

Comparison of supervised exercise training and home-based exercise training in chronic heart failure

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ABSTRACT

Objective: This study was planned to compare the outcomes between supervised and home-based exercise training in patients with chronic heart failure.

Methods: The study was conducted at the Department of Physical Therapy in Ankara University, Faculty of Medicine, Turkey between 2000 and 2001. Twenty-two patients with stable chronic heart failure were randomly assigned to the supervised exercise training group (n=11) or the home-based exercise training group (n=11). Symptom-limited maximal exercise tests with gas exchange analysis were carried out before randomization. Work load equivalent to 60% of achieved peak heart rate at the tests was determined as exercise training work load for each subject. Both groups participated in a program of 3 exercise training sessions per week for 3 months. The exercise tests were repeated after 3 months.

Results: After training, peak exercise duration increased

significantly in the supervised exercise training group and the home-based exercise training group ($p < 0.05$). There was substantial improvement in peak $\dot{V}O_2$ with exercise training in the supervised exercise training group ($p < 0.05$) but, peak $\dot{V}O_2$ did not change significantly in the home-based exercise training group ($p > 0.05$).

Conclusion: Supervised and home-based exercise training enhanced exercise capacity in patients with chronic heart failure. The training program must be tailored to each patient's specific limitations, individual needs and possibilities. Home-based exercise training may be a training alternative to stable chronic heart failure patients who prefer not to participate in an outpatient supervised training program.

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Exercise intolerance is the major chronic heart failure (CHF) symptom limiting patient's ability to perform normal daily activities. Several studies with CHF patients found that these patients demonstrated marked improvements in exercise tolerance when properly managed.¹⁻⁴ Several articles have been published concerning the effects of exercise training on patients with CHF. Although some recommendations have been suggested, specific guidelines for the methods to be employed for this training have not been thoroughly

established.^{4,7} Long-term exercise adherence is difficult for many people, but for patients with CHF continued exercise is especially problematic because these patients frequently experience dyspnea and fatigue, symptoms that can severely limit exercise participation.^{8,9} The effect of alternate formats such as home-based exercise on symptoms, quality of life, and exercise adherence in CHF patients is not well understood.⁶ Our study was designed to compare the outcomes between supervised and home-based exercise training in patients with CHF.

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Methods. Twenty-nine patients with a diagnosis of heart failure of >3 months duration participated in the study. All patients fulfilled criteria of the New York Heart Association; class II or III CHF. They had an ejection fraction <40%. Exclusion criteria were: valvular heart disease, exercise-induced cardiac arrhythmias, symptomatic myocardial ischemia within 3 months. Written informed consent was obtained from all the subjects. Thirteen patients were classified as having ischemic cardiomyopathy. They had a myocardial infarction or had angiographic evidence of coronary artery disease that could explain the extent of ventricular dysfunction. The remaining 16 patients, who did not meet these criteria, were classified as having idiopathic dilated cardiomyopathy. Twenty-three patients were taking cardiac glycoside (digoxin), 28 were taking diuretics, 10 were taking angiotensin-converting-enzyme (ACE) inhibitors, and 10 were taking antihypertensives. All medication dosages remained stable during the study. The patients taking beta-blocker drugs were also excluded from the study. All the patients were sedentary prior to starting our training program. This study was a prospective, randomized comparison of 2 groups of patients. The study was carried out at the Department of Physical Therapy in Ankara University, Faculty of Medicine, Turkey between 2000 and 2001. The supervised exercise training group (SETG) performed 12 weeks of physical training on treadmill at the laboratory. The home-based exercise training group (HETG) performed 12 weeks of physical training by themselves. All tests and measurements were performed in both groups at entry and after the 12 week study. A symptom-limited, peak exercise test was performed using a motorized treadmill (Max1 Marquette 1995 Milwaukee) and a Sensormedics Vmax 29 Ergospirometry System (Sensormedics, Yorba, California). The testing protocol was the Modified Bruce protocol.¹⁰ Test end points included a rating of perceived exertion 16 on a scale that ranges between 6-20, with 6 representing little exertion and 20 very heavy exertion,¹¹ achievement of age-predicted maximal heart rate, or inability to maintain walking, or both. Patients were familiarized with all testing procedures before the exercise testing. Peak oxygen consumption was measured continuously by indirect calorimetry by a Sensormedics Vmax 29 Ergospirometry System. The system was calibrated before the start of each study. Patients were monitored by electrocardiography Max 1 Stress Test Monitor (Marquette 1995 Milwaukee) at rest, during exercise, and during 5 minutes of recovery. Systolic and diastolic blood pressures were measured using a standard cuff and sphygmomanometer. Heart rate was measured on 12-lead electrocardiogram. Rating of perceived exertion was assessed by Borg scale.

