

Physical Activity as a Nonpharmacological Treatment for Depression: A Review

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Physical activity is increasingly being cited as an alternative to more traditional drug treatments for treating depression. Although an increasing amount of research has investigated this theory, much of the literature has been criticized from a methodological perspective. Given rising concern for the increasing costs of mental health care, it is timely and important to examine valid, reliable, and objective research findings on the potential role of physical activity as a low-cost nonpharmacological intervention for the treatment of depression. This article reviews cross-sectional, longitudinal, and randomized studies that investigated the role of physical activity in the prevention and alleviation of depression. The review found that although there is undoubtedly a need for more research with a greater emphasis on methodological strength, the scientific literature is generally supportive of the beneficial effects of aerobic and nonaerobic exercise on depression in clinically and nonclinically depressed adults. Implications for public health are discussed.

Keywords: Exercise; depression; intervention studies; nonpharmacological treatment of depression

OVERVIEW

Clinical depression affects 2% to 5% of the U.S. population per year (Kessler et al., 1994) and accounts for approximately 6% to 8% of general medical practices (Katon & Schulberg, 1992). The prevalence of this disorder, in conjunction with the cost of drug therapy, traditionally the treatment of choice for depressive symptoms, has significant financial implications for individual and national health care costs. Depressed individuals typically spend 1.5 times more on health care costs than nondepressed individuals and, if undergoing drug therapy, spend up to three times more on outpatient pharmacy costs than non-drug-treated individuals (Simon, VonKorff, & Barlow, 1995). Major depression alone accounts for 6.7 million disability-adjusted life years (DALYs) in the United States, second only to ischemic heart dis-

ease (Murray & Lopez, 1996). A report on mental health recently released by the U.S. Surgeon General (U.S. Department of Health and Human Services, 1999) reported that 4 of the 10 leading causes of disability for persons age 5 and older are mental disorders and that among developed nations, including the United States, major depression is the leading cause of such disability.

The mental health benefits of exercise and physical activity were acknowledged more than a decade ago by both the National Institute of Mental Health (Morgan & O'Connor, 1988) and the U.S. Department of Health and Human Services (1991). Nevertheless, they have received far less research and media attention in comparison to the well-reported physical benefits. In recent years, there has been growing attention in the research literature on exercise as a potential alternative therapy to more traditional drug treatments for depression (Blumenthal et al., 1999; Dunn, Trivedi, & O'Neil, 2001; Moore & Blumenthal, 1998; Phillips, Kiernan, & King, 2001) for both primary and secondary prevention.

The purpose of this article therefore is to briefly review the scientific literature on the role of exercise in the prevention and alleviation of depression. Given rising concern for the increasing costs of mental health care, it is timely and important to examine objective research findings on the potential role of exercise as a low-cost nonpharmacological intervention for the treatment of depression. This review will include results from epidemiological studies and randomized trials of exercise and depression.

EPIDEMIOLOGICAL STUDIES

Cross-Sectional Studies

Over the past 15 years, most cross-sectional studies have reported an inverse association between physical activity and depressive symptoms. Hassmen, Koivula, and Uutela (2000), in a random sample of 1,547 males (46 ± 10.9 years) and 1,856 females (45.5 ± 11.3 years), reported a significant inverse association between depressive symptoms as measured by the Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) and six levels of self-reported exercise frequency ranging from daily to a few times per year. In this study, those who exercised at least twice per week reported significantly less depression compared to those who exercised either less frequently or not at all. Bhui and Fletcher (2000)—in a case-control sample from the Health and Lifestyle Survey, a national population-based longitudinal survey in the United Kingdom (Cox, 1993)—examined the protective effect of physical activity on anxiety and depression. An initial total of 5,352 men and women were assessed at baseline. Depressive states were assessed via the General Health Questionnaire (Goldberg & Williams, 1988). Activity levels were categorized by self-report as one of four intensity levels: *no activity*, *low intensity* (gardening, walking, etc.), *medium intensity* (keep fit, golf, cricket, etc.), or *high intensity* (mainly sports). Number of minutes per day was also reported. After adjusting for potential confounders such as mobility, medication use, and smoking, the authors found that for men, physical activity appeared to be protective against depression and anxiety states in those who reported exercising at least 92 minutes per day compared to those who reported exercising less than 44 minutes per day. Such protective effects did not appear to vary according to intensity.

