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BEHAVIORAL MANAGEMENT OF EXERCISE TRAINING IN VASCULAR HEADACHE PATIENTS: AN INVESTIGATION OF EXERCISE ADHERENCE AND HEADACHE ACTIVITY

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A behavioral package was used to shape and maintain the adherence of 5 subjects with vascular headache to a program of aerobic exercise training. Repeated measures of exercise behavior were examined through the use of a bidirectional changing criterion design. Repeated measures of headache activity were also collected. Results demonstrated a functional relationship between the behavioral package and exercise adherence, because all 5 subjects showed exercise behavior that matched bidirectional changing exercise criteria. The results also indicated clinically significant collateral reductions in vascular headache activity in 4 subjects. Subjects whose aerobic fitness levels were not masked by vasoactive medication also showed measurable increases in aerobic fitness. The results are discussed in terms of the methodology used to demonstrate a functional relationship between the adherence package and exercise behavior and the possible mechanism(s) by which aerobic exercise activity might affect vascular headache activity.

DESCRIPTORS: behavioral management, exercise adherence, aerobic exercise, Cooper Points, changing criterion design, headache

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Aerobic exercise training has been shown to be effective in the treatment of an array of disorders including coronary artery disease (e.g., Clausen, 1976), borderline hypertension (Martin & Dubbert, 1985b), obesity (Epstein & Wing, 1980), anxiety disorders, and depression (Goldwater & Collis, 1985). A number of physiological and psychological benefits have been associated with aerobic exercise training including peripheral vasodilation both during and for extended periods after exercise (Dowell, 1983; Guyton, Jones, & Coleman, 1973), increased collateral vascularization, improved efficiency of peripheral blood distribution and return (Clausen, 1976), and improved adaptation to physical and psychosocial stress as shown by changes in physiological, biochemical, and subjective measures (Sinyor, Schwartz, Peronnet, Brisson, & Seraganian, 1983). Because of its association with vascular changes and sympathetic arousal reduction, aerobic exercise training may be an efficacious treatment for vascular headache—a stress-related disorder (Holroyd, 1986) that appears to involve lability or disregulation of the cerebral vasculature (Friedman, 1978; Moskowitz, 1984).

A necessary condition for evaluating the effect of aerobic exercise on vascular headache activity is

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obtaining adherence to the aerobic exercise protocol (Haynes, 1984). This presents a particular challenge to efficacy research involving aerobic exercise because, in spite of known physiological and psychological benefits, high nonadherence and dropout rates are often observed in aerobic exercise programs (Dishman, 1982; Martin & Dubbert, 1982a, 1982b, 1985a). Those attempting to establish an exercise program often find that the high response requirements and short-term aversive consequences of exercise exert more functional control over exercise behavior than do the more temporally removed reinforcing consequences (Wysocki, Hall, Iwata, & Riordan, 1979). With headache sufferers, attaining adherence to a program of aerobic exercise may be especially difficult because headache activity may serve as an additional deterrent to consistent exercise.

Experimental evaluation of the efficacy of aerobic exercise as a treatment for vascular headache requires powerful intervention strategies to ensure that aerobic exercise is reliably performed. Successful adherence interventions often have been "packages" comprised of several components such as contracting (Wysocki et al., 1979), lottery procedures (Epstein, Thompson, Wing, & Griffin, 1980), praise, and flexible goal setting (Martin et al., 1984).

The primary purpose of the present study was to examine the efficacy of a behavioral adherence package for modifying aerobic exercise behavior in vascular headache sufferers. In addition to demonstrating a functional relationship between the adherence package and exercise behavior in these subjects, repeated measures of vascular headache activity were examined to identify possible collateral reductions in vascular headache activity associated with aerobic exercise.

METHOD

Subjects

Volunteer subjects, recruited through local public service announcements and physician referrals, were required to have medical clearance and be under the care of a physician. A structured interview and screening procedure with the following inclusion and exclusion criteria were used to select subjects.