Rate-pressure products were obtained by systolic blood pressure times heart rate. All these measurements were carried out after 30 minutes of rest, at the end of each stage of exercise, at peak exercise and during the recovery period. The results of this symptom-limited exercise tests were used to determine the exercise training work load equivalent to 60% of the achieved peak heart rate. After exercise testing was completed, patients were randomly assigned to a supervised exercise training group (SETG, n=14) or a home-based exercise training group (HETG, n=15). In both the training groups, exercise training was performed 3 times a week. During each session, patients completed a 5 minute slow warm-up phase, a 30-minute aerobic phase (walking), a 5 minute cool-down phase and a 5 minute recovery phase to total 45 minutes of exercise. All patients undertook 12 weeks of training. The SETG, walked on a treadmill at the laboratory under supervision. These patients participated in individual training sessions and they were monitored during each exercise session. Heart rate, systolic and diastolic blood pressure was measured in warm-up phase, with 10 minutes intervals in aerobic phase, in cool-down phase. The measurements were repeated at recovery after 5 minutes of rest periods. Walking was selected as the type of exercise for patients in the HETG too. Training was performed at a place near home (for example, a garden or a park). The group was instructed to exercise 3 days a week. They were asked to increase the duration and intensity of training after 2 or 3 weeks to reach 60% peak heart rate and a period of 30 minutes. Each subject received an instructional session. The session included learning to count pulse rate and to monitor heart rate, and ratings of perceived exertion. They were evaluated as to their accuracy in checking their exercise pulse rates. They were also encouraged to use a rating of perceived exertion of 12-14 to guide their exercise intensity. Subjects were asked to complete exercise follow-up logs daily to report heart rates, ratings of perceived exertion, duration of exercise and any symptoms experienced. Exercise follow-up logs were returned to the project staff on a biweekly basis. The HETG also received weekly phone calls for monitoring adherence and progress, answering questions and providing individualized feedback. The group was also asked to call the hospital for control purposes once a month until the end of the study.

Statistical analysis. Intragroup comparisons of the exercise test responses between before training and after training were made with the Wilcoxon signed rank test. Exercise test responses were compared before and after the participation in 2 different training programs using analysis of covariance. In analyzing change, main effects for group assignment were examined with baseline

Table 1 - Baseline characteristics of the patients in the 2 treatment groups.

Characteristics	Dropouts (n=7)	SETG (n=11)	HETG (n=11)
Age (year)	58 ± 2	52 ± 8	49 ± 11
Male/female	6/1	8/3	8/3
BMI (kg/m ²)	25.5 ± 1.8	27.6 ± 3.5	27.9 ± 3.4
LVEF (%)	33.5 ± 2.4	36±4	37±6

Data presented as mean value ± SD or number of patients
 BMI - body mass index, LVEF - left ventricular ejection fraction
 SETG - Supervised exercise training group,
 HETG - Home exercise training group

levels of the dependent variables serving as covariates. All statistical analyses were carried out with the Statistical Package for Social Sciences windows version 10, with $p < 0.05$ established as the level of significance.

Results. Of the 29 patients randomly assigned at baseline, 22 completed the exercise testing and training protocol with no adverse events. Seven patients dropped out (3 in the SETG, 4 in the HETG). Reasons for dropout included health (n=4)

and personal reasons (n=3). Among patients who completed the study, no differences in demographic characteristics were seen between the 2 study groups after randomization (Table 1) ($p > 0.05$). Compliance with the exercise training program, defined as percentage of sessions attended, averaged 81% in the HETG and 97% in the SETG. Resting heart rate and rate-pressure product decreased significantly ($p < 0.05$) but resting systolic and diastolic blood pressures did not change after the training program in the SETG ($p > 0.05$). No significant changes were observed in the resting measurements in the HETG after the training program ($p > 0.05$) (Table 2). No significant differences could be found between the 2 groups on the resting heart rate, resting systolic blood pressure, resting diastolic blood pressure and resting rate-pressure product ($p > 0.05$) (Table 2). After training, peak exercise duration and work load reached (speed and grade of treadmill) increased significantly in the SETG, and in the HETG ($p < 0.05$). Rating of perceived exertion at peak exercise decreased significantly after training in the 2 groups ($p < 0.05$). There was no significant difference in peak exercise duration and work load, rating of perceived exertion between SETG and HETG ($p > 0.05$) (Table 2). Peak heart rate, systolic blood pressure and rate-pressure product at peak exercise were similar in both groups after training

Table 2 - Effects of physical training on exercise testing parameters.

