

We examined the effects of acute and long-term exercise on perceptions of personal efficacy in sedentary, middle-aged males and females. Both males and females demonstrated significant increases in efficacy following acute exercise. Females, who had demonstrated initially lower self-perceptions than males, made dramatic increases in efficacy during the exercise program, equaling or surpassing those of males. Exploratory analyses revealed significant relationships between self-efficacy and subsequent physiological responses to exercise.

Key Words: Aerobic exercise, Self-efficacy, Physiological responses, Gender differences

Effects of Acute and Long-Term Exercise on Self-Efficacy Responses in Sedentary, Middle-Aged Males and Females¹

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Due to the rapidly increasing growth in the older population of the United States (U.S. Bureau of the Census, 1982), the mental and physical health of the aged has become a major concern. Exercise has been suggested as the single health practice most strongly associated with health and longevity among the aged (Palmore, 1970), and low physical activity levels have recently been implicated as an important risk factor in all-cause mortality, cardiovascular disease, and cancer (Blair et al., 1989). Recent reports have demonstrated aging populations to make substantial physiological gains as a result of regular exercise participation (e.g., Blumenthal et al., 1989; Cunningham et al., 1987; Emery & Blumenthal, 1990; King et al., 1989).

From a psychological perspective, however, the effects of regular exercise in the aged have been equivocal. Some studies have reported psychological improvements (e.g., Blumenthal, Williams, Needels, & Wallace, 1982; Dustman et al., 1984; Molloy et al., 1988; Perri & Templer, 1985), whereas others have reported minimal or no changes (e.g., Blumenthal et al., 1989; Blumenthal, Schocken, Needels, & Hindle, 1982; Emery & Gatz, 1990; King et al., 1989; Panton et al., 1990). Some of the equivocality and inconsistency reported in the literature with respect to the psychological effects of exercise participation may well be due to methodological short-

comings, including inadequate duration of exercise interventions, inadequate sample sizes, and inappropriate measurement of psychological variables.

The effect of exercise on the individual's sense of perceived control over events is one area that has gone largely unexplored. Sense of control has been shown to be an important variable in coping with stress and in mental and physical well-being (see Rodin, 1986, for a review). One situation-specific sense of control, self-efficacy, is concerned with the individual's beliefs in his or her capabilities to execute necessary courses of action to satisfy situational demands. In essence, self-efficacy is a situational-specific form of confidence assessing individuals' perceptions to successfully perform particularized behaviors. Bandura (1977, 1986) has identified self-efficacy as a common cognitive mechanism mediating behavioral change, theorizing self-efficacy to influence the activities that individuals choose to approach, the effort expended on such activities, and the degree of persistence demonstrated in the face of failure or aversive stimuli. Efficacy cognitions are also postulated to influence thought processes and affective reactions (Bandura, 1986).

Percepts of personal efficacy are primarily influenced by past-performance accomplishments or mastery experiences. In essence, coping successfully with past demands leads to increased efficacy that, in turn, influences effort, persistence, and affect in future behavioral attempts. Bandura (1986) emphasizes that self-efficacy is specific to domains or behaviors as opposed to being a generalized perception of capabilities. Thus, for example, a traitlike measure of physical ability would be inappropriate for assessing walking efficacy. Indeed, several reports have demonstrated the theoretical specificity of self-efficacy measures and the ability of such measures to predict behavior more accurately than gen-

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eralized measures (e.g., Hofstetter, Sallis, & Hovell, 1990; McAuley & Gill, 1983).

Percepts of efficacy have been consistently shown to be important determinants of a variety of health-related behaviors (see O'Leary, 1985, for a review), including exercise (see McAuley, in press-a, in press-b). Recent reports have linked efficacy cognitions to changes in intensity level of activity within a community sample of elderly adults (Sallis et al., 1986), and in treadmill performance, strength gains, and exercise compliance in postmyocardial infarction patients (Ewart, Stewart, Gillilan, & Kelemen, 1986; Ewart, Stewart, Gillilan, Keleman, Valenti, Manley, & Kaleman, 1986), and compliance in individuals suffering from chronic obstructive pulmonary disease (Kaplan, Atkins, & Reinsch, 1984). Furthermore, exercise-specific efficacy expectations have predicted frequency and intensity of exercise in sedentary, middle-aged adults engaged in low-impact aerobic exercise programs (McAuley, in press-a; McAuley & Jacobson, 1991) and metabolic and affective perceptions during graded exercise testing (McAuley & Courneya, 1990).

