Physical Fitness and Enhanced Psychological Health

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A great deal of attention has been given to the association between physical fitness and psychological health. The purpose of this view is to examine recent developments in the burgeoning exercise and psychological health literature and to explore avenues for future research. The current review focuses on research that has examined enhancement of psychological health and well-being among nonclinical populations since 1980. Four areas of psychological functioning are reviewed: (1) psychological well-being and mood, (2) personality and self-concept, (3) physiological stress responsivity and (4) cognition. Exercise appears to improve mood and psychological well-being as well as enhancing self-concept and self-esteem. Exercise appears to do little for personality functioning. Furthermore, mixed empirical support exists to suggest that exercise influences stress responsivity and cognitive functioning. However better research designs and procedures are still needed. Theories regarding the connection between exercise and psychological functioning as well as suggestions for future research are offered.

A great deal of attention has been given to the role of physical fitness and exercise in the enhancement of psychological health and well-being. Numerous articles have been published in both the professional and popular presses extolling the virtues of regular physical exercise. The exercise "boom" of the 1970s saw a substantial increase in the number of people engaged in aerobic exercise, such as running and aerobic dancing (Cooper, 1982). The exercise craze, which has continued into the 1990s, is a multibillion-dollar-a-year business. Health clubs, corporate fitness programs, video work-outs, and triathlons were the hallmarks of the 1980s.

Numerous businesses in the United States have implemented some type of program to promote physical fitness among their employees (Falkenberg, 1987). They range from company-paid memberships at private health and fitness clubs to complete work-site fitness facilities. These programs have been developed not only to improve and maintain employee health, but also to promote psychological well-being and productivity, and reduce absenteeism, insurance claims, and stress. Numerous articles have appeared in various business and management magazines concerning fitness as an avenue towards improving employee work behaviors (e.g., Edmondson, 1987; Gelb, 1985; Howard, 1987; Klock, 1985). The popular notion that not only will exercise improve appearance and health but also enhance mood, self-concept, and general

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psychological well-being, has perpetuated the exercise craze. People commonly report a reliance on exercise as a means of maintaining a wealth of physical and psychological benefits. The present article considers the nature of the scientific evidence for these claims.

CURRENT STATE OF THE PROFESSIONAL AND POPULAR LITERATURE

Well over 1,000 articles have been published in scientific journals on the psychological effects of exercise (Hughes, 1984). In preparation for this review, more than 200 published articles were located in the professional literature since 1980 alone. The number of articles and reports published in popular magazines on this topic is staggering. According to the *Reader's Guide to Periodical Literature*, over 150 articles were published on exercise in 1986 alone. The vast majority of popular magazine articles that focus on the psychological benefits of regular exercise highlight its tension and stress-reducing effects.

A number of articles reviewing the exercise and psychological health literature have also appeared during the past decade (Browman, 1981; Doan & Scherman, 1987; Folkins & Sime, 1981; Hales & Travis,1987; Hughes, 1984; Ledwidge, 1980; Martinsen, 1989; Mobily, 1982; Oberman, 1984; Phelps, 1987; Ransford, 1982; Rippe, Ward, Porcari, & Freedson, 1988; Sachs, 1982; Simons, Epstein, McGowan, & Kupfer, 1985; Sonstroem, 1984; Taylor, Sallis, & Neddle, 1985; Tomporowski & Ellis, 1986). Most of these reviews, however, have focused on narrow, very specific aspects of the exercise and psychological health connection or on specific populations. For example, some of these reviews have highlighted the role of exercise in treating anxiety and/or depressive disorders (e.g., Hales & Travis, 1987; Ledwidge, 1980; Martinsen, 1989; Ransford, 1982; Simons et al., 1985). Some have discussed physical health effects with only a brief overview of the effects of exercise on mental health (e.g., Oberman, 1984; Phelps, 1987; Rippe et al., 1988). Other reviews have focused only on aerobic exercise (e.g., Hughes, 1984; Sachs, 1982) while others have examined the role of exercise on only cognitive processes (e.g., Tomporowski & Ellis, 1986), self-esteem (Sonstroem, 1984), or personality (Doan & Scherman, 1987).

The last comprehensive and extensive review of the exercise and psychological health literature was the 1981 article by Folkins and Sime which appeared in the *American Psychologist.* This excellent review examined the literature on the effects of exercise on cognition, perception, work behavior, sleep, social behavior, affect, personality, and self-concept. These authors concluded that exercise leads to improved mood, self-concept, and work behavior as well as improved cognitive functioning during and immediately following exercise. The authors also concluded that except for self-concept, personality is not affected by improvements in physical fitness. Folkins and Sime (1981) also examined the extensive methodological problems in the exercise and psychological health literature. Only 15% of the studies they reviewed employed true experimental designs and the majority of these studies were conducted using clinical populations only. Of those experiments using normal subjects, almost

all studied children. Few of the studies included appropriate control groups, and random assignment to experimental conditions was rarely done.

It is surprising that only a small proportion of scientific studies have examined the role of exercise on psychological health among normal populations, in light of the pervasiveness of the fitness phenomenon and the numerous claims made for the benefits of exercise on mental state. Thus, while the professional literature has focused on exercise as a clinical intervention, the popular press has touted to the general public the virtues of exercise in enhancing well-being, mood, and self-concept. Given this state of affairs, it seems essential to determine whether newer scientific work supports these latter assertions.

PURPOSE AND METHODS

The purpose of this review is to examine developments in the burgeoning exercise and psychological health literature since the publication of the Folkins and Sime (1981) article and to explore avenues for future research. The current review highlights the research that has examined enhancement of psychological health and well-being in nonclinical populations.