Parameters	SETG		HETG		Difference	
	Baseline	After training	Baseline	After training	F-value	P-Value
Heart rate (beats/min)						
At rest	88.9±11.2	*83±7.8	81.6±13.4	81.0±13.	0.09	>0.05
At peak exercise	145.8±18.7	146.4±14.9	137.3±23	144.4±18.9	0.04	>0.05
SBP (mm Hg)						
At rest	120±14.1	113.6±15.6	110.9±21.1	113.6±16.9	0.59	>0.05
At peak exercise	150±24.4	142.7±21.4	140.9±28.7	140.9±25.4	1.55	>0.05
DBP (mm Hg)						
At rest	83.1±9	80±10.9	76.3±12	76.8±8.4	0.22	>0.05
At peak exercise	90.9±13.9	*81.3±8.3	87.3±11.7	85.4±8.2	1.89	>0.05
Rating of perceived exertion						
At peak exercise	15.82±4.1	*10.82±3	16.73±2.8	*13.45±1.5	1.12	>0.05
Rate-pressure product (mm Hg10²)						
At rest	107±18.5	*98.3±23.3	88.9±12.7	91.7±17.4	0.03	>0.05
At peak exercise	212±38.2	208.2±33.2	191.8±32	198.8±40.8	0.33	>0.05
Peak O ₂ consumption (ml/kg/min)	19.85±7.6	*23.3±6.8	21.9±5.8	23.60±7.40	0.93	>0.05
Peak exercise durations (s)	626.9±255	*836.1±167.1	574.1±203	*700.3±232.4	0.05	>0.05
Work load (speed) (km/h)	4.22±1.73	*5.70±1.04	4.07±1.09	*5.02±1.11	1.46	>0.05
Work load (grade) (%)	11.45±3.78	*14.36±1.5	12±1.55	*13.45±1.57	0.26	>0.05

* $p < 0.05$, SBP - systolic blood pressure, DBP - diastolic blood pressure
 SETG - Supervised exercise training group, HETG - Home exercise training group

($p > 0.05$). No significant differences were observed in these variables between the 2 groups ($p > 0.05$) (Table 2). In the SETG, diastolic blood pressure at peak exercise decreased significantly after training by 90.9 ± 13.9 mm Hg to 81.3 ± 8.3 mm Hg ($p < 0.05$). In the HETG, diastolic blood pressure at peak exercise was similar after training ($p > 0.05$). There were no significant differences in diastolic blood pressure at peak exercise between the 2 groups ($p > 0.05$) (Table 2). There was substantial improvement in peak oxygen consumption with exercise training in the SETG from 19.85 ± 7.6 ml/kg/min to 23.3 ± 6.8 ml/kg/min ($p < 0.05$). In the HETG, peak oxygen consumption was unchanged ($p > 0.05$). No significant differences were found in peak oxygen consumption between the 2 groups ($p > 0.05$) (Table 2).

Discussion. Home-based exercise training programs offer the advantage of continuing the program indefinitely. Thus, patients are able to spend more time with their families.^{8,12,13} There has been little research on home-based exercise training compared to supervised exercise training in CHF patients.^{5,8,12,14} Also, the beneficial effects of physical training on exercise tolerance have been demonstrated in CHF, but it is unclear whether significant improvements can also be achieved through unsupervised home-based training regimes. The purpose of our study was to compare the effects of supervised and home-based exercise training on functional capacity in patients with CHF. Exercise duration increased significantly after 3 months exercise training in both groups. Peak oxygen consumption increased in both groups, however, improvement of peak oxygen consumption reached a statistical significant level only in the SETG after training. This finding is consistent with Wielenga et al's study.¹⁵ In the study, after 12 weeks of endurance training, exercise time increased significantly but oxygen consumption increased without significance. Oka's study⁶ used only a home-based exercise format. The study evaluated the effects of a home-based, walking and resistance exercise program on 3 month physical fitness levels in patients with CHF. No significant differences in peak oxygen consumption were observed between the 2 groups which is similar to our results. Also, other studies found that patients with severe left ventricular dysfunction, improved their maximal exercise performance after a prolonged regime of physical training.^{2,15-21} The study of the European Heart Failure Training Group that had a total number of 134 stable heart failure patients and all of the trials published up to 1998 have shown a consistent 15-20% increase in peak oxygen consumption in patients with CHF.^{22,23} Quite similarly we also found a 17.6% increase at peak oxygen consumption in the SETG. Although not

