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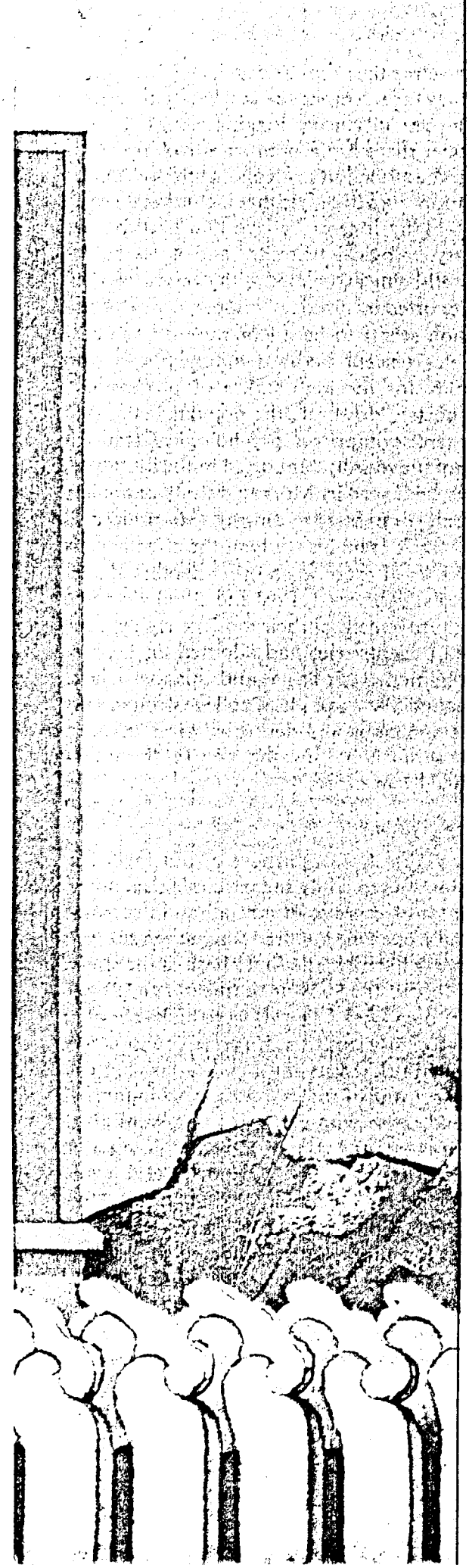

The Prescription of Exercise for Depression

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Prescribing exercise programs based on patients' physical conditions and life circumstances is a safe and effective way to treat depression—a disorder that is almost endemic. On page 49, John Greist, MD, describes similar results in a running program.

Depression is widespread in our time. It is the most common kind of psychopathology that physicians see,[1] and to some extent it underlies many of the physical complaints they are asked to treat.[2] Suicide has recently become the second most common cause of death among adolescents; its incidence in this age-group has doubled in little more than a decade.[3]

Everyone has a favorite explanation for this trend. Some blame social changes, the "decline in moral values," and the "erosion of the family"; some claim that contemporary life-styles are unnatural and unhealthy; others cite economic factors, overpopulation, and the fear of war and nuclear disaster.

But treatment for depression cannot wait for agreement about causes. Although surprisingly little is known about

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Some college students have overcome addiction to alcohol and/or drugs by exercising.

the mechanisms of the interactions of the mind and the body, medicine does offer treatment possibilities, including drugs (tricyclics and monoamine oxidase inhibitors),[4] electroshock therapy,[5] and even sleep deprivation.[6] We use psychopharmacology, psychophysiology, and psychotherapy to treat depression in our patients, but we are impressed by the benefits many depressed patients have derived from extended, systematic periods of regular physical exercise such as jogging, swimming, walking, tennis, and the like. Exercise is also effective in fending off the depressed and pessimistic moods that mentally healthy people have from time to time.

Unfortunately, research—including our own—into the ways that physical exercise relieves depression has yielded no definitive scientific information. Experience has shown that this phenomenon exists, but the mechanisms of mind/body reciprocity remain mysterious. However, it is apparent that they are multifarious and enormously complicated.