No relationship between physical activity and depression was found for women, which made the authors suggest that the higher prevalence of depressive states in women may have a hormonal or physiological basis, making women less amenable to the protective effect

afforded by exercise. However, in this study, women had lower incomes, were less available for work, and were involved in less exercise and exercise of lower intensity than men. Their data predicted that those not working were commonly less healthy, with the implication being that the women sampled in this study would include those who were more available to be sampled but were more vulnerable and/or engaged in less healthy lifestyles. Based on these data, the authors' alternative explanation for their findings was that men had more transient and hence more recent-onset disorders, which were more likely to be alleviated by physical activity.

Aine and Lester (1995) reported no association between exercise and depressive symptoms in a smaller sample of 90 college-age students, although no gender differences were reported. Rajala, Uusimake, Kuikaanniemi, and Kiela (1994), however, in common with Bhui and Fletcher (2000), have also reported gender differences in the prevalence of depression in a random sample of 345 males and 435 females. Physical activity was assessed via questionnaire and classified by categories (little, moderate, or much exercise to and from work and during leisure time). Depressive symptoms were assessed by the Self-Rating Depression Scale (Zung, 1965) via self-report questionnaires, interview-administered questionnaires, and clinical examination. The authors found significant gender differences in depressive symptoms (relative risk [RR] for women relative to men = 1.8). In men, the prevalence of depressive symptoms was higher for those with a sedentary lifestyle compared to those who were moderately active. Other cross-sectional studies report similar positive associations in adults between depression and both frequency (Krause, Goldenhar, Liang, Jay, & Maeda, 1993; Weyerer, 1992) and intensity or amount of physical activity (Brown & Lawton, 1986; Fredrick, Frerichs, & Clark, 1988; Lobstein, Mosbacher, & Ismail, 1983; Ross & Hayes, 1988; Ruuskanen & Ruoppila, 1995; Stephens, 1988; Stephens & Craig, 1990).

Longitudinal Studies

Longitudinal studies report similar findings to the cross-sectional studies cited. Paffenbarger, Lee, and Leung (1994), in a 23- to 27-year follow-up study, found lower depression rates among physically active and sports-playing individuals in a cohort of 21,596 Harvard alumni men, ages 35 to 74 years, recruited in 1962 or 1966. Cases of clinical depression were represented by alumni self-report and physician diagnosis. Physical activity was assessed by assigning kilocalorie values to self-reported physical activity (walking, stair climbing) or sports play. When these three latter activities were combined in a single physical activity index, the authors found that the physical activity index in 1962 or 1968 predicted depressive symptoms at follow-up (< 1,000 kcals/week, RR = 1.00; 1,000-2,400 kcals/week, RR = 0.83; 2,500+ kcals/week, RR = 0.72).

Lampinen, Heikkinen, and Ruoppila (2000), in an 8-year follow-up of a large prospective study of older Finnish men and women, reported that age-related decreases in the intensity of physical exercise increased the risk of depressive symptoms, as measured by a modified version of the Beck Depression Inventory (Beck et al., 1961). Types and levels of exercise/physical activity were assessed using a questionnaire (Hirvensalo, Lampinen, & Rantanen, 1998) with six categories ranging from necessary household chores to participation in competitive sports. Intensity was assessed for each activity using a 7-point Likert-type scale but was subsumed into three categories for statistical analysis: necessary chores, regular walking (at least weekly), and strenuous physical exercise (leading to perspiring and heavy breathing). At follow-up, change in levels of physical activity was assessed via three categories—