Psychological Abstracts, *Medline*, and *Social Sciences Index* were searched for studies testing adult humans that were published in refereed scientific professional journals during or after 1980. Studies using either clinical populations or focusing on psychopathology and treatment were eliminated from the review. Studies that were severely flawed methodologically (n = 25; e.g., failed to use control groups; relied exclusively on self-report data for both independent and dependent variables without reliability checks; utilized ancedotal case studies) were examined and briefly commented on in the current review. Primary attention was given to 41 studies that did not suffer from such extensive methodological weaknesses. Four areas of psychological functioning have been best covered in research findings since 1980: (1) psychological well-being and mood, (2) personality and self-concept, (3) physiological stress responsivity, and (4) cognition.

PSYCHOLOGICAL WELL-BEING AND MOOD

In seeking to understand the beneficial effects of exercise and how they are produced, it is important to consider separately the changes in mood and well-being immediately after an exercise workout and the longer-term benefits of maintaining an exercise regimen. Thirteen studies since 1980 met our criteria for review on this topic. Four of the studies (Berger & Owens, 1983, 1988; Lichtman & Posner, 1983; Steptoe & Cox, 1989) tested the short-term effects of exercise by examining the hypothesis that exercise improves mood and well-being immediately following a workout. The other nine studies (Blumenthal, Williams, Needels, & Wallace, 1982b; Goldwater & Collins, 1984; Hayden & Allen, 1984; Hughes, Casal, & Leon, 1986; King, Taylor, Haskell, & DeBusk, 1989; Lobitz, Brammell, Stoll, & Niccoli, 1983; Lobstein, Mosbacher, & Ismail, 1983; Moses, Steptoe, Mathews, & Edwards, 1989; Sothmann

& Ismail, 1984) focused on the longer-term benefits of exercise. Ten of the thirteen studies reported improvements in psychological well-being and/or mood among exercisers.

Short-term Benefits

Lichtman and Posner (1983) studied 32 exercise class subjects at a local YMCA and 32 community college hobby class subjects matched for age. Although both exercise and hobby activities were associated with mood improvement, physical activity had a stronger association.

Berger and Owens (1983) examined 36 beginning and intermediate college swim class members and 42 students attending physical education and health sciences lecture classes as controls. Results demonstrated that immediately following their class the swimmers experienced significantly improved mood relative to the control group. Berger and Owens (1988) then examined 170 subjects attending either swimming, fencing, hatha yoga, body conditioning, or lecture control classes. Presenting subjects with questionnaires both prior to and immediately following three class sessions revealed at least some significant mood improvements for the swimming, fencing, and yoga groups as well as one of the two control classes. The mood changes were especially strong among the yoga group.

Finally, Steptoe and Cox (1989) studied 32 fit and unfit female students who participated in two 8-minute trials of high intensity exercise and two 8-minute trials of low-intensity exercise. The authors found that high-intensity exercise resulted in increases of self-reported tension/anxiety and fatigue while positive mood changes (vigor and exhilaration) were found following low-intensity exercise.

The results of these four studies lend support to the notion that moderate physical activity can improve mood and well-being immediately following an exercise workout while high-intensity exercise might actually increase negative mood states such as tension and anxiety. All four studies were correlational in nature, however and did not randomly assign subjects to experimental and control conditions. Therefore, cause and effect relationships cannot be examined in these studies. Furthermore, the exercise and nonexercise groups in both the Lichtman & Poser (1983) and the Berger & Owens (1983) were not matched for duration or frequency of activity.

Long-term Benefits

Six studies assessing the benefits of exercise following an exercise program employed experimental manipulations by having a portion of their subjects participate in exercise programs over several weeks while the remaining subjects were assigned to control conditions (Blumenthal et al., 1982b; Goldwater & Collins, 1985; Hughes et al., 1986; King et al., 1989; Lobitz et al., 1983; Moses et al., 1989). Three studies used correlational methods to test the hypothesis that anxiety (Hayden & Allen, 1984; Sothmann & Ismail, 1984) and depression (Hayden & Allen, 1984; Lobstein et al., 1983; Sothmann & Ismail, 1984) were lower in physically active as compared to sedentary adults.

Six of these eight studies found significant improvements in well-being and/or mood among exercisers (Blumenthal et al., 1982b; Hayden & Allen, 1984; Lobitz et al., 1983; Lobstein et al., 1984; Moses et al., 1989).

Four of the six studies using experimental designs with random assignment to exercise condition concluded that exercise successfully improved well-being and/or mood. Blumenthal et al. (1982b) examined 16 males and females who registered for a 10-week exercise program and 16 matched control subjects from a pool of community volunteers. Results revealed that the exercisers exhibited less anxiety, tension, depression, and fatigue than the controls. The authors noted that the exercise group tended to change in the desired direction on almost all measures while the control group either remained the same or got worse.

Lobitz et al. (1983) studied 18 males and females who reported experiencing mild daily stress. They were assigned to either a 7-week aerobic exercise program, a 7-week anxiety management training program, or a no-treatment control group. Both the exercise and anxiety management groups, but not the control group, reported significant reductions in state anxiety. Only the exercise group showed significant reductions in Type A behavior and only the anxiety management group reported significant reductions in trait anxiety. The state-trait anxiety findings by Lobitz et al. (1983) provide evidence for greater improvements on state relative to trait psychological measures among exercisers.

Goldwater and Collins (1985) studied 51 nonexercising volunteers from a university setting and randomly assigned them to a 6-week aerobic exercise group (n = 27) or a 6-week pseudo-exercise control group (n = 24) designed to "minimize . . . cardiovascular (conditioning) . . . while still giving the appearance of a conditioning program" (p. 177). Results demonstrated significant improvements in anxiety and well-being for the exercise group relative to the control group. Moses et al. (1989) examined 94 community volunteers and randomly assigned them to a 10-week high intensity aerobic training program, a moderate intensity aerobic program, an attention-placebo control condition, or to a wait-list control condition. Results demonstrated significant psychological benefits for the moderate exercise group relative to the high intensity or control conditions. Furthermore, the moderate exercise group scored higher on a perceived coping measure during a 3-month followup.