It is known that exercise produces marked changes in blood hormone levels. For example, strenuous exercise causes significant increases in growth hormone, luteinizing hormone, testosterone, and androstenedione.[7] Our study of the psychological correlates of exercise in normal and depressed subjects considered such neurophysiological processes as proprioceptive and hyperthermic stimulation of the striatum, optimization of brain catecholamine metabolism,[8] and salt loss. We took careful precautions against experimental bias.[9] Nevertheless, although we can systematically report the results of exercise, we cannot demonstrate the mechanisms of improvement.

It is our conviction that physicians should provide whatever relief that is available for any disorder as nearly endemic as depression. We hope that as the interest in exercise as a palliative becomes more widespread, we will learn more about the mechanisms involved. In our university community we can see how the low self-esteem and apathy characteristic of depression can incapacitate young people for meeting the scholastic and social pressures they face. Among the college students now successfully using jogging as a daily routine, there are a number who have overcome addiction to alcohol and/or drugs by adopting a life-style that includes exercise.

Many joggers believe that exercise has psychological benefits, and a feeling of well-being associated with exercise is often reported by physically fit persons. Depression seems to be uncommon among athletes (except perhaps among those who play for the high stakes of professional sports). However, the popular belief that exercise improves psychological states is not universally supported in the literature, as evidenced by Morgan's study of anxiety and depression among 36 men and women[10] and his study of the effects of six weeks of exercise on other depressed subjects.[11] However, Post and Goodwin noted improvement in their moderately depressed patients who had adopted an exercise regimen.[12] Folkins and his associates found that a sample of college women were less anxious and depressed after taking a semester-long jogging course than they had been before.[13]

Methods

Phase 1. The purpose of our investigation was to study the psychological correlates of exercise in normal and depressed subjects. One hundred sixty-seven subjects participated in the first phase of the study. Most of the 96 women (mean age 19) and 71 men (mean age 24) were high school or university students. Informed consent was obtained. Everyone but the six controls chose one of the exercises listed in table 1, and those who chose jogging were given suggestions from Cooper's aerobic method.[14] All were given various psychological tests including the self-rating Zung Depression Scale,[15] the Eysenck Personality Inventory, and Human Figure Drawings. They were required to keep a journal of their activities in the physical fitness program, recording pulse rates before and after exercise, mood variations in relation to exercise, sleep and dream experience, and any emotional trauma during the period. No subject was taking psycho-

Table 1. Depression Scores Before and After Ten Weeks of Exercise (Phase 1)

Group	Depression Scores				
	Before Exercise		After Exercise		
	Mean	SD	Mean	SD	t*
10 newspaper respondents who jogged (fall)	44.00	11.03	35.70	5.77	3.01§
17 high school softball team members (spring)	45.24	9.38	43.00	6.84	1.12
13 high school tennis team members (spring)	47.30	6.98	43.23	6.64	2.27‡
10 university volunteers who jogged (fall)	44.00	11.03	35.70	5.77	3.01‖
15 university students (varied exercise†) (fall)	46.73	11.37	39.73	5.95	3.32‖
8 university wrestling team members (winter)	37.00	5.55	33.00	4.99	5.29‖
29 university students who jogged (fall)	45.45	9.18	38.55	6.32	4.68¶
59 university students who jogged (spring)	43.63	8.17	36.17	7.99	7.78¶
6 controls without exercise program (spring)	49.00	10.47	51.66	13.35	1.64

*Two-tailed values of the t-test for correlated means were used to evaluate the significance of differences in the depression scores of each group before and after the exercise period. Means of mood self-ratings for the normal controls before and after exercise were compared with the corresponding means for the depressed subjects by means of the Wilcoxon Matched-Pairs Signed Rank Test. Between-group differences were analyzed by the Mann-Whitney U-Test.
† jogging, softball, swimming, and tennis
‡ $p<.05$
§ $p<.02$
‖ $p<.01$
¶ $p<.001$

tropic medication or other treatment for emotional problems, and all were in good physical health.

The psychological tests were repeated after ten weeks, and improvement in physical fitness was measured by the degree of reduction in the resting pulse rates of the first and last three days of the period being compared. All subjects had been exercising for an average of 30 minutes a day, three days a week. Those who were involved in team play were supervised by coaches, but joggers were not supervised. Contact between the subjects and the investigators was limited to the two testing sessions.