A recent study by Emery and Gatz (1990) attempted to assess the effects of an aerobic exercise program on physiological change, self-efficacy, and the relationship between these two variables in a sample of elderly community residents. As expected, some positive changes in physiological responses over time were found. However, Emery and Gatz had little success in demonstrating either change in self-efficacy over time or in finding a relationship between efficacy and physiological change. Given that Emery and Gatz employed trait measures of perceived control (e.g., locus of control, health locus of control), which fail to appropriately measure the construct of self-efficacy, it is really not surprising that efficacy and physiological change were not related. Indeed, Bandura (1986) goes to considerable length to emphasize the need for a microanalytic assessment of self-efficacy detailing the generative capabilities of the individual, rather than relying on a global or omnibus measure of perceived control.

The present study was designed to examine the effects of acute (single graded exercise test) and long-term (structured exercise program) exercise on perceptions of personal efficacy with respect to physical capabilities. Given our concern with the methodological shortcomings of previous exercise studies with aging populations, a number of considerations were taken into account. First, an exercise program of sufficient length to maximize health benefits associated with physical activity (Pollock, Wilmore, & Fox, 1984) was provided. Second, a sample population randomly stratified by gender and age cohort, of adequate size to attain sufficient power, and approximating a segment of the population that stands to accrue considerable health benefits from exercise, was selected. Third, we based our hypotheses regarding psychological change through exercise in a theoretical framework, that of self-efficacy theory (Bandura, 1977, 1986).

This study had three objectives. The first con-

cerned testing self-efficacy theory's prediction that successful mastery experiences will lead to enhanced efficacy cognitions in sedentary, middle-aged adults. It was hypothesized that successful performance of an acute bout of exercise would be perceived as a positive mastery experience, thereby leading to significant increases in efficacy cognitions. Furthermore, it was expected that participation in a long-term exercise program, with incremental increases in duration of activity, would serve to enhance these cognitions.

In adopting this perspective, it is necessary to consider the possible differing perceptions that males and females may have about themselves. Bandura (in press) has reported that healthy men tend to have more positive perceptions of their physical (cardiac) capabilities than do healthy women, despite little relative differences between them on measures of peak heart rate and maximal work load achieved on the treadmill. Therefore, a second purpose of the study was to determine whether males and females differed in terms of formation of efficacy cognitions as a result of acute and long-term exercise participation.

The final objective of the study was an exploratory examination of the relationships between self-efficacy cognitions assessed prior to the structured exercise program and physiological responses following the exercise program.

Methods

Subjects

Subjects were recruited via local media advertising (newspaper, radio, and television public service announcements) as participants in a larger, ongoing exercise project. Criteria for entry into the program were: being sedentary (operationalized as no regular involvement in exercise or activity regimens in the previous 6 months), middle-aged (45–64 years of age), and otherwise healthy or asymptomatic, as determined by a preprogram physician's examination. Selections were based on stratified sampling restrictions, in which approximately equal numbers of males and females from four different age cohorts (45–49, 50–54, 55–59, 60–64 years) were required. A total of 103 subjects (53 females, 50 males) initially took part in the study; however, only 81 subjects were available for postexercise program testing. Analyses were conducted only on those subjects that participated in both pre- and postexercise program testing.

Average age of the subjects was 54 years, and the majority of the sample were married (68%) or divorced/separated (20%). Subjects were generally well educated; 67% had some college education.

Measures

Efficacy Measures. — Three measures of self-efficacy were employed to determine subjects' beliefs in their physical capabilities as related to exercise and fitness. Specifically, efficacy with respect to

sit-ups, bicycling, and walking/jogging capabilities were designed following the recommendations of Bandura (1977, 1982). The sit-up efficacy scale was composed of items representing the subjects' confidence in being able to successfully complete increasing numbers of sit-up repetitions in 1 minute. The bicycle efficacy scale took a similar approach, examining subjects' beliefs in their ability to cycle for progressively longer time periods at increasing work loads. Finally, items on the walk/jog efficacy scale reflected judgments of being able to successfully complete successive quarter-mile distances within 4-minute intervals. Pilot testing on a similar group of subjects suggested such intervals to be practical.

For each item on the self-efficacy scales, subjects were asked whether they felt they could successfully execute that behavior. If they responded positively to an item, they then indicated their degree of confidence in that response on a 100-point percentage scale comprising 10-point increments (100% = complete certainty, 10% = highly uncertain). Total strength of self-efficacy was then calculated by summing the confidence ratings and dividing by the total number of items in the scale, resulting in a maximum possible efficacy score of 100. These assessments are in accord with the recommendations of Bandura (1977, 1986). All scales were internally consistent (all α 's > .80).

