Untitled.
URL: http://asset.jmir.pub/assets/d56e982b5b347fe817792725e60e85b3.docx

Figures

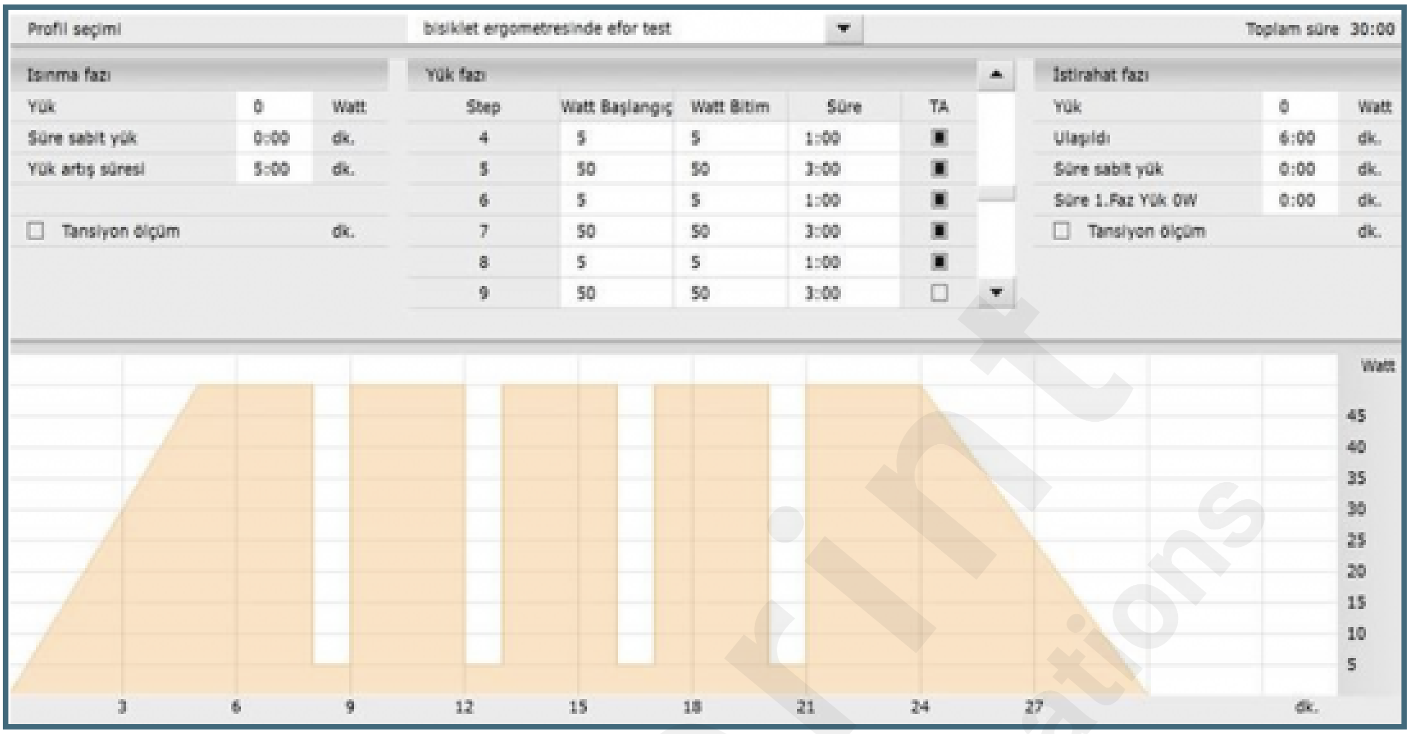
Exercise tolerance test protocol and intervention.



Continuous aerobic exercise training model.



Interval aerobic exercise training model.



Flow diagram of the study.