Hughes et al. (1986) also examined longer term improvements in mood among exercisers but failed to find an association between exercise and mood. These authors examined 21 sedentary males and used a randomized cross-over design such that following a 12-week treatment program, the exercise group became the control group while the control group became the exercise group for another 12-week period. Results failed to show significant improvements in mood for the exercise group relative to the control group.

Finally, the most recent study in this area (King et al., 1989) failed to find significant changes in depression, tension, well-being, or mood following a 6-month aerobic exercise program. These authors studied 120 middle-aged subjects who were randomly assigned to either a home-based aerobic exercise program or to a control group. Although perceived fitness was associated with a decrease in tension following the

exercise program, actual fitness (as measured by VO2 Max) was not associated with any psychological improvements.

A few methodological concern should be noted regarding these six studies. First, two of these studies examined fewer than 25 subjects while using a sizable number of measures (Hughes et al., 1986; Lobitz et al., 1983). Two studies had a large number of dropouts from the experimental condition (Goldwater & Collins, 1985; Hughes et al., 1986). Five of the six studies used exercise programs of 12 weeks or less while most did not match experimental and control groups in terms of the frequency and duration of sessions. However, Moses et al. (1989) used a large number of subjects, had a 3-month follow-up, and utilized four treatment conditions varying the intensity and aerobic conditions of the groups. King et al. (1989) also used a large number of subjects as well as having a 6-month aerobic exercise program. Unfortunately, the King et al. (1989) study did not include a follow-up or additional control groups other than a no-treatment control.

Two of the three studies using correlational approaches discovered that anxiety (Hayden & Allen, 1984) and depression (Lobstein et al., 1983) differentiated physically active from sedentary subjects. The third study (Sothmann & Ismail, 1984) revealed that neither anxiety nor depression was associated with physical activity.

Hayden and Allen (1984) studied 98 college students who were self-selected into three groups: sedentary, active nonrunners who exercised regularly, and committed runners. The researchers also interviewed a "knowledgeable informant nominated by the subject" (p. 71) in order to validate subjects' self-reported levels of anxiety and depression. Results indicated that both exercise groups scored significantly lower than the sedentary group on both state and trait anxiety as well as depression. The informant data revealed that only trait anxiety differentiated the sedentary group from the exercise groups. These authors concluded that exercisers reported feeling less anxious and depressed than sedentary people and were perceived by significant others as being better adjusted on these dimensions as well.

Lobstein et al. (1983) examined 22 middle-aged men who were either physically active or sedentary. These authors found that depression was the most significant discriminator between physically active and sedentary men, followed by social introversion. They concluded that physically active men are less depressed and more extroverted than sedentary men.

Although the study by Sothmann and Ismail (1984) focused on biochemical associations between personality and fitness, a portion of their research design was similar to the study conducted by Lobstein et al. (1983). These authors examined 34 healthy males from a range of fitness conditions. Unlike the Hayden and Allen (1984) and Lobstein et al. (1983) investigations, these authors failed to find significant associations between physical fitness and either anxiety or depression. One possible explanation may be that while Sothmann and Ismail (1984) examined subjects on a continuum of fitness levels, both Lobstein et al. (1983) and Hayden and Allen (1984) examined distinct exercise groups. It should be noted that since all three studies used correlational designs, cause and effect relationships cannot be assessed. Furthermore, Lob-

stein et al. (1983) examined a large number of dependent measures relative to their fairly small (n = 22) sample size.

Other Studies

Sixteen other studies have also examined the connection between exercise and well-being and/or mood (Blumenthal, Schocken, Needels, & Hindle, 1982a; Brown & Lawton, 1986; Coleman, Washington, & Price, 1985; Dyer & Crouch, 1987; Emery & Blumenthal, 1988; Ewing, Scott, Mendez, & McBride, 1984; Farrell, Gustafson, Morgan, & Pert, 1987; Hayes & Ross, 1986; Parent & Whall, 1984; Pauly, Palmer, Wright, & Pfeiffer, 1982; Perri & Templer, 1985; Rape, 1987; Severtsen & Bruya, 1986; Simons & Birkimer, 1988; Tucker, Cole, & Friedman, 1986; Valliant & Asu, 1985; Wilfley & Kunce, 1986; Williams & Getty, 1986). These studies were methodologically less rigorous than those reviewed here, and of these studies, 12 concluded that exercise is associated with improved well-being and/or mood. Ewing et al. (1984) found signifiant differences between exercisers and nonexercisers on positive but not on negative moods while Simons and Birkimer (1988) reported mood improvements especially among the more disturbed subjects. However, due to methodological considerations, confidence in the results and conclusions of these studies must be viewed with caution.

Summary

In summary, empirical research conducted since 1980 suggests that exercise improves mood and well-being and reduces anxiety, depression, and stress. Most studies failing to find associations between exercise and mood tend to have significant methodological flaws. While there is evidence that exercise improves general mood and well-being following a more long-term exercise program, support for these long-term, cumulative effects is not as compelling as the recent research on the immediate effects of exercise on mood and well-being following a workout.

PERSONALITY AND SELF-CONCEPT

A number of researchers have examined changes in personality and self-concept as a result of exercise conditioning. Five studies met our criteria for review regarding this topic. With so much attention on the relationship between the Type A behavior pattern and coronary heart disease, some recent studies have attempted to use exercise to change aspects of this personality style. Two focused on changes in Type A behavior (Lobitz et al., 1983; Roskies, Seraganian, Oseasohn, Hanley, Collu, Martin, & Smilga, 1986) while three examined global personality functioning (Lobstein et al., 1983; Jasnoski & Holmes, 1981; Plante & Karpowitz, 1987).