Physiological Measures. — Physiological assessment at baseline and at 20 weeks consisted of a battery of physical fitness tests designed to assess cardiorespiratory and vascular functioning, abdominal strength, body composition, and total blood serum cholesterol level. *Cardiorespiratory fitness* was assessed via submaximal bicycle ergometer graded exercise testing. This employed a modified Astrand-Ryhming protocol (Siconolfi et al., 1982) with continuous electrocardiographic and blood pressure monitoring. This protocol was the basis for calculating aerobic capacity (predicted VO_2max), resting heart rate, and maximum diastolic and systolic blood pressure. *Abdominal strength* was measured via standardized assessment of abdominal curls (modified sit-ups). The abdominal curls assessment required subjects to perform the task at a maximum rate of 35 repetitions per minute (subjects could perform the task at a slower rate but not faster) until fatigue or until a 90-second time limit expired. *Body composition* was evaluated by using total body weight and percentage of body fat. The former was assessed by using a calibrated scale and was expressed in pounds. Percentage of body fat was measured by using the seven-site technique and generalized equation developed by Jackson and Pollock (1978). Finally, *total serum cholesterol* was ascertained from blood samples drawn in the early morning following a 14-hour fast.

Procedures

Graded Exercise Test. — All subjects were scheduled for individual appointments on separate occa-

sions for graded exercise testing (GXT) and blood tests at a sports medicine research laboratory. All Institutional Review Board and human subjects information, orientation to the GXT protocol, physician's approval, and subjects' informed consent were administered and collected at an orientation session prior to GXT scheduling. A clinician from a local commercial laboratory conducted the blood draws, which were subsequently analyzed by that laboratory. Upon arriving at the laboratory for their GXT, subjects completed each of the three efficacy scales before completing the abdominal strength (sit-ups) test and being prepared for the GXT.

The modified Astrand-Ryhming protocol (Siconolfi et al., 1982) required subjects to pedal at 50 rpm at an initial work load of 150 kgm/min. The work load was increased by 150 kgm/min every 2 minutes until the subject reached 70% of their predicted maximum heart rate ($220 - \text{age} \times .70$). At this point, if subjects were still exercising, the test was terminated at the conclusion of the next full minute, whereupon subjects entered into a supervised cool-down phase while their heart rate returned to normal. Throughout the GXT, heart rate was assessed each minute and blood pressure every 2 minutes. Information from the initial submaximal GXT was used to provide each participant with a personalized exercise prescription of low to moderate intensity (65%–75% maximum predicted heart rate). Following recovery from the GXT, subjects completed the efficacy measures once again.

Exercise Program. — Subjects participated in a 20-week exercise program led by trained exercise instructors. The exercise classes met three times per week for approximately 1 hour each session. Subjects were randomly assigned to one of four exercise classes, two of which were held in the morning and two in the early evening. Two exercise leaders (one male, one female) supervised the exercise classes, alternating between groups periodically to ensure equal exposure of the leaders to all participants. Each leader was a second-year graduate student in exercise physiology with considerable teaching experience, and certified in cardiopulmonary resuscitation. The exercise leaders supervised the exercise classes and were responsible for monitoring and recording subjects' intensity, duration, and frequency of exercise.

The exercise class consisted of a warm-up phase, aerobic activity period, and then a cool-down phase. Subjects were led in stretching, flexibility, and abdominal strength (sit-ups) exercises by the exercise leaders for approximately 10 minutes at the beginning of each session. They then participated in the walking program, the aerobic portion of the session. Participation in this phase was closely monitored by the exercise leaders, and subjects engaged in aerobic activity for progressively longer durations on a twice-weekly basis for the first 10 weeks. Thus, the activity lasted for 15 minutes for the first 2 weeks, increasing to 20–25 minutes for the second 2 weeks, 25–30 minutes for weeks 5–6, 30–35 minutes for

Table 1. Means and Standard Deviations (in Parentheses) of Physiological Measures from Pre- to Post Exercise Program for Total Sample, Males, and Females