statistically significant, peak oxygen consumption increased in the HETG. Enhancement of oxidative capacity in the leg muscles is possibly the reason for this improvement. Exercise training improves skeletal muscle nutrition and intrinsic skeletal muscle abnormalities, blood flow to exercising muscles and delays, the onset of anaerobic metabolism in skeletal muscle in CHF.²⁴ More recently Meyer²⁵ indicated that the peripheral effects of training in CHF patients may reach their maximum after 2-3 months. Inadequate training intensity could be a possibility that explained why the increase in peak oxygen consumption of insignificant statistical achievement in the HETG after training. This might result from our sample's exercise intensity being lower than reported, so a longer exercise program duration may be needed to achieve significant changes in peak oxygen consumption. Previous studies have noted that, adherence with the home-based exercise was one factor necessary to achieve benefit.^{6,8,13} The HETG's compliance was (81%) less than the SETG's compliance (97%). So the SETG may be more trained than the HETG and after training, peak oxygen consumption improved significantly only in the SETG.

Peak oxygen consumption did not increase significantly in the HETG, although no significant differences were observed in peak oxygen consumption after training between the 2 groups. There are a number of reasons for this result. Recently, one report emphasized that more important than any intensity recommendation, exercise training in CHF must be monitored and terminated when an acute decrease in blood pressure, onset of angina, significant dyspnea and fatigue, a feeling of exhaustion, or serious exercise-induced rhythm disorders are observed.⁷ We chose lower intensity (at 60% of achieved heart rate during symptom limited exercise testing) training prescriptions in the HETG to avoid any adverse occurrences and also in the SETG to provide comparable training intensity levels between 2 groups. This may be a reason, and another reason may be our small sample size in each group. It probably lessened the differences between the SETG and the HETG. Alternatively, our study's method was very different from the other controlled studies. In our study, home-based exercise training was thought as one of the training alternatives, so there was no control group which was sedentary in our trial. To our knowledge, there are no previous studies comparing supervised, and home-based exercise training in CHF patients. Some of the previous studies were not controlled trials.^{23,26} In some other controlled studies, patients with CHF participated in only supervised training programs^{17,19,21} or in only home-based training programs^{2,6,14,16} or in a combination of both.^{27,28} Lack

of a completely sedentary control group may be another factor which explained the nonsignificant differences in peak oxygen consumption between the 2 groups.

Peak oxygen consumption and exercise duration are usually used as end points in the evaluation of exercise performance.²⁹ Our data suggested that in both groups there was an increase in the peak exercise duration and that only in the SETG, the peak VO₂ increased significantly. So our study only confirms the results of numerous other CHF training studies.^{2,15-23} It must be noted that our study has several limitations. The main limitation is the small number of patients. At baseline, 29 patients participated in the study and their exercise testings were completed. After randomization, throughout the study the dropout rate was 21% (n=3) in the SETG and 27% (n=4) in the HETG. The study's dropout rate is similar to other trials.^{14,15,21} Reasons for dropout were health reasons [worsening heart failure (n=3; 2 SETG, 1 HETG), sudden death (n=1 HETG)] and personal reasons (n=3; 1 SETG, 2 HETG). Also, the reasons for dropout in this study were similar to previous studies.^{14,15,18,21} Our trial did not take into consideration the cost effective analysis and measurement of health-related quality of life. Unfortunately, these limitations do not allow for distinguishing clearly between the effects of the "supervised exercise training" and the "home-based exercise training" in patients with CHF. It should be mentioned that both training methods contributed to positive changes in exercise capacity. Home-based exercise training may be a training alternative to stable CHF patients who prefer not to participate in outpatient supervised training programs, however, other parameters including adherence to program, patient satisfaction with the program and generic health status measures should be considered.

In conclusion, our study should be considered a pilot study showing that home-based exercise training may be effective to improve exercise capacity in patients with CHF. The training program must be tailored to each patient's specific limitations, individual needs and possibilities. There is a need for future research, which will be carried out with larger sample groups, to show the benefits of home-based exercise training in these patients including the effects of physiological outcomes, symptoms, quality of life, and exercise adherence.

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