increased, maintained, or decreased—over the period of the study in each of the three intensity levels (i.e., necessary chores, regular walking, or strenuous exercise). The authors found that those individuals who had reduced their intensity during the 8-year follow-up period reported more depressive symptoms than those who remained active. This relationship remained after controlling for socioeconomic factors, health status, and physical functioning. In common with a number of cross-sectional studies cited above, Lampinen et al. (2000) also found evidence of gender differences in the predictive value of physical exercise in relation to depressive symptoms over an 8-year period among a sample of men and women age 65 years and older. Those who reported a reduction in the intensity of their daily physical activity over the follow-up period reported more depressive symptoms than those who remained active or increased physical activity. Women in the strenuous exercise group reported more depressive symptoms than men, although the authors suggest this may have been a function of the lack of numbers in this group, combined with the greater number of women recruited for the whole sample. Because almost twice as many women as men were recruited, the authors suggest that the results for the whole sample may have skewed the data somewhat toward the physical and mental life of women more than men.

Other prospective studies also report positive findings of physical activity on depression (Camacho, Roberts, Lazarus, Kaplan, & Cohen, 1991; Farmer et al., 1988; Foreyt, Brunner, Goodrick, St. Joer, & Miller, 1995; Mobily, Rubenstein, Lemke, O'Hara, & Wallace, 1996; Morgan & Bath, 1998; Stewart et al., 1994). In contrast to these studies, Cooper-Patrick, Ford, Mead, Chang, and Klag (1997) found no relationship between physical activity level and subsequent psychiatric distress in a 15-year follow-up of 690 male and 62 female former medical students. Physical activity was assessed according to questions abstracted from the Harvard alumni physical activity questionnaire (“Do you exercise to sweat weekly?” “How many ‘sweats’ per week?”). Participants were also asked whether they were inactive, became active, or remained active while in medical school. Depression was assessed by self-report and by review of medical records with the use of the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)* (American Psychiatric Association, 1994). At follow-up, the authors found that the risk of depression was similar for exercisers and nonexercisers. No relationship was found between physical activity level and subsequent psychiatric distress. The authors concluded that, in contrast to the majority of studies cited, any protective effects of physical activity on depression were probably small.

Summary

Most cross-sectional and longitudinal studies, with few exceptions, report an inverse association between exercise/physical activity and depression, with some evidence suggesting that gender and/or intensity may moderate the effect. However, more prospective studies are needed to further clarify these relationships.

INTERVENTION STUDIES

Although exercise is generally believed to make you “feel good,” the scientific evidence in support of a causal role for exercise remains somewhat speculative due to a lack of valid and reliable research methods (Brown, 1990; Lawlor & Hopker, 2001; Morgan, 1994). A number of literature reviews on exercise and mental health and/or depression already exist in both narrative (Byrne & Byrne, 1993; Dunn & Dishman, 1991; Moore & Blumenthal, 1998;

Morgan, 1994; Phillips et al., 2001; Raglin, 1990; Taylor, Sallis, & Needle, 1985) and meta-analysis (Kugler, Seelback, & Kryskemper, 1994; Lawlor & Hopker, 2001; McDonald & Hodgdon, 1991; North, McCullagh, & Tran, 1990) formats. Recent reviews have also addressed the dose-response aspects of physical activity and exercise on depression and depressive symptoms (Dunn et al., 2001). These reviews have all reiterated the methodological shortcomings of this particular body of literature, including the use of inadequate sample sizes, lack of random assignment to groups, an absence of placebo or control groups, and use of nonblinded methodological designs (Brown, 1990; Lawlor & Hopker, 2001).

In view of the lack of methodological rigor of many of these studies, the remainder of this article will focus only on published studies with a randomized design for clinically depressed, symptomatic, and healthy populations.

Aerobic Exercise in Clinically Depressed Populations

Martinsen, Medhus, and Sandvik (1985), in a randomized controlled trial of inpatients with major depressive disorder, assigned patients to an aerobic exercise or an occupational therapy group designated as the control group. Significant postintervention improvements were reported in depression scores between the aerobic exercise and occupational therapy groups. However, both groups were also reported as receiving psychotherapy during the intervention period, which calls into question the validity of the control group and thus, potentially, the independent effect of the aerobic exercise intervention. Greist, Klein, Eischens, Gurman, and Morgan (1979) randomly assigned 28 males and females diagnosed with minor depressive disorder to one of three interventions (aerobic exercise, short-term psychotherapy, and long-term psychotherapy). All interventions were reported as reducing depression scores. No formal statistical analysis was presented in this study, however, and the randomization procedure was not strictly maintained throughout the intervention period, thus making interpretation of results difficult.

