

Comparing Aerobic With Nonaerobic Forms of Exercise in the Treatment of Clinical Depression: A Randomized Trial

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We compared aerobic with nonaerobic forms of exercise in the treatment of clinical depression. Ninety-nine inpatients, who met the DSM-III-R criteria for major depression, dysthymic disorder, or depressive disorder not otherwise specified (NOS), took part in the study. They were randomly assigned to two different physical training conditions, aerobic and nonaerobic. In both conditions, one hour of training was performed three times a week for a period of 8 weeks. There was a significant increase in maximum oxygen uptake ($\dot{V}O_2$ max) in the aerobic group; there was no change in the nonaerobic group regarding this variable. Depression scores in both groups were significantly reduced during the study, but there was no significant difference between the groups. The correlation between increase in physical fitness and reduction in depression scores was low. The study indicates that the antidepressive effects associated with exercises are not restricted to aerobic forms of training.

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IN AN EARLIER STUDY, we found that aerobic exercises were associated with reduced depression scores in hospitalized patients who met the DSM-III criteria for major depression.¹ Our results are in accordance with eight other experimental studies on clinically depressed patients. All show aerobic exercise to be better than placebo or no treatment,²⁻⁵ and as effective as other forms of treatment, including different forms of psychotherapy.⁶⁻⁹ Although some of these studies have methodological shortcomings,¹⁰ all results indicate that aerobic exercise is associated with an antidepressive effect in unipolar depressive disorders of mild to moderate severity.¹¹

In our previous study,¹ which consisted of both a group of patients who were randomly assigned to aerobic training and a control group, the magnitude of depression score reduction paralleled that of increased physical fitness. In patients with a small or no increase (<15%) in maximum oxygen uptake ($\dot{V}O_2$ max), the mean reduction in depression scores was similar to that of the control group. The patients with a substantial increase (>15%) in $\dot{V}O_2$ max had a much larger mean reduction in depression scores. This indicates that exercise-related reductions in depression scores depend upon an increase in the $\dot{V}O_2$ max. In men, there was a strong correlation between increase in aerobic capacity and reduction in depression scores ($r = 0.43$). A similar correlation was not found in women ($r = -.13$).¹² In the control group, patients who were administered tricyclic antidepressant agents (TCA) had a better treatment response than those who were not on medication. Such a difference was not found in the training group. This indicates that medication cannot potentiate the antidepressive effect of exercise.¹²

Most exercise intervention studies have used aerobic exercise, with jogging as the most common activity. Exercise can be divided into aerobic (training of cardiorespi-

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ratory or aerobic endurance) and nonaerobic forms (muscular strength, flexibility, coordination, and relaxation).¹³ An important question is whether the psychological benefits of exercises are restricted to aerobic exercise, or if they can be achieved with other forms. This is important from a theoretical as well as practical perspective. If it can be shown that the antidepressive effects are restricted to aerobic forms of exercise, one has come a step further in isolating an effective element within physical training. This will be useful in scientific efforts to discover the mechanisms by which the antidepressive effects of exercise are mediated. In practice, performing intensive, aerobic exercise may be strenuous and sometimes difficult for clinically depressed patients. If the same psychological gains can be achieved with less intensive forms of exercise, this will have great practical importance.

To test the importance of the aerobic element of training, controlled studies are required in which patients are randomly assigned to aerobic and nonaerobic forms of exercise. Only one such study has been published, showing both aerobic (running) and nonaerobic (weight lifting) exercise to be equally effective, and both being better than no exercise at all.⁵ Because neither of the training groups achieved any increase in $\dot{V}O_2$ max, the importance of the aerobic element of training could not be assessed.

The purpose of this randomized trial was to answer the following questions: (1) Are there differences between aerobic and nonaerobic forms of exercise in the treatment of clinical depression?; (2) Are there differences in treatment response between patients with large increases and those with small increases in physical fitness?; (3) Is there any correlation between the increase in physical fitness level and the reduction in depression scores?; (4) Will patients who receive both exercise treatment and TCA have better treatment response than those who are not administered medication?