Type A Behavior

Both Roskies et al. (1986) and Lobitz et al. (1983) assessed Type A behavior before and after an aerobic exercise program condition and a stress management condition. Both studies found benefits for the aerobic training and stress management interventions but only Lobitz et al. (1983) found reductions in Type A behavior among the exercisers. Roskies et al. (1986) examined 107 males and randomly assigned them to either an aerobic exercise group, a cognitive-behavioral stress management group, or a weight-training group. All groups met for a 10-week period. Results indicated that the stress management group, but not the aerobic exercise group, showed substantial reductions in Type A behavior while the weight-training group showed some reduction. These authors concluded that the stress management treatment was clearly superior in reducing Type A behavior. The study by Lobitz et al. (1983), reviewed earlier in this article, reported reductions in Type A behavior for an exercise group but not the anxiety management group, and reductions in trait anxiety for only for anxiety management group.

Some notable procedural differences between the Roskies et al. (1986) and Lobitz et al. (1983) studies may explain their conflicting conclusions. Roskies et al. (1986) examined male business managers who scored in the Type A range of functioning on the Structured Interview whereas Lobitz et al. (1983) investigated both males and females obtaining a wide variety of scores on the Jenkins Activity Survey. Furthermore, while Roskies et al. (1986) utilized jogging as their exercise treatment, Lobitz et al. (1983) used "mechanical devices . . . typically used in cardiac rehabilitation for aerobic condition" (p. 685) as their exercise treatment condition. Differences in subject selection, measures of Type A behavior, and/or treatment selection may account for their opposing conclusions. For example, possibly the weight-training treatment condition employed in the Lobitz et al. (1983) study was more effective in reducing the anger and hostility components in Type A behavior relative to a jogging program such as the one used by Roskies et al. (1986). Unfortunately, both studies used a fairly short training program (i.e., 10 and 7 weeks) and did not report followup results.

Global Personality Functioning

Jasnoski and Holmes (1981), Lobstein et al. (1983), and Plante and Karpowitz (1987), assessed global personality functioning among exercisers. While Jasnoski and Holmes (1981) examined personality variables among exercisers before and after an aerobic exercise program, Lobstein et al. (1983) and Plante and Karpowitz (1987) measured personality dimensions among self-selected physically active and sedentary subjects. Jasnoski and Holmes (1981) and Lobstein et al. (1983), but not Plante and Karpowitz (1987), found significant relationships between exercise and personality.

Jasnoski and Holmes (1981) studied 103 college females before and after a 15-week aerobic training program. These researchers reported that participation in the program, when statistically controlling the effects of changes in aerobic conditions, resulted in subjects reporting being less inhibited, more imaginative, and more self-

assured. Greater aerobic performance was significantly associated with more self-assurance, more free-thinking, and less tension. Improvements in Type A behavior approached but did not reach statistical significance in its association with participation in the fitness program. These authors concluded that although improved physical fitness is associated with personality, the social factors involved with fitness training are also related to personality. Other researchers have also noted the importance of social factors influencing psychological functioning among exercisers (e.g., Hughes, 1984). For example, social reinforcement may be one reason for the extreme popularity of group aerobic dancing.

In an investigation that focused primarily on the influence of aerobic exercise on physiological stress responsivity, Plante & Karpowitz (1987) administered a series of personality questionnaires and interviewed 107 college males who were either "intense aerobic exercisers, moderate aerobic exercisers, or nonexercisers" (p. 670). None of the groups significantly differed on any of the personality dimensions assessed. Plante & Karpowitz (1987) concluded their results do not support previous research that suggests exercisers differ from nonexercisers in terms of trait personality characteristics. As reported earlier, Lobstein et al. (1983) found that physically active men were less depressed and more extroverted than sedentary men.

As noted earlier, Lobstein et al. (1983) examined only 22 subjects with a large number of dependent measure. Both Jasnoski & Holmes (1981) and Plante & Karpowitz (1987) examined over 100 subjects and used much fewer dependent measures. However, these two studies examined young college students and thus the generalizability of results must be considered.

Unlike the earlier published research examining personality and exercise, the most recent studies (Plante & Karpowitz, 1987; Roskies et al., 1986) failed to find significant associations between personality and exercise. Possibly this trend reflects the fact that more and more people are exercising. While certain types of individuals may have exercised on a regular basis a number of years ago, numerous people with all types of personality characteristics now exercise.

Other Studies

Additional studies with more significant methodological flaws, such as failing to use control groups, using numerous measures with few subjects, and failing to randomly assign subjects to experimental and control conditions, have examined the role of exercise and personality variables. Most of these studies have assessed self-concept or self-esteem (Parent & Whall, 1984; Pauly et al., 1982; Perri & Templer, 1985; Plummer & Koh, 1987; Tucker, 1982; Valliant & Asu, 1985). Others have examined locus of control (Coleman et al., 1985; Perri & Templer, 1985; Valliant & Asu, 1985), emotional stability (El-Naggar, 1986), and global personality functioning (Blumenthal et al., 1982a). All six of the studies examining self-concept or self-esteem reported significant associations between these variables and exercise. Four of these investigations revealed significant improvements in self-esteem and/or self-concept following an exercise program (Pauly et al., 1982; Perri & Templer, 1985; Tucker, 1982; Valliant

& Asu, 1985), while two studies found that physically active subjects scored higher on self-esteem than sedentary subjects (Parent & Whall, 1984; Plummer & Koh, 1987).

Only one of the three studies assessing locus of control found significant improvements in internal locus of control following an exercise program (Perri & Templer, 1985). Blumenthal et al. (1982a) failed to find significant associations between either Type A behavior or global personality functioning following an 11-week exercise program for elderly subjects. El-Naggar (1986) also failed to find significant "emotional stability" (p. 80) differences between a pre- and post-four-month aerobic exercise program among male subjects. Although results from these additional studies must be viewed cautiously due to methodological considerations, it is compelling that all of the studies examining self-concept and/or self-esteem found significant positive associations between these variables and exercise while mixed results surfaced among studies examining locus of control and other personality variables.