Inclusion criteria. Subjects were required to report a minimum frequency of one headache per month and minimum 1-year history of the disorder, carry a physician's diagnosis of vascular headache, and meet at least four of the following vascular headache criteria: predominantly unilateral pain, headache frequently accompanied by nausea, positive family history of vascular headache, photophobia, positive response to ergotamine tartrate for headache pain relief, and pulsatile pain. Subjects were required to make a $100 refundable deposit as part of a behavioral contract and to have a significant other agree to serve as a reliability observer and mediator of social reinforcement.

Exclusion criteria. As a health precaution, subjects were screened for health risk factors (e.g., hypertension) by the PAR-Q+ (Martin & Dubbert, 1987)—a modification of the Physical Activity Readiness Questionnaire (PAR-Q; DNHW, 1978)—and by interview and blood pressure assessment. Those with risk factors were required to attain approval to participate from their physicians. In order to control other sources of variability, subjects were also excluded on the basis of the following: evidence of a possible neurological disorder (e.g., recent change in headache symptoms), history of a major psychiatric disorder, evidence of psychopathology, current use of relaxation procedures, pregnancy, and history of consistent aerobic exercise or current involvement in an aerobic exercise program. Retrospective exercise histories provided by each subject and a significant other indicated that none had been successful in establishing aerobic exercise during the past year prior to the study. Subjects were not required to discontinue routine medication but were required to maintain constant dosages through the study. Five female subjects were selected.

Headache history and medication use. Ann, age 38, reported vascular headache onset at age 13. Ann took 60 mg propranolol daily for prophylaxis of headache, ergotamine tartrate to abort them, and acetaminophen or Fiorniol for analgesia.

Beth, age 36, estimated having had vascular headaches since her early 20s. Beth took one Limbitrol #10-25 daily for prophylaxis of headache, aspirin, ibuprofen, or acetaminophen for low to moderate headache pain, and Synalgos DC for severe headache pain. Cathy, age 56, started having vascular headaches at age 16. Cathy took 120 mg propranolol for prophylaxis of headache and acetaminophen for analgesia. Denise, age 38, reported vascular headache onset at age 10. She took no prophylactic medication for headache but used aspirin or ibuprofen for headache analgesia. Eileen, age 33, started having vascular headaches at age 24. She also reported having occasional discrete and discriminable muscle contraction headaches. Eileen took 60 mg propranolol daily for vascular headache prophylaxis, ergotamine tartrate for vascular headache abortion, and Synalgos DC or Esgic for analgesia. All subjects reported having vascular headaches that were incapacitating at times and indicated that headache activity significantly interfered with their daily living.

Setting and Equipment

Exercise was performed in a range of settings including an exercise room, a jogging course, and the subjects' homes. Equipment included Ross stationary exercise cycles and Tunturi stationary cycle ergometers for on-site aerobic exercise and fitness assessments, an Amerec 130 electronic pulsemeter to measure exercise intensity and assess aerobic fitness, and Accusplit digital pedometers to record walking and jogging distances.

Measurements

The primary dependent variable in the study was aerobic exercise behavior. Collateral measures included headache activity and aerobic fitness. Exercise was self-recorded repeatedly throughout the study and reported for each exercise occasion. Headache measures were self-recorded four times daily and reported weekly. Aerobic fitness was assessed during baseline, at mid- and posttraining, and at 3-month follow-up.

Exercise adherence. Aerobic exercise behavior was calculated in terms of Cooper Points (Cooper, 1977) as was done in other exercise adherence studies (e.g., Dubbert et al., 1984; Epstein et al., 1980; Keefe & Blumenthal, 1980; Wysocki et al., 1979). A Cooper Point is a standardized measure of the amount of aerobic benefit derived from different exercise topographies, intensities, and durations.