Bosscher (1993) randomly assigned 24 women inpatients matched for depression scores to either a three-times-per-week running group or a usual care group. The authors reported significant reductions in depression scores according to the Zung (1965) Self-Rating Depression Scale for the running versus the usual care group. However, the usual care group consisted of mixed sports activities such as field hockey, soccer, volleyball, trampolining, and gymnastic activities. The same activities were not consistently performed throughout the intervention period and also incorporated a major running and/or anaerobic component. This would mean a potentially large overlap between comparison groups, so making any differences between these groups hard to determine and/or explain. For example, in this study, depression increased significantly only in the running group, yet paradoxically, self-efficacy, which is regarded as an important factor in the development and/or improvement of depression, increased in both groups. The authors report a number of limitations to this study, including potential differences in treatment expectancy or interest due to unavoidable logistical issues and low power, secondary to a small number of participants, but do not address the potential effects of the similarities in treatment groups referred to above.

Blumenthal et al. (1999) also reported the positive effects of exercise in older adults with major depressive disorders. The authors randomly assigned 156 older adults older than 50 years old with major depressive disorder to a program of aerobic exercise, antidepressant treatment, or a combination of the two. Participants were evaluated pre- and postintervention using the *DSM-IV* (American Psychiatric Association, 1994), the Hamilton Rating Scale for Depression (Hamilton, 1960), and the Beck Depression Inventory (Beck et al., 1961). After

16 weeks of treatment, all groups significantly improved depression scores, but there were no significant differences between groups. The authors report that causal mechanisms for such effects are as yet unknown. A number of limitations to this study were discussed: (a) the short-term nature of the intervention period, which is addressed in the Babyak et al. (2000) study below; (b) the absence of a “no-treatment” group to control for “spontaneous recovery,” which was not included for methodological and ethical reasons; and (c) the lack of a socialization control group, which was regarded as an important topic for future research. The authors concluded that exercise was associated with clinically significant improvements in depression and could be considered as an alternative to antidepressants for the treatment of depression in older adults.

In a 24-week follow-up to this study, Babyak et al. (2000) found a significantly lower relapse rate in the aerobic group compared to the antidepressant or combination group. Exercising on one’s own was associated with a significantly reduced probability of depression diagnosis at the end of that period (odds ratio [OR] = 0.49, $p = .0009$). The authors concluded that in this population, exercise therapy was not only feasible but also associated with significant therapeutic benefit, particularly if exercise was continued over time. Other randomized trials have reported similar positive effects of aerobic exercise in patients with minor depressive disorder (Klein et al., 1985; Sexton, Maere, & Dahl, 1989). In these studies, depression was significantly reduced in all groups, whether they exercised aerobically at low or high intensity (Sexton et al., 1989) or used aerobic exercise, meditation/relaxation, or group therapy (Klein et al., 1985). No differences were found between any of the intervention groups. Netz et al. (1994) have also reported similar results of the effect of exercise on depression in an older population. These authors compared the effect of aerobic exercise to a socialization control group in 17 male and female psychogeriatric participants diagnosed via the Geriatric Depression Scale (Yesavage et al., 1983). In this study, however, although depression was significantly reduced in both groups, aerobic exercise effects on depression were significantly greater than the socialization control group.

Summary

The relatively few randomized studies conducted in clinically depressed patients all report beneficial effects of aerobic exercise—being either equally or more effective than alternate interventions, including medication, psychotherapy, group therapy, or meditation/relaxation. Early evidence also indicates that such effects may not be mediated by age. These findings are also supported by two recent meta-analyses (Lawlor & Hopker, 2001; North et al., 1990). However, all of these studies were of short duration (9-12 weeks) and, with few exceptions, (Babyak et al., 2000) reported no follow-up data. More well-designed, randomized studies need to be conducted with long-term follow-up to increase confidence in these early results.