Summary

In summary, the research published since 1980 considering the effects of exercise on personality functioning and self-concept consistently suggests that exercise improves self-concept, self-esteem, and self-assurance. The research also implies that exercise improves creative or free-thinking. However, empirical evidence on the effects of exercise on Type A behavior, locus of control, extraversion, and other personality dimensions is inconclusive. Furthermore, research on personality characteristics that differentiate exercisers from nonexercisers is also contradictory and inconclusive. Unfortunately, the short- versus long-term, cumulative effects of exercise on personality and self-concept functioning have not yet been adequately explored.

PHYSIOLOGICAL STRESS RESPONSIVITY

A large number of studies have examined the association between exercise and physiological stress responsivity. Most have hypothesized that the physiological adaptation (e.g., cardiovascular efficiency) associated with regular exercise influences physiological reactivity to and recovery from stressful psychological, psychosocial, and physical events. Rapid physiological recovery from stress might therefore contribute to better psychological coping (e.g., Hollander & Seraganian, 1984; Keller & Seraganian, 1984).

Twenty-one studies published since 1980 met our criteria and were reviewed. These studies fell into one of two categories. A number of studies employed an experimental design in which subjects were randomly assigned to exercise or control conditions (Blumenthal, Emery, Walsh, Cox, Kuhn, Williams & Williams, 1988; Holmes & McGilley, 1987; Holmes & Roth, 1988; Keller & Seraganian, 1984; Sinyor, Golden, Steinert, & Seraganian, 1986, Roskies et al., 1986; Sherwood, Light, & Blumenthal, 1989). At an approximately seven- to twelve-week follow-up, subjects' physiological stress responsivity (reactivity to and/or recovery from stress) was assessed by exposing

them to stressful laboratory tasks while measuring physiological changes in heart rate, blood pressure, skin conductance or catecholamine levels. The second category of studies used a correlational design in which subjects were differentiated into either aerobically fit or unfit groups (Hollander & Seraganian, 1984; Holmes & Roth, 1985; Hull, Young, & Ziegler, 1984; Jamieson & Lavoie, 1987; Keller & Seraganian, 1984; Lake, Suarez, Schneiderman, & Tocci, 1985; Light, Obrist, James, & Strogatz, 1987; Plante & Karpowitz, 1987; Shulhan, Scher, & Furedy, 1986; Sinyor, Peronnet, Brisson, & Seraganian, 1988; Sinyor, Schwartz, Peronnet, Brisson, & Seraganian, 1983; Turner, Carroll, Costello, & Sims, 1988; van Doornen & de Degeus, 1989; Zimmerman & Fulton, 1981). Subjects then participated in a stressful laboratory procedure during which physiological measures were obtained.

The most common laboratory stressors employed in these studies were cognitive tasks such as mental arithmetic problems (e.g., Blumenthal et al., 1988; Lake et al., 1985; Shulhan et al., 1986; Sinyor et al., 1988; Turner et al., 1988), digit span backwards (e.g., Holmes & McGilley, 1987; Holmes & Roth, 1985; 1988), Raven's Progressive Matrices (e.g., Roskies et al., 1986; Zimmerman & Fulton, 1981), and/or the Stroop color-naming task (e.g., Jamison & Lavoie, 1987; Keller & Seraganian, 1984; Sinvor et al., 1983). However, a few studies relied on physical stressors such as electric shock (Light et al., 1987; Plante & Karpowitz, 1987), a cold pressor task (e.g., Lake et al., 1985; Light et al., 1987), and/or intense white noise (e.g., Sinyor et al., 1988; van Doornen & de Degeus, 1989).

Almost all of the studies in this area used pulse rate and/or blood pressure as psychophysiological dependent variables. However, a few studies examined plasma catecholamines (e.g., Hull et al., 1984; Sinyor et al., 1983, 1988), skin resistance or conductance (e.g., Hollander & Seraganian, 1984; Keller & Seraganian, 1984; Plante & Karpowitz, 1987), or electrocardiographic T-wave amplitude responses (Shulhan et al., 1986). Sample sizes ranged from 6 subjects (Sinyor et al., 1988) to over 100 (Light et al., 1987; Plante & Karpowitz, 1987; Roskies et al., 1986). However, the vast majority of these studies had less than 50 subjects. While most studies examined both physiological reactivity to and recovery from laboratory stressors, others measured reactivity only (e.g., Holmes & McGilley, 1987) or just recovery (e.g., Hollander & Seraganian, 1984; Keller & Seraganian, 1984).

These investigations have yielded mixed results. It is therefore difficult to assess if and how exercise influences physiological stress responsivity to psychosocial stressors. Of the studies using experimental designs, most conclude that exercise positively influences physiological stress recovery (Blumenthal et al., 1988; Holmes & Roth, 1988; Keller & Seraganian, 1984; Sinyor et al., 1986). However, Roskies et al. (1986) failed to find a significant association between exercise and physiological stress recovery.

In terms of physiological stress reactivity, mixed results are also reported. While some of the experimental design studies assessing the influence of exercise on physiological stress reactivity found significant associations (Holmes & McGilley, 1987; Holmes & Roth, 1988) others did not (Roskies et al., 1986; Sinyor et al., 1986).

Of the studies using correlational methods, some report that exercise is associated

with enhanced physiological stress recovery (Hollander & Seraganian, 1984; Keller & Seraganian, 1984; Sinyor et al., 1983). However, many studies failed to find an association between exercise and recovery measures (Holmes & Roth, 1985; Hull et al., 1984; Jamieson & Lavoie, 1987; Plante & Karpowitz, 1987; Sinyor et al., 1988; Zimmerman & Fulton, 1981).