Measure	Preprogram	Postprogram	Change
Total			
Resting heart rate	76.46 (12.88)	72.70 (12.86)	-3.75 (12.10)**
VO ₂ max ml/kg/min.	27.01 (06.18)	31.03 (07.55)	4.02 (06.43)***
Systolic blood pressure	172.01 (22.78)	165.43 (21.86)	-6.58 (25.30)*
Diastolic blood pressure	87.98 (11.53)	83.48 (11.14)	-4.49 (12.36)**
Percentage of body fat	30.78 (06.91)	27.17 (06.64)	-3.61 (03.71)***
Serum cholesterol	223.92 (35.13)	216.43 (33.74)	-7.49 (28.23)*
Weight (lb)	180.37 (35.34)	175.83 (34.56)	-4.54 (07.10)***
Sit-up repetitions	25.35 (17.46)	50.32 (19.44)	24.96 (17.55)***
Time to reach 70% maximum heart rate	6.36 (01.68)	7.01 (01.31)	.65 (01.13)***
Females			
Resting heart rate	78.45 (13.70)	73.11 (13.54)	-5.34 (11.72)**
VO ₂ max ml/kg/min	25.79 (06.25)	30.16 (08.04)	4.37 (06.43)***
Systolic blood pressure	164.09 (22.17)	162.70 (24.83)	-1.39 (25.68)
Diastolic blood pressure	84.75 (11.47)	82.18 (10.22)	-2.57 (13.54)
Serum cholesterol	220.20 (30.52)	213.05 (31.27)	-7.15 (20.98)*
Percentage of body fat	34.62 (06.33)	30.39 (06.28)	-4.23 (03.20)***
Weight (lb)	164.30 (30.06)	159.48 (29.36)	-4.82 (07.87)***
Sit-up repetitions	19.02 (14.56)	44.12 (18.14)	25.09 (17.67)***
Time to reach 70% maximum heart rate	5.30 (01.49)	6.27 (01.34)	.98 (01.32)***
Males			
Resting heart rate	74.08 (11.57)	72.22 (12.16)	-1.86 (12.44)
VO ₂ max ml/kg/min	28.57 (05.81)	32.14 (06.83)	3.58 (06.50)**
Systolic blood pressure	181.43 (19.95)	168.68 (17.47)	-12.76 (23.72)**
Diastolic blood pressure	91.81 (10.51)	85.03 (12.10)	-6.78 (10.51)***
Serum cholesterol	228.41 (40.00)	220.50 (36.55)	-7.91 (35.41)
Percentage of body fat	26.21 (04.33)	23.34 (04.81)	-2.87 (04.15)***
Weight (lb)	199.49 (31.70)	195.27 (30.16)	-4.22 (06.15)***
Sit-up repetitions	32.92 (17.80)	57.72 (18.54)	24.81 (17.64)***
Time to reach 70% maximum heart rate	7.62 (00.79)	7.89 (00.46)	.27 (00.69)*

* $p < .05$; ** $p < .01$; *** $p < .001$.

weeks 7–8, and finally up to 40 minutes by the tenth week. This latter prescription of duration was maintained for the remainder of the program. In this way, a measure of control was implemented over the duration aspect of participation. At the end of each session, subjects were led through a cool-down period comprising light stretching and slow walking.

Although not the primary focus of the present report, the issue of participant adherence should be addressed briefly. Of the total 57 exercise sessions, 24.1% of the total sample ($N = 103$) attended less than one session per week on average. At the other end of the spectrum, 51.7% of the sample attended two or more times per week. This 51.7% adherence rate approximates adherence rates reported elsewhere (e.g., Dishman, 1982; Sallis et al., 1986). However, the adherence rate for subjects who completed both pre- and postprogram testing was considerably higher, with approximately 65% of the sample ($N = 81$) attending two or more sessions per week on average. Further details regarding adherence to the exercise program are reported elsewhere (McAuley, in press-a).

At the completion of the 20-week exercise program, subjects were scheduled for a postprogram physiological screening in the laboratory. At this time, all physiological and efficacy variables assessed prior to the program were once again measured.

Results

The physiological measures were grouped according to conceptual similarity and analyzed by multivariate analysis of variance (MANOVA). The conceptual groupings were: cardiorespiratory responses (resting heart rate, time to reach 70% heart rate maximum, and estimated VO₂max), vascular responses (systolic and diastolic blood pressure), body composition (percentage of body fat and total weight), abdominal strength (sit-up repetitions), and total serum cholesterol. For the grouped variables, a repeated measures MANOVA with gender as a between-subjects factor and time as the within-subjects factor were employed to determine the effects of the exercise program over time. In the case of the abdominal strength (sit-up repetitions) and cholesterol measures, repeated measures analysis of variance (ANOVA) were employed. Descriptive data with respect to the physiological measures for all subjects and for males and females separately are presented in Table 1.

Cardiorespiratory Responses. — The repeated measures MANOVA for the measures of cardiorespiratory fitness (resting heart rate, VO₂max, and time taken to reach 70% predicted maximum heart rate) revealed significant main effects for time ($p < .001$)

and gender ($p < .001$) as well as a significant interaction ($p < .05$). Follow-up analyses for the time by gender interaction indicated that males and females differed significantly in the magnitude of their time to reach 70% predicted heart rate. Females increased their time quite markedly from pre- to postprogram ($p < .001$), whereas males had a significant but more modest increase ($p < .05$). The time main effect indicated significant reductions in resting heart rate ($p < .005$) and increases in VO_{2max} ($p < .001$) and time taken to reach 70% predicted maximum heart rate ($p < .001$). Males took longer to reach 70% predicted heart rate maximum ($p < .001$).