Aerobic Exercise in Populations With Depressive Symptoms

Although early studies of physical activity and depression focused almost exclusively on clinical populations (Morgan, 1969), the more recent literature has reported a number of intervention studies that have investigated the ameliorative effects of physical activity in

nonclinical symptomatic populations. McCann and Holmes (1984) randomly assigned 41 undergraduate females to either an aerobic exercise progressive relaxation or control group. Following a 10-week intervention period conducted three times per week, the authors reported significant reductions in depression scores, as measured by the Beck Depression Inventory (Beck et al., 1961), for aerobic exercise compared to both progressive relaxation and control groups. No differences were found between the latter two groups. In a similarly designed study with older adults but with a shorter intervention period, McNeil, LeBlanc, and Joyner (1991) reported significantly reduced Beck Depression Inventory scores for a group performing 6 weeks of aerobic exercise three times a week and a socialization group meeting two times a week versus a “waitlist” control group. No differences were found between the aerobic and socialization groups. Similar results have been reported in randomized studies comparing aerobic exercise versus a cognitive group and a combined group (Fremont & Craighead, 1987) and aerobic exercise versus an inactive control group (Brown, Ramivez, & Taub, 1978).

Summary

Randomized exercise studies conducted with adults reporting depressive symptoms are fewer than those with clinical depression, but they report similarly positive results. However, as with these latter studies, caution must be exercised in imputing causation until further research with stronger methodologies has been conducted.

Aerobic Exercise in Healthy Populations

The effect of physical activity interventions on depressive symptoms in healthy individuals (i.e., those who score in the normal range for depressive symptoms) has received little research attention. Results from early studies were equivocal, reporting both positive effects (Berger & Owen, 1983; Blumenthal, Williams, Needles, & Wallace, 1982; Folkins, 1976) and no effect (Folkins, Lynch, & Gardner, 1972; McPherson, Paivio, Yuhasz, Rechnitzer, & Lefcoe, 1965; Morgan, Roberts, Brand, & Feinerman, 1970; Naughton, Bruhn, & Lategola, 1968; Perri & Templer, 1984) on depression. However, most of these studies employed a nonrandomized design or lacked an appropriate control group.

Recent studies in healthy populations using a randomized design (Brown et al., 1995; Emery & Blumenthal, 1991; King, Taylor, Haskell, & DeBusk, 1989; Netz et al., 1994), with few exceptions (Blumenthal et al., 1989), generally report no changes in depressive symptoms using a variety of assessment instruments. Blumenthal et al. (1989) randomly assigned 101 older men and women to an aerobic exercise, yoga, or waitlist control group. After 12 weeks, the authors reported significantly reduced depression, as measured by the Center for Epidemiological Studies Depression Scale, for men but not women in the aerobic and yoga group compared to the waitlist control. However, only one of these studies has reported an intervention longer than 16 weeks. King et al. (1989) randomly assigned 357 community-living males and females to one of three aerobic exercise groups (high intensity, group based; high intensity, home based; low intensity, home based) or a control group. Following 1 year of aerobic exercise performed three times per week, the authors reported no differences in Beck Depression Inventory (Beck et al., 1961) scores between the aerobic exercise and control groups.

Summary

Randomized studies in healthy adults typically report little or no impact of aerobic exercise on depressive scores in otherwise healthy adults, as measured by a wide variety of assessment instruments.