Similarly, while some of these studies found associations between exercise and physiological stress reactivity (Holmes & McGilley, 1987; Holmes & Roth, 1985; Lake et al., 1985; Light et al., 1987; Shulhan et al., 1986; Turner et al., 1988), others did not (Jamieson & Lavoie, 1987; Plante & Karpowitz, 1987; Sinyor et al., 1983; Sinyor et al., 1988; van Doornen & de Degeus, 1989; Zimmerman & Fulton, 1981). Furthermore, some authors determined that exercise participation and/or aerobic fitness was associated with physiological responsivity among some physiological measures (e.g., blood pressure) or among some laboratory stressors (e.g., shock task) but not among others. For example, Shulhan et al. (1986) found that exercise was associated with T-wave amplitude responsivity but not heart rate, while Light et al. (1987) found that exercise was associated with reactivity during a shock avoidance task but not during a cold pressor task.

A number of hypotheses have been offered to explain the mixed results of these studies. Differences between types of dependent variables, measuring different aspects of physiology, subject characteristics, stressors, demand characteristics, and definitions of fitness and exercise may help to explain the inconsistencies among these studies. Furthermore, many of the better-designed studies used a small number of subjects (e.g., Sinyor et al., 1988), short training programs (Sinyor et al., 1986), failed to control for initial physiological differences among various fitness groups (Keller & Serganian, 1984), used only one stressor (e.g., Holmes & Roth, 1988), or assessed only one psychophysiological measure (e.g., Holmes & McGilley, 1987). However, a few studies examined over 100 subjects (Light et al., 1987; Plante & Karpowitz, 1987; Roskies et al., 1986), used three or more psychophysiological dependent measures (Blumenthal et al., 1988; Hull et al., 1984; Plante & Karpowitz, 1987; van Doornen & de Degeus, 1989), as well as cognitive, physical, and psychosocial laboratory stressors (Lake et al., 1985; Light et al., 1987; Plante & Karpowitz, 1987) and still did not yield consistent findings. Recently, Crews and Landers (1987) conducted a meta-analytic review of 34 studies examining aerobic fitness and reactivity to psychosocial stressors. These authors concluded that aerobically fit subjects have a reduced psychosocial stress response. However, 14 of the 34 studies utilized in the meta-analysis were unpublished manuscripts, 5 did not use a control group, and none were screened for methodological quality.

In summary, although a sizable number of studies has examined the association between exercise and physiological stress responsivity, research has not yet consistently demonstrated that exercise influences physiological response to stressful tasks. The most impressive evidence favors the notion that exercise might influence physiological stress recovery. Thus, brief training programs designed to increase exercise behavior and aerobic conditioning may improve subjects' physiological recovery following the presentation of a laboratory stressor. However, the generalizability of

these findings is in question as this area of research has not been extended beyond the laboratory setting.

COGNITIVE PROCESSES

An extensive review of the effects of exercise on cognitive functioning has recently been published (Tomporowski & Ellis, 1986) and will therefore be only highlighted here. Studies comparing the test performance of subjects differing in physical fitness during and after short duration, moderately intense exercise (e.g., Sjoberg, 1980) generally support the view that cognitive function is facilitated by an increase in physical arousal. However, methodological shortcomings as well as the use of cognitive tasks that are easily influenced by motivation are problems in many of these studies. The effects of long duration exercise are even less clear. For example, Tomporowski, Ellis & Stephens (1987) studied subjects of low, moderate, and high fitness after each group had engaged in a strenuous run. No differential effects for any group, compared to a no-exercise control group, were found for performance on a memory task.

Much of the research examining the association between cognitive function and physical fitness focuses on the elderly. Spirduso (1980) reviewed this literature and concluded that a positive relationship exists between physical fitness and psychomotor speed (i.e., reaction times and movement times) among elderly subjects. However, Spirduso (1980) warned that the methodological problems in this area of research are troublesome. More recent research has shown that aerobic fitness training improves neuropsychological test performance among the elderly (Dustman, Ruhling, Russell, Shearer, Bonekat, Shigeoka, Wood, Bradford, 1984). Furthermore, Blumenthal and Madden (1988) report that memory-search performance was associated with aerobic fitness. However, unlike Dustman et al. (1984), Blumenthal and Madden failed to find an association between memory-search performance and changes in fitness associated with a 12-week exercise training program. Perhaps these differences could be attributed to the fact that Blumenthal and Madden used a fairly short exercise program (12 weeks) and examined only memory-search performance while Dustman et al. (1984) used a 48-week exercise program and examined a wide range of neuropsychological functioning.

In summary, current data have failed to provide clear and convincing support for the notion that physical exercise improves cognitive functioning. However, some research suggests that physical fitness may improve cognitive functioning among elderly subjects. Temporowski and Ellis (1986) suggest that methodological problems as well as the fact that most studies in this area were conducted in a piecemeal fashion with little emphasis placed on theory-based parametric approaches have plagued this area of research.

POSSIBLE MECHANISMS TO EXPLAIN THE EXERCISE-PSYCHOLOGICAL HEALTH CONNECTION

Exercise appears to be associated with modest gains in a variety of psychological variables. If exercise improves psychological functioning then it is important to ex-

amine the possible mechanisms underlying this association. A number of biological and psychological mechanisms have been proposed to explain the exercise and psychological functioning connection.

Biological Mechanisms

Numerous biological hypotheses have been proposed to explain the connection between exercise and psychological health. One theory states that increases in body temperature due to exercise result in short-term tranquilizing effects (Von Euler & Soderberg, 1956, 1957). This theory is based upon the notion that temperature changes in the brainstem result in decreased muscle spindle activity and synchronized electrical activity in the cerebral cortex, causing a more relaxed state. A second theory posits that regular exercise facilitates stress adaptation because the increase in adrenal activity resulting from regular exercise increases steroid reserves which are then available to counter stress (Hughes, 1984; Michael, 1957). A third theory proposes that reduction in resting muscle activity potential following exercise causes tension release (deVries, 1968). A fourth theory suggests that exercise enhances the neurotransmission of norepinephrine, serotonin, and dopamine (Ransford, 1982), resulting in improved mood.