A gradual increase in measured exercise behavior, however, does not necessarily indicate a gradual increase in adherence, because exercise programs start with a low exercise criterion that gradually increases. Exercise adherence, therefore, was measured by comparing the number of Cooper Points earned against a criterion that was changed throughout the exercise program. Cooper (1977) suggests a weekly minimum of 24 Cooper Points for women to achieve and maintain a good level of aerobic fitness. Therefore, the maximum criterion in our program was eight Cooper Points per session or 24 per week. Eight Cooper Points is equivalent to running 1.5 miles in 10 to 12 min.

Headache measures. Using a six-point Likert scale that has been socially validated and frequently used in headache treatment outcome studies (Blanchard & Andrasik, 1985; Epstein & Abel, 1977), subjects rated headache intensity four times daily. From these ratings the following data were derived for each subject: average weekly headache rating (calculated by dividing the sum of each week's headache ratings by 28, the total number of observations per week), highest headache rating per week, and number of headache-free days per week. Subjects also recorded headache-related medication use, number of physician's office visits, and number of days of worked missed.

Aerobic fitness. Subjects completed a submaximal aerobic fitness assessment at pre-, mid-, and posttraining and at 3-month follow-up by use of a bicycle ergometer according to the Astrand protocol (Astrand, 1960). However, 3 subjects (Ann, Cathy, and Eileen) were taking a beta-adrenergic blocking agent (viz., propranolol) for vascular headaches. Although beta blockers do not appear to attenuate exercise-induced aerobic fitness improvements (Ewy et al., 1983; Wilmore et al., 1983), their inhibition of sympathetic stimulation of heart rate such as that induced by exercise would confound the results of aerobic fitness assessments based on heart rate (Bove, 1983). Thus, aerobic fitness measures for 3 of the 5 subjects were of questionable validity.

Procedure

Baseline. During the first baseline session, subjects received a description of the study, provided informed consent, and were trained to record aerobic exercise and headache activity. Significant others were trained to record exercise behavior for reliability purposes. Subjects completed their first aerobic fitness test during the last week of baseline. Using a baseline procedure from Wysocki et al. (1979), subjects were informed that for an unspecified period, they would be given the opportunity to explore different forms of aerobic exercise before participating in the formal exercise program. This baseline procedure permitted the measurement of exercise behavior that occurred when the exercise equipment and facility were made available to the subjects. They were told that they may be asked at any time to begin the program involving a package for promoting exercise adherence. The investigators were present to observe and record exercise behavior. Baseline lasted for 3 to 6 weeks, because some subjects started baseline recording while others were screened for the study.

Aerobic training. During the first session of each week, each subject was given a personalized exercise prescription based on age and exercise preference. Subjects attended one weekly on-site exercise session and were instructed to train at home using jogging, walking, or aerobically comparable levels of other exercise for their second and third sessions each week.

The exercise program included a behavioral adherence package with the following components: instructions, modeling, behavioral contracting, goal setting, stimulus control, performance feedback and praise, shaping, and verbal strategies (cf. Martin & Dubbert, 1984). Instruction and modeling were combined to explain and demonstrate aerobic training procedures. Behavioral contracts specified contingencies for exercise adherence and nonadherence. At the beginning of training, each subject made a $100 deposit that was refunded in $5 payments on each occasion in which she adhered to the exercise criterion. If a subject missed a scheduled session, she was given an opportunity to make it up the next day, in which case she received $3 for exercising to criterion. If a subject exercised below *or above* criterion during a scheduled or make-up session, she forfeited her refund payment. Additionally, subjects whose adherence produced a minimum of $85 refund were allowed to keep the pedometer issued to them and were offered free, alternative headache treatment (relaxation training) at the end of the 3-month follow-up assessment.

Cooper's exercise program served as a guideline for setting individualized goals for each subject. Subjects chose from stationary cycling, walking, and jogging for their preferred exercise topographies. Goals were initially low and found to be well within the exercise tolerance of each subject. Each subject's goal was increased only when her exercise consistently met criterion. Consistency was defined as when at least the last three data points did not vary more than 20% from criterion and visual inspection of the data indicated no trend.