MATERIAL AND METHOD

During the study, all patients were hospitalized at the Modum Bads Nervesanatorium, a psychiatric clinic specializing in the inpatient treatment of voluntarily admitted patients suffering from severe neuroses or personality disorders. During a 15-month period, all patients admitted with depressive symptoms were offered the opportunity to take part in the study. Using the Structured Clinical Interview for Depression (SCID) for DSM-III,¹⁴ patients were given DSM-III-R diagnoses on Axes I and II (Table 1).

Patients meeting the criteria for major depression, dysthymic disorder, or depressive disorder not otherwise specified (NOS), and who additionally had an admission score of ≥ 9 on the Beck Depression Inventory (BDI),¹⁵ were included in the study. Psychotic patients and those with somatic contraindications to exercises were excluded. Multiple diagnoses were used on both axes. Axis II diagnoses were clustered according to the recommendations in the DSM-III-R, with each patient being assigned to one cluster only. Twenty randomly selected audiotaped interviews were independently diagnosed by the principal author (E.W.M.) and another psychiatrist (Ø.S.). Interrater reliability was estimated by the use of kappa. The kappa value was 0.84 on Axis I and 0.76 on Axis II.

One hundred and fifteen patients were asked to take part in the study. Six refused, and ten did not meet the inclusion criteria. The remaining 99 patients, 38 men and 61 women, were the subjects of this study. Forty-one patients met the criteria for depressive disorder only. Fifty-eight patients also met the criteria for anxiety disorder (Table 1). All patients took part in the occupational therapy treatment program at the clinic and attended psychodynamically oriented individual psychotherapy, one to two sessions per week.

Patients were randomly allocated to two different physical training programs, aerobic and nonaerobic, by block randomization with respect to sex. Comparison of the groups with respect to important sociodemographic and previous treatment variables is shown in Table 2. A higher proportion of patients

Table 1. DSM-III Diagnoses of Patients

| DSM-III Diagnoses | No. of Patients | |
|---|-----------------|------------|
| | Aerobic | Nonaerobic |
| Axis I (multiple diagnoses) | | |
| Major depression without melancholia | 23 | 25 |
| Major depression with melancholia | 11 | 5 |
| Major depression in remission | 1 | 3 |
| Dysthymic disorder | 12 | 15 |
| Depressive disorder NOS | 2 | 2 |
| Panic disorder with agoraphobia | 17 | 13 |
| Panic disorder without agoraphobia | 3 | 2 |
| Social phobia | 6 | 7 |
| Generalized anxiety disorder | 2 | 8 |
| Obsessive compulsive disorder | 0 | 1 |
| Somatiform disorders | 0 | 2 |
| Alcohol abuse/dependence | 5 | 6 |
| Diazepam abuse/dependence | 4 | 3 |
| Axis I (each patient in one category) | | |
| Depression only | 23 | 18 |
| Depression and anxiety | 28 | 30 |
| Axis II (each patient in one cluster) | | |
| Paranoid/schizoid/schizotypal | 15 | 9 |
| Histrionic/narcissistic/borderline | 9 | 6 |
| Avoidant/dependent/masochistic/passive-aggressive | 15 | 18 |
| No diagnosis | 12 | 15 |

in the aerobic group was employed and had previously engaged in regular exercise and competitive sports. The two groups were quite similar regarding the other variables.

Patients in the aerobic group performed intensive aerobic exercise, and the main goal was to achieve increase in aerobic capacity. Brisk walks and jogging were the most common activities. The intensity of the training corresponded to approximately 70% of maximum aerobic capacity, which is optimal to achieve increase in $\dot{V}O_2$ max. Patients in the nonaerobic group trained muscular strength, flexibility, and relaxation. The intensity of the training was kept low, to avoid any effect on the $\dot{V}O_2$ max. In both programs, the patients trained in small groups of five to ten individuals under the supervision of an experienced instructor. Both groups performed an hour of effective training three times a week for a period of 8 weeks.