Phase 2. The second phase of our study involved 561 university students. One hundred one of the students were clinically depressed; 91 undertook the exercise program, and the other ten served as controls. Four hundred six normal controls exercised and 54 normal persons served as no-exercise controls. Our purpose in working with this sample was to extend and validate the first study, because in relying on the Zung self-rating inventory only, we had been unable to determine whether changes in subjective affective states other than depression are also associated with exercise. Therefore, we sought information about multidimensional mood change. Also, in the first experiment there were no exercising controls, and a variety of physical activities were recorded. In the second study we used controls more nearly comparable: clinically depressed joggers and normal joggers, and the five-days-a-week jogging group and the group that jogged only three days a week.

All subjects were offered an inducement to participate in the study. Psychology students were allowed to drop their lowest quiz grade after successfully completing the two sets of psychological tests; a journal of moods, pulses, and sleep and dream experience; and a 12-minute fitness test. Subjects chose whether to jog three or five times each week or to refrain from exercise altogether. Those in the latter group were told to engage only in the moving about required in their daily living, such as walking from a parked car to class. Both jogging groups were told to gradually increase their exercise to a minimum of 30 minutes a session. As in the first experiment, subjects were taking no medication and received no treatment but the exercise.

The Minnesota Multiphasic Personality Inventory-Depression Scale, a questionnaire on sleep, a confidential health questionnaire, the Activation-Deactivation Adjective Checklist,[16] and a multifactor

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Table 2. Depression Scores for Subjects Jogging Three or Five Times Per Week for Ten Weeks (Phase 2)

	Before Exercise Mean	Before Exercise SD	After Exercise Mean	After Exercise SD
Jogging Five Times Per Week				
Group 1 ($\bar{N}=54$) Normal Controls, No Exercise	42.0	4.42	41.4	6.25
Group 2 ($\bar{N}=23$) Normal Controls, Exercise	35.3	4.27	32.5*	5.17
Group 3 ($\bar{N}=10$) Depressed, No Exercise	54.1	5.90	51.4	13.42
Group 4 ($\bar{N}=26$) Depressed, Exercise	58.0	7.84	43.4*	8.82
Jogging Three Times Per Week				
Normal Controls ($\bar{N}=383$)	40.6	5.29	38.4*	6.51
Depressed ($\bar{N}=65$)	54.5	5.06	46.2*	8.10

* $p<.001$

adjective checklist[17] were added to the psychological tests used earlier. These checklists are self-report inventories with lists of adjectives in random sequence. The subjects indicate on a six-point intensity scale how each adjective applies to them at the time of reply. All of the psychological tests were administered under standard conditions at the same time of day to avoid diurnal mood variations.[18] All subjects, including those who did not exercise, had the same amount of contact with the experimenter/instructor to minimize unintended treatment effects.

Results

The results for the first phase of our study are shown in table 1. Depression scores decreased with wrestling, mixed exercises, jogging, and probably with tennis. However, there was no change in depression in the softball team members or the group that had no exercise routine. Although the exercise was performed at different times of the year, there was no significant influence on depression attributable to the seasons.

The results for the second phase of the study are shown in table 2. Jogging for five days a week for a ten-week period was associated with significant reductions in the depression scores of both the depressed subjects and the nondepressed control group. Similar patterns were exhibited by those who jogged only three days a week for the same period. The subjects who did not exercise during the same interval had virtually unchanged scores.

Responses to the adjective checklists shown in figures 1 and 2 indicate that the negative affective states of anger/ hostility, fatigue/inertia, and tense/anxious were significantly decreased among the depressed subjects who jogged. Positive affective states of cheerfulness, energy, and general activation were significantly increased among the depressed subjects who jogged.

Discussion

The apparent antidepressant effect of exercise may depend to some degree on the intensity, duration, and frequency of the physical activity. Subjects who played softball, like those who took no exercise at all, had unchanged depression levels, and tennis players showed only slight—although significant—reductions. Those who jogged five days a week for ten weeks had the greatest reduction in depression. When depressed subjects could select their exercises, the most depressed chose the most vigorous. Because the investigators did nothing to conceal the purpose of their study, the subjects' choices may reflect their compliance—or their desperation.