A popular biological theory states that psychological improvements resulting from exercise are due to the release of endogenous morphine-like chemicals (i.e., endorphins and enkephalins) synthesized in the pituitary gland (Farrell, 1981; Markoff, Ryan, & Young, 1982). Although a prevalent theory throughout the 1970s and early 1980s, the opiate hypothesis has recently been tempered by research suggesting that opiates may be associated with improvements in negative but not positive moods (Farrell et al., 1982; Haier, Quaid, & Mills, 1981; Hughes, 1984).

Although biological factors may be related to the psychological improvements associated with exercise, they do not provide evidence compelling enough to adequately explain the relationship between exercise and psychological health. For example, the similar psychological gains achieved through either aerobic or anaerobic exercise (e.g., Doyne, Ossip-Klein, Bowman, Osborn, McDougall-Wilson, & Neimeyer, 1987), as well as the psychological gains associated with perceived relative to actual fitness (e.g., King et al., 1989), suggest that these biological theories cannot adequately explain the complex connection between exercise and psychological functioning.

Psychological Mechanism

Many psychological theories have also been offered to explain improvements resulting from exercise. One theory suggests that improved physical fitness provides people with a sense of mastery, control, and self-efficacy (e.g., Bandura, 1977; Ismail & Trachtman, 1973). Another states that exercise is a form of meditation that triggers an altered and more relaxed state of consciousness (e.g., Buffone, 1980). A third theory proposes that exercise is a form of biofeedback which teaches exercisers to regulate their own autonomic arousal (e.g., Hollandworth, 1979). Then there is the

view that exercise provides distraction, diversion, or time out from unpleasant cognitions, emotions, and behaviors (e.g., Long, 1983). A fifth theory states that since exercise results in the physical symptoms associated with anxiety and stress (e.g., sweating, hyperventilation, fatigue) without the subjective experience of emotional distress, repeated pairing of the symptoms in the absence of associated distress results in improved psychological functioning (Hughes, 1984). A sixth theory claims that the substantial social reinforcement afforded exercisers may also lead to improved psychological states (Hughes, 1984); a seventh suggests that exercise may act as a buffer, resulting in decreased strain caused by stressful life events (Kobasa, Maddi, & Puccetti, 1982). Finally, Schwartz, Davidson, and Coleman (1978) propose a systems model such that exercise competes with negative affects, such as anxiety and depression, in the somatic and cognitive systems.

Although all eight of these hypotheses appear reasonable, few published studies have adequately examined them using rigorous research methods. Thus, we can currently only speculate about the psychological and social factors that impact on the exercise and psychological health connection.

Interestingly, until recently, investigators have not considered the possibility that many positive results may accrue because of psychological gains experienced from trying to get fit rather than, or at least in addition to, gains attributable to physical fitness per se. Yet the rapidity of the changes reported in most studies suggest that factors other than those stemming from increased fitness, are likely to be responsible. The perception of fitness may be more closely associated with improvements in functioning than actual fitness. King et al. (1989) found that perceived fitness was more closely associated with improvements in psychological variables among 120 middle-aged adults following a 6-month exercise program than were measures of actual fitness (VO2 max). Possibly perceived fitness may improve psychological variables due to an enhancement of self-efficacy (Rodin & Plante, 1989). Perhaps perceived health and fitness also result in an increase in mental and physical health-promoting behaviors.

Although various biological and psychological theories have been offered to explain the exercise and psychological health connection, no one theory or group of theories have been confirmed with sufficient scientific evidence. Furthermore, no integrated theoretical model has been either proposed or substantiated to explain cause and effect relationships between exercise and psychological health. This lack of clarity may well be due to methodological inadequacies that pervade the literature. The current lack of compelling data to support the array of largely untested theories calls for a sound and integrated theoretical and empirical approach to the problem.

METHODOLOGICAL ISSUES

The methodological problems detailed by Folkins and Sime (1981) continue to plague this area of research. Although improved designs and procedures have been incorporated into a few notable studies published during the 1980s, the three types of studies that do not permit reasonable causal inferences (one group posttest only

design, posttest only design with nonequivalent groups, one group pre-test–post-test design; Cook & Campbell, 1979) persist as the most prevalent research designs used currently.

Methodological flaws include threats to both internal and external validity. Threats to internal validity include nonrandom assignment into experimental and control conditions, the failure to use any control groups at all, examining a small number of subjects in combination with a large number of dependent variables, sole reliance on self-report information without examining the reliability of this information, and having numerous dropouts from the experimental condition relative to the control conditions. Threats to external validity include the use of nonstandard measures of exercise, fitness, and/or psychological constructs as well as the use of atypical exercise regimens.

A number of methodological considerations concern the choice of measures employed in these studies. The most frequently used measures include the Profile of Mood States (POMS; McNair, Lorr, & Droppleman, 1971) and the Speilberger State-Trait Anxiety Scale (Spielberger, Gorsuch, & Lushene, 1970). Other commonly used assessment devices include the Minnesota Multiphasic Personality Inventory (MMPI; Hathaway & McKinley, 1967), the Sixteen Personality Factors Questionnaire (16 PF; Cattell, Eber, & Tatsuleo, 1970), the Jenkins Activity Rating (JAS: Jenkins, Rosenman, & Zyzanski, 1974), and the Beck Depression Inventory (BDI; Beck & Beamesderfer, 1974). Also, many studies employed unpublished author-developed measures without providing reliability and validity information on these assessment devices. Numerous studies used only one assessment device to examine the psychological construct of interest. Furthermore, high face validity in combination with important demand characteristics results in the need to be cautious in interpreting findings using these scales. More sophisticated instruments as well as the use of multimodal approaches are needed to assess changes in psychological variables associated with physical activity. Examining perceived fitness and health as well as subjects' attributions regarding the reasons for improvements in psychological functioning as a result of exercise activity, may also shed further light on the exercise and psychological health connection.