The effect variables, level of depression and physical fitness, were measured on admission and again after 8 weeks. Depression was assessed using a therapist rating, the Montgomery and Åsberg Depression Rating Scale (MADRS),¹⁶ and a self-report instrument, the BDI. The scores at both points of time, as well as the reduction in scores from beginning to end, were highly correlated on both measures ($0.64 < r < 0.79$; $P < .001$). The same trends in development were seen with each of the instruments. In the result section of this report we have chosen to present only the MADRS ratings.

The ratings were performed by a psychiatrist (Ø.S.) and a psychologist (A.H.), who were blind to the randomization. Each patient was scored by the same rater at both assessments. To assess interrater reliability, twenty randomly selected patients were interviewed and rated by a third researcher (E.W.M.) in the presence of the other two, who also rated these patients. Interrater reliability was found to be high. The intraclass coefficients (ICC 1,1) were >0.97 .

Physical condition was assessed by a submaximal bicycle ergometer test, and the $\dot{V}O_2$ max was calculated according to Åstrand's indirect method.¹⁷ To validate the Åstrand test, 40 patients also performed maximal tests, where the $\dot{V}O_2$ max was measured directly using the Douglas Bag method,¹⁷ the standard method for measuring $\dot{V}O_2$ max. The results of two tests were highly correlated on admission ($r = .67$),¹⁸ and the same trend in development of $\dot{V}O_2$ max in the two groups was seen with both methods. Only the calculated values according to the Åstrand test will be presented here. The values of $\dot{V}O_2$ max on admission were compared with predicted normal values.¹⁷

Nine patients dropped out of the study, eight in the aerobic and one in the nonaerobic. The patient in the nonaerobic group and six of the patients in the aerobic group disliked the inpatient role and were

Table 2. Demographic Characteristics, Previous Psychiatric Treatment, and Physical Activity Level of Patients

| Characteristic | Aerobic (n = 51) | Nonaerobic (n = 47) |
|---|---------------------|------------------------|
| Female | 33 | 30 |
| Mean age (SD) | 40.9 (9.1) | 41.2 (10.9) |
| Marital status | | |
| Married | 31 | 25 |
| Separated/divorced | 6 | 7 |
| Widowed | 2 | 3 |
| Single | 12 | 13 |
| Occupation | | |
| Employed | 28 | 21 |
| Receiving social security benefits | 16 | 24 |
| Other, not employed | 7 | 3 |
| Sick leave in the year before admission (wk) (SD) | 16.7 (19.7) | 17.1 (25.5) |
| Previous psychiatric treatment | | |
| None | 4 | 7 |
| Outpatient | 22 | 18 |
| Hospitalized | 25 | 23 |
| Mean age and duration of disorder (yr) | | |
| Age at onset of affective disorder (SD) | 30.9 (15.8) | 28.8 (13.6) |
| Age at onset of anxiety disorder (SD) | 23.9 (18.5) | 23.7 (12.9) |
| Duration of affective disorder (SD) | 3.7 (4.7) | 3.7 (4.5) |
| Duration of anxiety disorder (SD) | 10.3 (9.4) | 9.5 (8.0) |
| TCA | 14 | 14 |
| Physical activity level on admission | | |
| Regular exercise | 9 | 9 |
| Sedentary | 42 | 39 |
| Highest physical activity level in adult life | | |
| Competitive sports/exercise ≥ 2 times/wk | 29 | 16 |
| Sedentary | 22 | 33 |

discharged against medical advice shortly after admission. Although they dropped out of the exercise program, all were given the opportunity to stay at the hospital; none of them accepted. One patient in the aerobic group had to stop due to a hiatus hernia, and one disliked the exercise program. Thus, only two of the withdrawals seemed to be exercise-related.