Blood Pressure. — The repeated measures MANOVA for the measures of blood pressure (systolic and diastolic) revealed significant main effects for time ($p < .01$) and gender ($p < .01$). Univariate analyses for the time and gender main effects, indicated that over the course of the program systolic and diastolic blood pressure decreased ($p < .05$) and that females had lower systolic and diastolic blood pressure ($p < .01$) than males.

Body Composition. — The MANOVA revealed a significant main effect for time ($p < .001$) and gender ($p < .001$). Both weight and percentage of body fat were significantly reduced over the course of the exercise program, and males were both leaner and heavier than females.

Abdominal Strength. — The repeated measures ANOVA for abdominal strength (sit-ups) indicated significant effects for both time ($p < .001$) and gender ($p < .001$), with considerable increases demonstrated over time and males being able to perform more sit-ups than females.

Total Cholesterol. — The repeated measures ANOVA for total serum cholesterol revealed a significant main effect for time ($p < .05$), with total cholesterol levels decreasing over the course of the exercise program.

Effects of Exercise Participation on Self-Efficacy

Perceptions of personal efficacy with respect to three types of exercise (sit-ups, bicycling, and walking/jogging) were assessed prior to and following the baseline GXT and then prior to and following the GXT conducted at completion of the exercise program. Due to the relationships between the dependent measures (self-efficacy), a repeated measures MANOVA with gender as a between-subject factor and time as within-subjects factor was conducted with the three efficacy measures as dependent variables. There was a significant multivariate gender by time interaction effect, $F(9, 58) = 2.03, p < .05$, a significant main effect for time, $F(9, 58) = 24.22, p < .0001$, and a significant main effect for gender, $F(3, 64) = 7.087, p < .0001$. Decomposition of these effects was accomplished by repeated measures and univariate analyses for each efficacy measure employ-

ing a Bonferroni adjustment for the number of tests conducted ($p = .017$). For clarity, the results for each set of efficacy measures are presented separately. Figures 1 and 2 detail the changes in self-efficacy over time by gender and collapsed across males and females.

Sit-up Efficacy. — The repeated measures ANOVA for sit-up efficacy revealed a significant main effect for time, $F(3, 70) = 27.34, p < .001$, and gender $F(1, 72) = 21.87, p < .001$, as well as a significant time by gender interaction, $F(3, 70) = 4.57, p < .007$. Follow-up tests for the time by gender interaction indicated that over the course of the 20-week program, females significantly increased their efficacy ($p < .001$), whereas males did not. Both groups demonstrated significant efficacy increases from pre- to post-GXT following the exercise program (see Figure 1).

Follow-up tests for the time main effect indicated that sit-up efficacy showed an increase of marginal significance from pre- to postbaseline GXT ($p < .019$), significantly increased over the course of the exercise program ($p < .015$), and once again from pre- to post-GXT following the exercise program ($p < .001$; see Figure 2). Follow-up tests for the gender main effect revealed females to have lower sit-up efficacy than males before ($p < .001$) and after ($p < .001$) baseline (see Figure 1).

Bicycle Efficacy. — The repeated measures ANOVA for bicycle efficacy revealed a significant main effect for time, $F(3, 66) = 26.71, p < .001$, and a significant time by gender interaction, $F(3, 66) = 4.59, p < .01$. Follow-up tests for the time by gender interaction indicated that females' efficacy increased from pre- to postbaseline GXT ($p < .001$) and increased once again from pre- to post-GXT following the exercise program ($p < .01$). Male subjects' bicycle efficacy increased significantly between pre- and postbaseline GXT ($p < .001$), decreased over the course of the exercise program, ($p < .01$), and then increased once again between pre- and post-GXT following the exercise program ($p < .01$; see Figure 1).

Follow-up tests for the time main effect indicated that subjects' perceived bicycle efficacy increased from pre- to postbaseline GXT ($p < .001$) and increased again from pre- to post-GXT following the exercise program ($p < .001$; see Figure 2).