Subjects and significant others were also trained in stimulus control procedures. For example, subjects were instructed to lay out exercise clothes the night prior to exercise to provide antecedent stimuli for exercise, and significant others were trained to prompt home exercise. In addition, telephone prompts were given to each subject on an average of once every 1 to 2 weeks during the first 4 weeks of the 12-week program and were faded to about once every 4 to 6 weeks as home exercise adherence was demonstrated.

Contingent personalized feedback and praise were given while subjects exercised during on-site sessions. Exercise performance was recorded and publicly displayed at these sessions. Feedback and praise were also given for fitness improvements. Additionally, each significant other was telephoned periodically to assess and reinforce compliance with procedures for monitoring and reinforcing the subject's exercise behavior.

Finally, subjects were instructed to use cognitive (i.e., covert verbal) strategies to facilitate exercise by attending to environmental and other pleasant stimuli rather than to aversive stimuli that may accompany exercise. They were instructed to recognize and replace self-defeating thoughts with positive, coping-oriented or externally focused, distracting self-verbalizations. They were asked to identify their strategies and were praised for reports that they had used them.

Maintenance. During the aerobic training phase, exercise maintenance was programmed by preparing subjects against exercise relapses (Marlatt & Gordon, 1980). Most exercise relapses result from exercising too intensely, resulting in immediate, aversive consequences (e.g., soreness) (Martin & Dubbert, 1987). Such relapses were minimized by the contingencies for adherence to gradually increasing exercise criteria. Subjects were also provided with a programmed lapse in and recovery of exercise under controlled conditions (King & Frederiksen, 1984; Martin et al., 1984). Near midtraining, each subject was given an exercise criterion of noticeably lower intensity and duration than that of the previous week. The criterion was then increased for exercise recovery. Adherence to the programmed lapse and recovery was promoted through continued management of the contingencies in the contract, instructions in the rationale and procedures for relapse inoculation training, increased density of social reinforcement, and a handout of strategies for recovering from lapses in exercise.

In addition, maintenance was programmed by requiring home exercise early in the program and by fading instructions, modeling, and prompting. Contingent praise was also given on a gradually leaner schedule of reinforcement. Significant others were instructed to do likewise.

Posttraining. Immediately following the completion of the program, each subject completed an aerobic fitness assessment and a questionnaire assessing headache activity. Each significant other completed questionnaires designed to socially validate the clinical significance of the program's efficacy on vascular headache activity. To determine how well posttraining exercise would be maintained in the absence of supporting contingencies from the program, no posttraining contingencies were mediated for exercise maintenance, except for requiring a fitness assessment at the 3-month follow-up. At 3 and 6 months posttraining, subjects provided 1 week of self-report data on daily exercise behavior and headache ratings. Subjects also completed questionnaires assessing their exercise behavior and headache activity during the 3- and 6-month interims. In addition, a fitness assessment was conducted at the 3-month follow-up. Each significant other verified the subject's report of posttraining exercise. To increase the probability that the 3-month follow-up data would be collected, subjects were told they would be provided brief stress management and relaxation training contingent upon completion of the 3-month follow-up assessment.

Experimental Design

A changing criterion design (Hall & Fox, 1977; Hartmann & Hall, 1976; Kazdin, 1982) replicated across 5 subjects was used to assess the functional relationship between the behavioral package and aerobic exercise behavior. Bidirectional changes in the exercise criterion were introduced during relapse inoculation training when the direction of the criterion change was temporarily reversed for each subject.

Reliability. Interobserver agreement between independently collected exercise data from the subject and one of the investigators was calculated on 100% of the on-site exercise sessions and approximately 8% of the home exercise sessions. Percentage of interobserver agreement was calculated by dividing the smaller number of Cooper Points recorded by the larger number for each observation, and multiplying by 100 (Wysocki et al., 1979). Agreement was 100% for all sessions.