Ninety patients completed the study, 43 in the aerobic and 47 in the nonaerobic group. There were no significant differences on important sociodemographic variables between those who withdrew and those who complied, indicating that the patients who complied were representative of the whole sample.

For statistical evaluations, two-tailed Wilcoxon rank-sum and signed-rank tests, as well as Spearman's ρ , were used. Interrater reliability on diagnoses was calculated by the use of kappa. Reliability of symptom ratings was calculated using intraclass coefficients (ICC 1,1).

RESULTS

The $\dot{V}O_2$ max in the aerobic group was slightly higher than in the nonaerobic group on admission (Fig. 1), but the difference was not statistically significant ($P > .10$). The $\dot{V}O_2$ max in the whole sample on admission was significantly lower ($P < .01$) than predicted normal values (mean, 83%). In the aerobic group, there

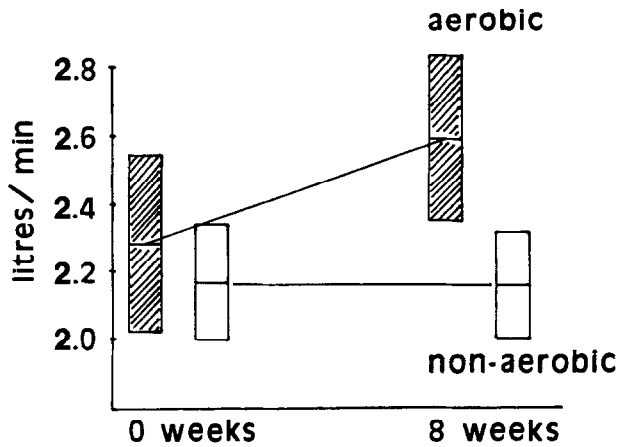


Fig 1. Mean value of $\dot{V}O_2$ max with 95% confidence intervals.

was a significant increase in $\dot{V}O_2$ max ($P < .001$). In the nonaerobic group, mean $\dot{V}O_2$ max was unchanged ($P > .10$). The increase in the aerobic group was significantly higher than in the nonaerobic group ($P < .001$).

The mean depression scores on admission were almost identical in the two groups ($P > .10$) (Fig. 2). Both groups had significant reductions in depression scores during the study ($P < .001$). The reductions in the two groups were almost equal, and the difference between the groups was not statistically significant ($P > .10$).

Patients with a substantial increase in $\dot{V}O_2$ max ($>15\%$) had almost similar reductions in depression scores as those with little or no increase. The difference was not statistically significant ($P > .1$). The correlations between increase in $\dot{V}O_2$ max and reduction in depression score were low for both sexes; $r = .16$ for women and 0.26 for men ($P > .1$ for both).

Fourteen patients in each group were administered TCA during the study. Patients receiving TCA had larger reductions in depression scores than those who were not on medication ($12.7 - 6.5 = 6.2$ v $12.3 - 8.3 = 4.0$), but the difference was not statistically significant ($P > .05$).

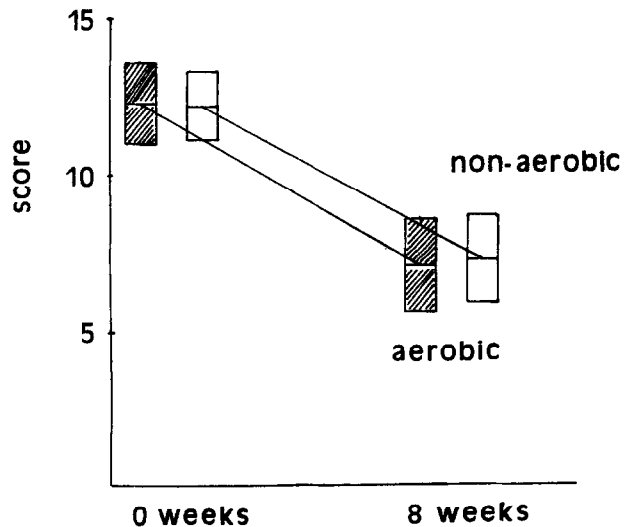


Fig 2. Mean score of the MADRS with 95% confidence intervals.