Walk/Jog Efficacy. — The repeated measures ANOVA for walk/jog efficacy revealed significant main effects for time, $F(3, 70) = 31.70, p < .001$, and gender, $F(1, 72) = 4.41, p < .04$. Follow-up tests for the time main effect indicated that subjects' walk/jog efficacy increased from pre- to postbaseline GXT ($p < .001$) and over the 20-week program ($p < .001$). However, no further changes as a function of postprogram GXT were evident (see Figure 2). Follow-up tests for the gender main effect indicated that females had lower efficacy at pre- and postbaseline GXT ($p < .017$), but following the program had similarly strong perceptions of walking capabilities as males (see Figure 1). Although the gender by time

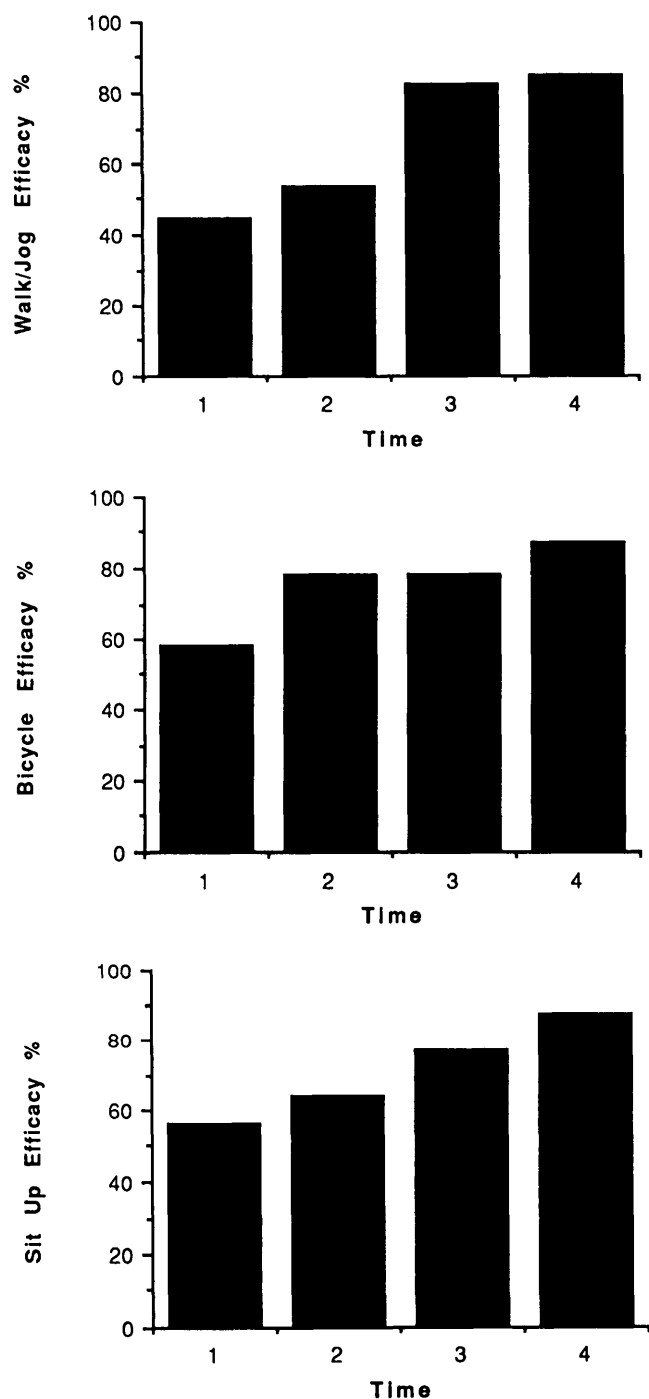


Figure 1. Changes in efficacy perceptions for all subjects pre- to post-graded exercise testing before (Time 1 to Time 2) and after the 20-week exercise program (Time 3 to Time 4).

interaction was not significant, a similar trend to the sit-up and bicycle efficacy measures was evident. That is, males had initially higher levels of efficacy, but these differences were all but eliminated following the exercise program.

Relationships Between Self-Efficacy and Physiological Responses

To examine the relationships between self-efficacy and physiological responses to exercise, correla-