In addition, each significant other observed and recorded exercise for approximately 15% of the subject's home sessions randomly selected from approximately each month of the study. (Denise's significant other reported reliability data for only 8% of her data.) Reliability was calculated for the occurrence and nonoccurrence of home exercise on a day-by-day basis by dividing the number of agreements by the number of agreements and disagree-

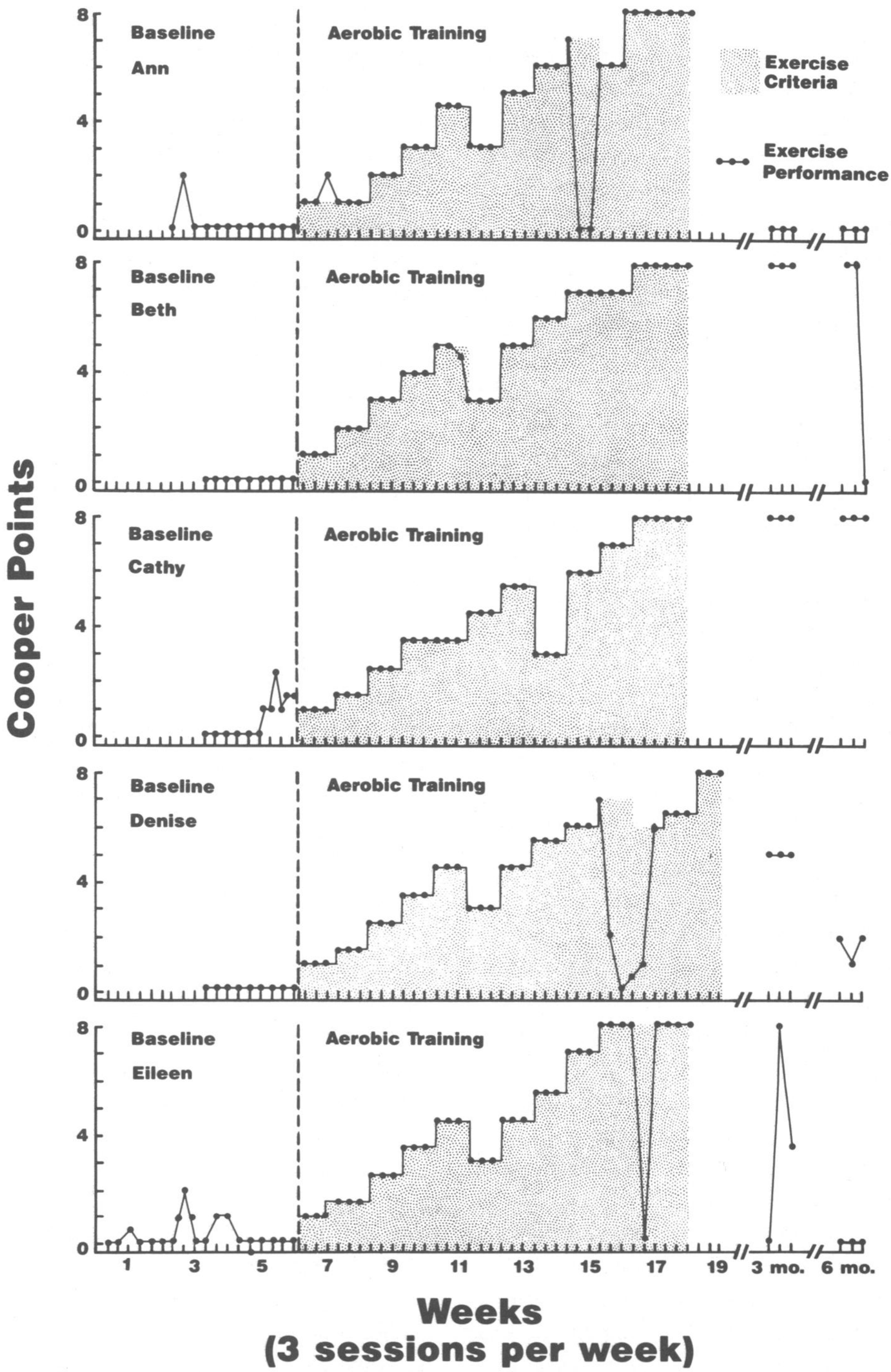

Figure 1. Aerobic exercise performance (Cooper Points; Cooper, 1977) of each subject during baseline, aerobic training, and 3- and 6-month follow-ups. During aerobic training, each subject's aerobic exercise performance (points connected by solid lines) was compared to exercise performance criteria (heights of shaded area) that were systematically changed throughout the program.

ments and multiplying by 100 (Hawkins & Dotson, 1975). An agreement on occurrence was scored when both subject and significant other reported that aerobic exercise was performed. Average percentage of agreement for all subjects on the occurrence of aerobic exercise was 74% (range, 33% to 100%); average percentage of agreement on nonoccurrence was 93% (range, 88% to 100%).

RESULTS

Exercise Adherence

A functional relationship between the behavioral adherence package and aerobic exercise behavior was established for all 5 subjects. They increased exercise from a weekly average of 0.8 Cooper Points during baseline to a weekly average of 23.6 Cooper Points (7.9 per session) during the last 2 weeks of training. This compared favorably to the weekly criterion of 24 (8 per session) recommended by Cooper (1977). They continued exercising at weekly averages of 14.9 Cooper Points (range, 0 to 24) at 3 months posttraining and 9.0 Cooper Points (range, 0 to 24) at 6 months posttraining.

Figure 1 depicts each subject's aerobic exercise behavior during baseline, aerobic training, and 3- and 6-month follow-up assessments. During baseline, each subject exhibited no or low, sporadic levels of aerobic exercise. During aerobic training, the functional relationship between the adherence package and aerobic exercise was evident; with a few exceptions largely attributable to illnesses (i.e., Ann in Week 15, Denise in Week 16), exercise behavior matched each criterion regardless of the direction, magnitude, or duration of the criterion change.