DISCUSSION

A significant increase in $\dot{V}O_2$ max occurred in the aerobic group, while the nonaerobic group was unchanged on this variable. Thus, the experimental manipulation was successful. Both groups had been training under almost equal circumstances except one: The aerobic group had received a strong aerobic stimulus while the nonaerobic had not.

The increase in physical fitness level had no impact on depression scores. The reduction in depression scores in the two groups was almost equal. This indicates that the antidepressive effects associated with physical exercises are not restricted to intensive aerobic forms of exercise. This supports the previous findings of Doyne et al.⁵ In the aerobic group, treatment response in patients with both large and small improvements in physical fitness was almost equal. There was no statistically significant correlation between increase in physical capacity and reduction in depression scores. These results contradict those of our previous study,¹ in which we found a better treatment response in patients with a substantial increase in $\dot{V}O_2$ max, as well as a strong positive correlation between increase in $\dot{V}O_2$ max and reduction in depression scores in men.¹² However, the number of patients in the present study was much larger, indicating that the present results are more reliable.

Although not statistically significant, in both groups there was a tendency for larger reductions in depression scores in patients who were administered TCA. In our earlier study, we did not see such an effect of medication on patients who exercised.¹¹ No other study has addressed this topic. The diverging results between our previous study and the present one, leaves unanswered the question of an eventual interaction between physical training and the use of TCA.

The patients in this study were hospitalized, and received other forms of therapy in addition to exercise. No control group without any form of exercise was included. Thus, this investigation does not try to answer the question of whether exercise per se is effective or not. Several studies have previously addressed this topic, all showing aerobic exercise to be associated with antidepressive effects.¹¹ We did not find it necessary to replicate these findings here.

The mechanisms by which the psychological effects of exercise are mediated, have not been specifically addressed in this study. However, they may be indirectly elucidated to some degree. Both physiological, biochemical, and psychological hypotheses have been suggested.¹⁹ Physiological hypotheses often implicate that a measurable increase in physical fitness level is a prerequisite for psychological change. Especially in depressed patients with reduced physical fitness level, normalization of the physical work capacity has been considered to be important.²⁰ The mean $\dot{V}O_2$ max on admission in the present study was 83% of predicted normal values. In this sample of physically unfit patients, similar reductions in depression scores were obtained with low intensity training (without fitness effect) as well as with intensive training (with measurable increase in $\dot{V}O_2$ -max). This indicates that the improvement in fitness itself does not play an essential role in the treatment of clinical depression.

Increased aminergic transmission²¹ and increased levels of endorphines and encephalines²² have also been suggested as possible explanations of the antidepressive effects associated with exercise. Biochemical changes will probably be most

prominent during intensive aerobic exercise, and the findings of the present study indirectly contradict these hypotheses.

The lack of a specific effect associated with intensive aerobic exercise indicates that psychological mechanisms are important. Previous studies have shown that enhanced self-esteem is associated with physical fitness training.¹⁹ To increase self-esteem, as well as experience mastery of and increase in response-contingent positive reinforcement, are important elements in the cognitive behavioral treatment of depression.²³⁻²⁵ Physical fitness training seems to be a method well-suited for achieving those goals. It is not clear whether there are specific effects of physical exercise compared with other forms of cognitive behavioral treatment. This should be the focus of further studies.

Our findings may be summarized as follows: We found no differences between aerobic and nonaerobic forms of exercise in the treatment of clinical depression; patients with greatly increased physical fitness had similar reductions in depression scores as those with little or no increase; the correlation between the magnitude of increase in physical fitness and reduction in depression scores was low; and the study indicates that aerobic fitness is not necessary for an antidepressive effect.

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