Furthermore, the vast majority of research has focused on exercise as a treatment for numerous physical and psychological disorders ranging from heart disease, cancer, and major depression to autism, mental retardation, and schizophrenia. Relatively few studies have focused on the enhancement of psychological functioning among nonclinical populations. Given that countless numbers of people use exercise to "feel better," this area of inquiry remains relatively unexplored.

FUTURE DIRECTIONS

A number of specific questions are of particular importance in illuminating the exercise and psychological health connection. These include psychological improvements that may be due to (1) exercise per se apart from preexisting characteristics of

exercisers, (2) the frequency and duration of exercise activity, and (3) the type of exercise.

EFFECTS OF EXERCISE ACTIVITY VERSUS BEING AN EXERCISER

Since most of the studies failed to randomly assign subjects into experimental and control conditions, it is difficult to determine if exercise improves psychological functioning or if exercisers, as a group, tend to be more psychologically fit than nonexercisers prior to embarking on an exercise program. Although a number of correlational studies have found that exercisers differ from nonexercisers on personality and other psychological variables (e.g., Hammer & Wilmore, 1973; Hartung & Farge, 1977), other studies report no psychological differences between these two populations (e.g., Goldfarb & Plante, 1984; Plante & Karpowitz, 1987). Therefore, the use of random assignment is strongly recommended in any future research in this area. Furthermore, research aimed at addressing the importance of engaging in exercise activity relative to the factors that motivate someone to become an exerciser would also assist in addressing the biological and psychological hypotheses concerning the exercise and psychological health connection. If being an exerciser were more closely associated with psychological improvements relative to exercise activity, intensity, or duration, then the evidence for some of the psychological theories outlined here would be further substantiated.

EFFECTS OF EXERCISE DURATION AND FREQUENCY

Although our review suggests that mood is sensitive to the short-term effects of exercise, it is currently unclear how long these effects last. We failed to uncover a single study that assessed follow-up psychological measures in order to determine if psychological improvements were maintained after an exercise workout or program was completed. It is therefore impossible to determine either the minimal or optimal frequency and duration of exercise necessary for achieving and maintaining significant psychological improvements.

The current research has not carefully addressed these important questions. While a few researchers have assessed changes in psychological states both during (e.g., Ewing et al., 1984) and immediately following (e.g., Berger & Owen, 1983, 1988) an exercise workout, the vast majority of studies wait until the end of an exercise program to attain post-test psychological measures. Further confounding interpretation is the fact that these programs vary dramatically from a few weeks (e.g., Goldwater & Collins, 1985) to a few years (e.g., Tsai, Baun, & Bernacki, 1987). While some researchers have required subjects to participate in exercise activities 3 to 5 times per week (e.g., Jasnoski & Holmes, 1981), others have required only one workout per month (e.g., Tsai et al., 1987). While some investigators require four years of regular exercise participation (e.g., Tsai et al., 1987) others require only one exercise session (e.g., Ewing et al., 1984).

Future research should measure psychological functioning before, during and im-

mediately following exercise activity as well as at various follow-up periods. Furthermore, future research should vary and examine the frequency and duration of both exercise sessions and programs in order to establish a clearer understanding of the optimal amount of exercise necessary for maximum psychological benefit. Perhaps experimental conditions that include from one to seven days per week of exercise activity could be considered. Varying the amount of time for each exercise period from very brief 5- to 10-minute workouts to longer 60- to 90-minute workouts should also be pursued. Finally, brief exercise programs (e.g., 6 weeks) versus longer program (e.g., 18 months) should also be examined.

EFFECTS OF TYPE OF EXERCISE ACTIVITY

Further exploration and clarification is needed to determine the types of exercise that enhance psychological functioning. Although most research in this area studied some form of aerobic exercise such as running, walking, biking, or swimming, many studies examined a combination of aerobic and anaerobic exercise, or anaerobic activity alone. Some researchers employed vigorous aerobic exercise protocols while others defined brief neck rolls and arm spins as exercise. Although most authors purport that aerobic exercise is the exercise of choice for enhancing psychological functioning, recent research has suggested that anaerobic exercise such as weight lifting may be just as effective in some cases (e.g., Doyne et al., 1987).

Furthermore, some researchers suggest that participation in nonexercise hobby activities may result in psychological improvements similar to those obtained through exercise (Blair, Personal Communication, December 1987; Plante & Karpowitz, 1987; Plante & Schwartz, 1990). Due to the social reinforcement hypothesis of exercise benefits (Hughes, 1984), it is also important to assess the effects of individual versus group exercise participation. Therefore, future research should examine the type of exercise activity and its relation to psychological variables, using various hobby or other nonexercise activities as control groups. For example, examining the psychological effects of participation in hobby activities such as reading, music, art, board games, yoga, and gardening relative to similar amounts of time engaged in both aerobic and anaerobic activities should be considered. The psychological benefits of exercising alone as compared with exercising with a group while keeping intensity, duration, and frequency constant should also be investigated.

CONCLUSIONS

Our review of studies published since 1980 using nonclinical subjects found that exercise improves mood and psychological well-being (especially immediately following exercise), self-concept and self-esteem, but has little effect on personality functioning. In addition, our review suggests that exercise is likely to decrease mild anxiety, depression, and stress, and may improve certain work-relevant behaviors. Research concerning cognition and physiological stress responsivity is currently somewhat un-

clear. These conclusions support many of those of Folkins and Sime (1981) based on an earlier group of studies.

Methodological problems have ultimately left unanswered the question of how exercise improves psychological well-being. Although numerous biological and psychological hypotheses have been offered, no one theory has received substantial empirical support. Future research should be aimed at carefully controlled examinations of both specific mechanisms and the interaction of mechanisms that may result in psychological improvements for exercisers. Adequate control groups, random assignment to treatment conditions, and state-of-the-art measures must be used. The popular and professional cultures of the 1980s have led people to assume that exercise is associated with psychological health and well-being. However, a number of questions await higher quality research to provide meaningful conclusions. Hopefully, many of these questions will be answered during the next decade.

NOTES

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