Four subjects reported that they maintained aerobic exercise at 3-month follow-up and 3 reported continued exercising at 6-month follow-up. By 3-month follow-up, Ann and her husband reported that she had stopped her posttraining exercise in response to developing painful hemorrhoids (verified by her physician). No reason was given for Eileen's failure to maintain her exercise at the 6-month follow-up. The other 3 subjects and their significant others reported that they continued exercising at weekly averages of 6 to 24 points at 3- and 6-month follow-ups.

Vascular Headache Activity

Table 1 summarizes vascular headache activity for each subject during baseline, end of training, and at 3- and 6-month follow-ups. In general, all subjects except Eileen reported collateral decreases in vascular headache activity (decreases in mean headache index and increases in mean number of headache-free days) associated with increased aerobic exercise. Additionally, for the first time since the beginning of baseline, several subjects reported full weeks without a headache (Ann, Weeks 13 and 17; Beth, Week 17; and Denise, Weeks 13 through 19). Eileen, whose headaches were unresponsive to exercise, reported one headache-free week during baseline.

An evaluation of each subject's self-reported daily medication use indicated no changes in routine medications. Also, no evidence of analgesic or ergotamine abuse was found, except perhaps for Beth, whose average of two Synalgos DC per day extended from baseline into Week 13. From Week 14 through the end of training, her use of Synalgos dropped to an average of one every 2.4 days. All 4 subjects who reported headache reductions during training (including Beth) also reported corresponding reductions in use of abortive or analgesic medications. Eileen continued to report similar use patterns of abortive and analgesic medications.

An interesting reversal in headache trend was observed with Ann's posttraining exercise relapse. At the end of training, Ann reported that she was virtually headache-free. However, in addition to reporting a total posttraining exercise relapse, Ann reported that her headache activity was returning to pretraining levels (see Table 1). The other 3 subjects who reported headache relief (Beth, Cathy, and Denise) continued reporting headache reductions at both follow-ups that were associated with continued posttraining aerobic exercise.