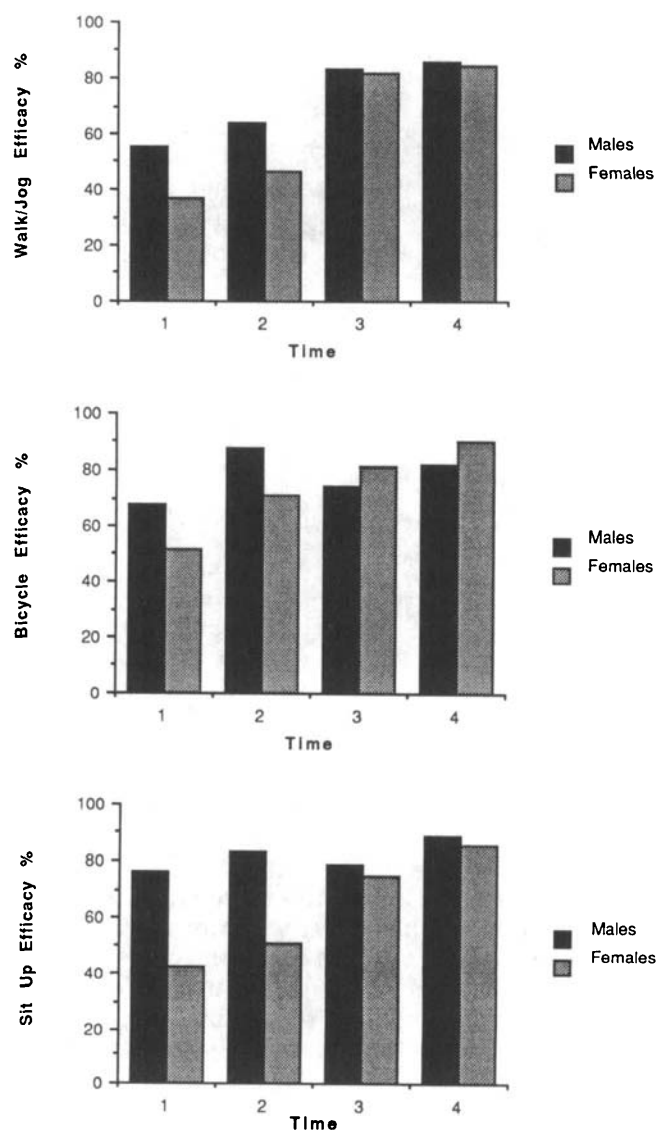


Figure 2. Changes in efficacy perceptions for males and females from pre- to post-graded exercise testing before (Time 1 to Time 2) and after the 20-week exercise program (Time 3 to Time 4).

tional analyses were conducted. Efficacy variables assessed postbaseline GXT were correlated with the four variables assessed following the exercise program that were representative of physiological responses to exercise conditioning: resting heart rate, estimated VO_2max , time taken to 70% maximum heart rate, and number of sit-ups completed in 90 seconds. Self-efficacy assessed at the conclusion of the baseline GXT was employed rather than efficacy prior to the preprogram GXT because it represents a more stringent test of the predictive power of efficacy. That is, efficacy at baseline is likely to be both suppressed and inaccurate due to the subjects' lack of exercise experience. Therefore, the information processed as a function of their GXT represents a more realistic interpretation of their exercise capability.

Table 2 depicts the correlations between the four physiological variables and the measures of self-

Table 2. Relationships Between Preprogram Self-Efficacy and Physiological Responses to Exercise

Measure	Bicycle efficacy	Walk/jog efficacy	Sit-up efficacy
Total			
Resting heart rate	-.02	-.09	-.09
Estimated VO ₂ max	.14	.20**	.31***
Time to reach 70% maximum heart rate	.38****	.40****	.50****
Sit-up repetitions	.21**	.10	.29***
Males			
Resting heart rate	-.38**	-.23*	-.19
Estimated VO ₂ max	.39**	.17	.16
Time to reach 70% maximum heart rate	.25*	.36**	.35**
Sit-up repetitions	-.05	-.02	.19
Females			
Resting heart rate	.15	.01	-.01
Estimated VO ₂ max	-.03	.15	.31**
Time to reach 70% maximum heart rate	.19	.21*	.24*
Sit-up repetitions	.15	-.04	.10

* $p < .10$; ** $p < .05$; *** $p < .01$; **** $p < .0001$.

efficacy. Subjects with greater sit-up efficacy completed more sit-ups, had greater aerobic capacity (VO₂max), and took longer to reach 70% of maximum heart rate. More efficacious subjects with respect to walk/jogging had greater aerobic capacity and took longer to reach 70% of maximum heart rate, as did subjects with higher bicycle efficacy.

For females as a group, the more efficacious with respect to sit-ups had greater aerobic capacity and took longer to reach 70% of maximum heart rate ($p < .07$). Efficacious males with respect to all three modes of activity took longer to reach 70% of heart rate. Higher bicycle efficacy also led to greater aerobic capacity in this group.

Discussion

The primary purpose of the present study was to examine the effects of acute (GXT) and long-term (20-week aerobic exercise program) exercise on perceptions of exercise efficacy in sedentary, middle-aged adults. Secondary purposes included the examination of possible differing efficacy responses in males and females and the relationship between efficacy cognitions and physiological responses to exercise.

The primary results of interest in this study are the effects of acute and long-term exercise on exercise efficacy in males and females. Subjects as a group showed significant efficacy gains from pre- to post-baseline GXT. Such findings provide support for Bandura's (1977, 1986) contention that past mastery experiences serve to amplify future efficacy cognitions and suggest that acute bouts of exercise can have a significant impact on cognitions. Furthermore, the fact that walking/jogging efficacy increased following this initial acute bout of exercise involving bicycle ergometry supports the generality aspect of the theory, which posits that successful mastery experiences are related to perceptions of capabilities in similar domains of functioning (Bandura, 1977, 1986).