Prescribing an appropriate regimen of exercise for a depressed patient is a therapeutic process. Physicians may follow their patients' course with sympathetic interest, ideally based on personal experience with practicing daily exercise. They may encourage and reinforce their patients by enthusiastically recognizing their growing mastery of their bodies and their rising performance levels. An individualized "dosage" may be established, as with any

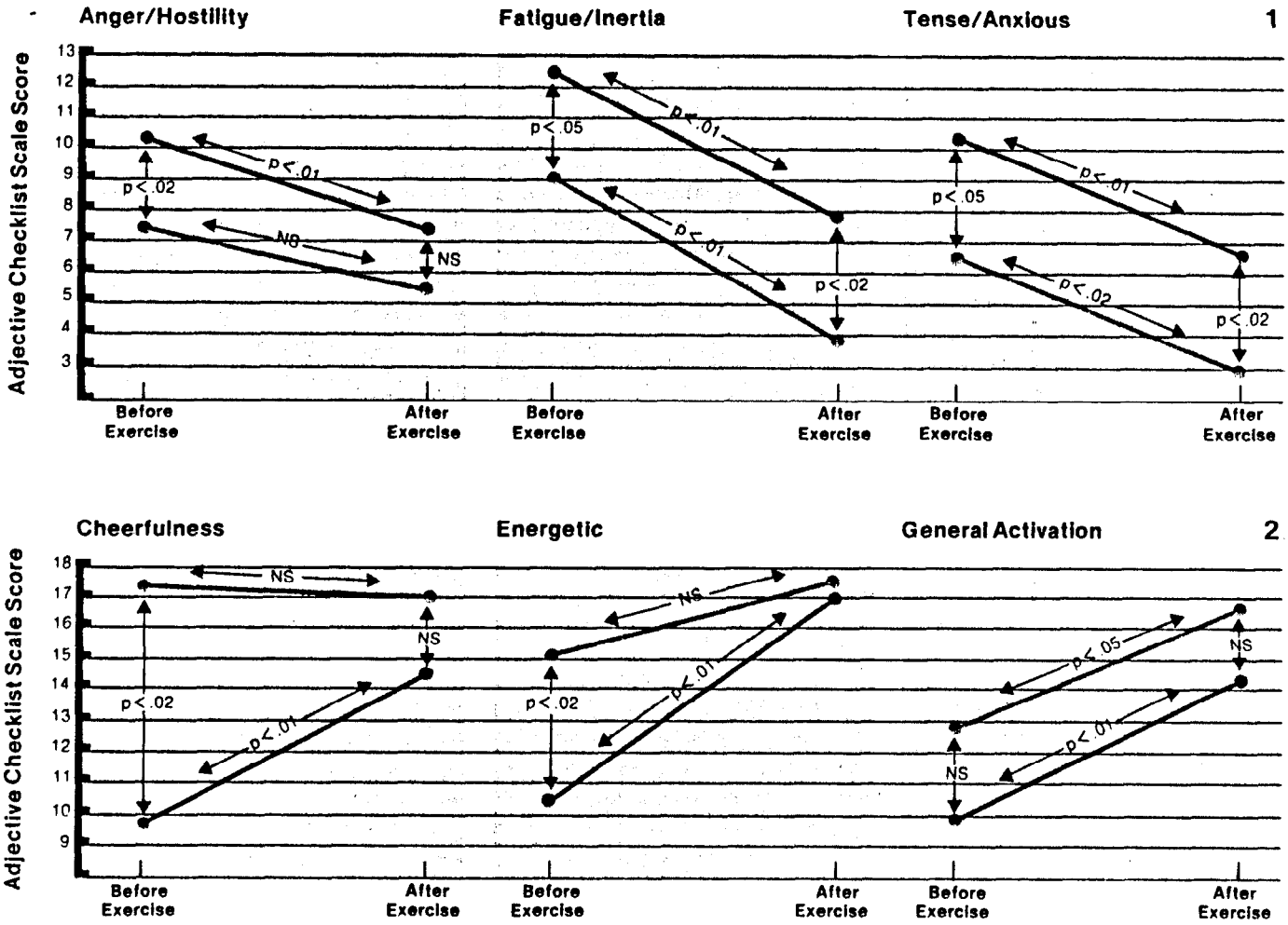

Figure 1. Changes in negative affective states associated with jogging for ten weeks

Figure 2. Changes in positive affective states associated with jogging for ten weeks

other prescription, on the basis of each patient's physical condition and life circumstances.[19] For example, a sedentary man must not simply be told to exercise more. A middle-aged woman may have an exercise program in which she does not have to make herself conspicuous if she has a negative self-concept, self-defeating interpretations of daily experiences, and a negative view of the future.