Anaerobic Exercise in Clinical, Symptomatic, and Healthy Populations

A small number of studies have also investigated the effect of anaerobic exercise, predominantly resistance training, on depression in clinically depressed (Doyle et al., 1987; Martinsen, Hoffart, & Solberg, 1989; Pelham, Campagna, Ritvo, & Birnie, 1993; Singh, Clements, & Fiatarone, 1997), symptomatic (Mutrie, 1988; Palmer, 1995), and healthy participants (Dustman, Ruhling, & Russell, 1984; Stein & Motta, 1992). These interventions have typically but not always (Singh et al., 1997) compared aerobic to resistance training or to resistance training combined with flexibility (Dustman et al., 1984; Martinsen, Hoffart, et al., 1989). With few exceptions (Mutrie, 1988), studies in clinically depressed and symptomatic patients have reported the positive effects of resistance training on depression, with no differences reported between resistance training and aerobic exercise (Doyle et al., 1987; Martinsen, Hoffart et al., 1989; Martinsen, Sandvik, & Kolbjornsrud, 1989; Sexton et al., 1989; Stein & Motta, 1992). This suggests that reductions in depression scores may not be dependant on an increase in aerobic fitness. For healthy participants, Dustman et al. (1984) reported no changes in depression scores for a combined aerobic, resistance, and flexibility exercise group compared to a nonrandomized control group following a 12-week intervention. This is in agreement with the majority of the literature on aerobic exercise. In contrast to this, Stein and Motta (1992) reported significantly reduced depression in both aerobic and resistance training groups compared to controls in healthy undergraduates following a 7-week intervention. However, the aerobic exercise intervention in this case was swimming, a mode that has been little used in depression research since the early quasi-experimental research of Morgan et al. (1970).

The strongest evidence to date on the beneficial effects of nonaerobic exercise was recently reported by Singh et al. (1997). Thirty-two community-living men and women participants ages 60 to 84 years and diagnosed with major or minor depressive disorder using the *DSM-IV* (American Psychiatric Association, 1994) were randomly assigned to either a progressive resistance training or an attention-control group. The progressive resistance group trained three times a week for 10 weeks at 80% of a "one-repetition maximum," the maximum amount of weight they could lift in a single effort. The control group consisted of an interactive health education program of lectures and videos followed by discussion. Depression was measured by the Beck Depression Inventory (Beck et al., 1961) and the Hamilton Rating Scale for Depression (Hamilton, 1960). Following the 10-week intervention program, depression was significantly reduced in the resistance training group compared to the control group. This is the first randomized controlled trial to directly compare the effects on depression of a high-intensity resistance training program with a nonexercise control group.

A recent meta-analytic review on physical activity and mood (which includes depression as a variable) in older adults (Arent, Landers, & Etnier, 2000) has provided additional support for the affective effects of resistance training. This review reported that although exer-

cise in general improves mood, the largest reported effect size (ES) was for resistance training (ES = .80) compared to that of aerobic exercise (ES = .35). These results, however, should be interpreted with caution because the resistance training mean effect size was derived from only 8 effect sizes compared to the 30 effect sizes used for aerobic exercise.

Summary

As with aerobic intervention studies, the results of anaerobic studies—predominantly resistance training—typically report beneficial effects on depression in clinical and symptomatic patients but rarely in healthy populations. Such effects also appear to be independent of mode of exercise and, in some cases, appear to be unrelated to increases in aerobic fitness.

CONCLUSIONS

The scientific literature appears to be generally supportive of the beneficial effects of physical activity and exercise on depression. There is undoubtedly still a need for more research in this area, with a greater emphasis on methodological rigor, adequate numbers, and follow-up. However, a majority of large cross-sectional and prospective studies and a majority of recent randomized clinical trials generally support the hypothesis that physical activity interventions of as little as 4 weeks can significantly and beneficially affect depression in clinically depressed and nonclinical, symptomatic adult men and women. The benefits of such interventions are not confined to aerobic exercise but have also been reported for nonaerobic exercise such as resistance training, flexibility training, and yoga. Data also suggest that increases in aerobic fitness may not be necessary to elicit any exercise-mediated improvement in depression. Resistance training may be particularly beneficial in this respect. In addition, although no causal mechanisms for this have yet been confirmed, little or no differences were found between exercise and pharmacological treatments for depression in the few studies that compared these interventions.

From a public health perspective, this is an intriguing prospect for practitioners and health educators alike because it suggests a potential for exercise as an accessible, low-cost nonpharmacological treatment for depression. Further research is necessary to more accurately determine and quantify minimal and optimal frequency, intensity, time, and type/mode of physical activity and exercise necessary to beneficially affect depression across a range of populations and health states. Where appropriate, such interventions should also be compared to more traditional drug-based treatments.

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