The pattern of efficacy beliefs throughout the 20-

week program is equally illuminating. Sit-up and walking/jogging efficacy significantly increased, as would be expected given the tenets of self-efficacy theory. Although perceived bicycle efficacy for the total sample remained essentially the same (see Figure 1), it declined for males, suggesting the generality effect of the exercise program in the maintenance of bicycle efficacy to differ between males and females. Graded exercise testing and sit-up assessment following the exercise program also resulted in significant increases in bicycling and sit-up efficacy, as one would expect; however, no similar increase emerged in walking/jogging efficacy. Again, theoretically one would not expect any increase in these specific cognitions following postprogram testing, but rather maintenance of perceptions of functioning.

Of additional interest was the testing of Bandura's (in press) assertion that males and females have differing perceptions of their physical capabilities, in spite of relatively little dissimilarity displayed in work output. As can be seen in Figure 2, females had significantly lower perceptions of their physical capabilities than did males prior to the exercise program. Although exercise testing produced increases in efficacy for female subjects, males increased their efficacy by approximately the same proportion. Of interest is that there was no significant difference between males and females on measures of aerobic capacity (e.g., VO₂max). However, males were generally in better physical shape (being leaner, able to perform more sit-ups, and taking longer to reach 70% predicted maximum heart rate). In view of the fact that VO₂max was estimated, this latter measure of physical fitness may be considered a more reliable measure of cardiovascular endurance. This suggests that an initial single bout of exercise, in and of itself, may not provide sufficient information to markedly reduce the differential in perceptions of capabilities. A recent report by Klesges et al. (1990) has also suggested that males are more likely to overestimate their activity participation than are females.

With respect to the effects of the exercise program, similar effects were evidenced. Strength of efficacy for males maintained a steady state for walking, but biking efficacy declined. However, females continued to demonstrate a linear increase in efficacy perceptions from beginning to end of the program and continued to become more efficacious following postprogram physiological testing (see Figure 1). The length of the program, coupled with constant interactions among subjects and exercise leaders, provided an environment rich in feedback regarding personal progress. This feedback served as perhaps more reliable information upon which to base efficacy perceptions than a singular bout of activity. Often males and females hold preconceptions of their abilities (in this case, physical) based on a multitude of diverse factors and experiences that may or may not be accurate. Such differences may be due to past experiences as a product of different cultural socialization of males and females. However, as males could perform more sit-ups,

were leaner, and took longer to reach the predetermined heart rate associated with termination of the submaximal test, the differences in preprogram self-efficacy in all likelihood were due to physiological influences.

Future research designed to enhance efficacy perceptions with respect to exercise might focus on a variety of methods for assessing exercise progress. Indices of cardiac functioning (resting, exercise, and recovery heart rate), ease of respiration during activity, perceptions of exertion, and affective responses during exercise are all possible measures of mastery and efficacy information that may well be more indicative of personal progress than simply recording duration or distance of activity.

As expected, significant improvement in physiological functioning occurred during the 20-week exercise program. Although not the primary thrust of this particular report, these results do support other reports of similar change (e.g., Blumenthal et al., 1989; King et al., 1989) and are therefore briefly presented. As a group, subjects reduced resting heart rate and increased aerobic capacity. Vascular (blood pressure) changes were also noted, but these may be simply a reactivity artifact of the situation. Considerable gains were made in abdominal strength, and, although not as pronounced, there were significant reductions in other cardiovascular risk factors (e.g., body fat, weight, total cholesterol). However, such changes cannot be definitively attributed to exercise participation. At most, exercise could be causing these changes; at least, exercise may be affecting such change indirectly by promoting other health behaviors (e.g., dietary change). Nevertheless, such results, in total, are encouraging and represent confirmatory evidence to suggest that sedentary individuals in their middle years of adulthood can make significant health-related gains through a relatively low-impact activity such as walking.

The exploratory analyses examining the relationships among efficacy expectations formed prior to the exercise program and physiological responses to the exercise program revealed some moderate relationships that deserve further examination under more stringent experimental conditions. A few significant correlations suggest that there is a relationship between aspects of exercise efficacy and such variables as abdominal strength, aerobic capacity, and time taken to reach termination point in a submaximal graded exercise test. These relationships tended to be attenuated when considered within males and females. Clearly, it is difficult to make any definitive statements about the relationships between self-efficacy and physiological responses to exercise at this point. Further research is necessary to determine whether such relationships are direct or are mediated, as suggested elsewhere (McAuley, in press-b), by other behavioral factors.

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