The physician's hardest task with a depressed patient of any age is likely to be that of obtaining his consent, continuing cooperation, and confidence. The majority of depressed patients put forth little exertion on any typical day. The inertia that accompanies the depressed person's increasing tendency to withdraw, his constriction of interests, and preoccupation with unhappiness makes it tempting to hypothesize that some of the features of depression may be symptoms of a primary movement disorder. Resourceful history-taking or requiring a journal from the patient may help the physician decide when a reluctant and badly withdrawn depressed person can be persuaded to embark on a program of exercise, such as when the extremity of his misery and isolation leads him to grasp at any straw his therapist offers.

We required daily records on exercise, mood change, and pulse rates from subjects who were not patients because it tended to ensure adherence to the exercise schedule. Many people who consider themselves staunch adherents of the old goal of *mens sana in corpore sano* delude themselves about the actual amount of time and care they give their bodies. Because our lives are hurried and today's urban living militates against developing the body, it is easy to see ourselves as exercising on the basis of an occasional week-

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end of tennis, or dieting on the basis of a few painful weeks of deprivation. A prescription for physical care that requires keeping a daily record of either exercise or food intake is likely to demonstrate that we do not rationally apply all we know about health care. Such records used with an exercise schedule pinpoint the correlation of mood improvement with exercise and give limited but useful data on the gradual attainment of general physical fitness. Testing by means of the Zung self-rating scale and other instruments is an important feature of the program.

Our tabulations help explain the improvement in well-being experienced by almost all of our subjects as they progressed in their programs of regular exercise. One must also consider the psychological benefits experienced by an admittedly depressed patient when he takes active steps on his own behalf, improves his body image, and is praised by his supervising physician.

As indicated, our samples included four subject categories: (1) persons of various ages who had discovered jogging for themselves and who agreed to provide information for our study; (2) recruits from the university community; (3) members of several athletic teams; and (4) patients. A program like ours is being used elsewhere, however, with victims of coronary occlusion, a catastrophe sure to bring depression.[20] Because antidepressant drugs have special risks for these patients, the acknowledged antidepressant effect of an exercise program will make a significant contribution.

Summary

On the basis of a study of about 700 subjects, including a number of persons with recognized clinical depression, we recommend that any rational, safe, and effective treatment regimen for depression should include a prescription for vigorous exercise to bring about and maintain optimal affective functioning. Although the mechanisms of mind/body exchange must be further explored, we urge consideration of

the palliative impact on depression of appropriately supervised and continued programs of physical activity.

We found that persons free of dysphoric moods reported a feeling of well-being associated with exercise, and depressed patients of widely differing ages who exercised also became less depressed and less anxious when physical fitness was achieved. Psychometric examinations of healthy as well as depressed persons made before and after the achievement of physical fitness support the following conclusions about the relationship between mood and movement:

1. Physical fitness is often associated with a feeling of well-being and reduced depression and anxiety.

2. Fitness appears to be associated with physical and psychological benefits regardless of the subject's age.

3. Although training for physical fitness may include a variety of exercise programs ranging from jogging to judo, competition may be minimized for maximum psychological gains.

4. Although physical exertion on the job may be physically beneficial, recreational or voluntary programs yield more psychologically useful exercise.

5. The biological benefits of exercise may be associated in part with changes produced among brain amines, salt metabolism, muscle neuronal activity, and striatal function.

6. A comprehensive history of the depressed patient's motor activity is useful in prescribing an exercise regimen of maximum benefit.

7. The role model of physicians who regard a physical fitness program as an integral part of their own lives cannot be overlooked. ■

Fitness appears to be associated with physical and psychological benefits regardless of age.

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