End of training headache indexes for the 4 subjects who reported headache relief decreased 44% to 100% from baseline averages—a magnitude

Table 1
Weekly Headache Activity (HA) during Baseline (BL), End of Training (ET),[a] 3-Month Follow-up (3F), and 6-Month Follow-up (6F)

	Mean HA index				Mean highest HA rating				Mean number HA-free days			
Subject	BL	ET	3F	6F	BL	ET	3F	6F	BL	ET	3F	6F
Ann	0.60	0.13	0.36	0.29	3.8	1.5	4	4	3.5	6.3	4	5
Beth	0.77	0.02	0.11	0	3.3	1.5	3	0	1.8	6.5	6	7
Cathy	1.14	0.64	0.29	0	2.3	2.5	1	0	0.7	4	5	7
Denise	0.62	0	0	0	4	0	0	0	4	7	7	7
Eileen[b]	1.07	0.98	1.32	0.68	3	4.5	5	4	2.6	4	3	5

[a] Last 2 weeks of training.
[b] Data were missing during Week 2 of Eileen's 6-week baseline.

considered clinically significant (Blanchard & Andrasik, 1985). The clinical significance of these headache reductions was also socially validated by significant others (Blanchard, Andrasik, Neff, Jurish, & O'Keefe, 1981; Kazdin, 1977) who, at posttraining and both follow-up assessments, reported noticeable decreases in headache-related behaviors (e.g., verbal report, analgesic use). In addition, all significant others reported other changes in subjects (e.g., improved mood, activity level) that they attributed to aerobic exercise.

Aerobic Fitness

Aerobic fitness measures were valid for Beth and Denise, who were the only 2 subjects not on beta blockade medication. Beth's baseline fitness assessment produced a Condition Index (Astrand, 1960) of 25 (*below* the "very poor" fitness category). Her Condition Index improved to 28 ("poor" fitness) by Week 12 and to 44 ("good" fitness) at posttraining. At 3-month follow-up, it dropped to 32 ("poor" fitness). It should be noted here that aerobic fitness is highly dependent upon the exercise modality by which it is modified and evaluated (McArdle, Katch, & Katch, 1981). Thus, it is not surprising that Beth's fitness level decreased slightly, because her posttraining exercise (aerobic dance) was topographically different than her training exercise and the exercise by which her fitness was assessed (cycling). Denise's baseline fitness assessment produced a Condition Index of 20 (*below* the "very poor" fitness category). At Week 12, her Condition Index improved to 32 ("poor" fitness). At posttraining, she maintained this index. At 3-month follow-up, it improved further to 38 ("average" fitness).

DISCUSSION

These results indicate that the behavioral adherence package was effective in the modification of aerobic exercise in all 5 subjects. Perhaps the most powerful demonstration of this functional relationship was provided by introducing bidirectional changes into the changing criterion design (Hartmann & Hall, 1976; Kazdin, 1982). With few exceptions, each subject exercised at levels that matched the criterion, whether it was increased or decreased, leaving little ambiguity about the impact of the intervention (Kazdin, 1982). Further, matching of exercise to criterion occurred regardless of how long a given criterion was maintained or how much of an increase over previous exercise requirements the criterion represented.

Given the poor exercise adherence rates found among nonchronic pain populations who begin an exercise program, the efficacy of the adherence package with headache sufferers in this study is particularly noteworthy. Initially, headache activity appeared to serve as an additional deterrent to exercise adherence. Subjects reported at times early in the program that they had a headache during exercise sessions. In fact, Cathy and Eileen reported increases in headache activity early in the program. Further, in spite of continued headache pain, Eileen continued to adhere to increasing exercise criteria throughout the program. Such observations suggest that the adherence package was particularly effective in overcoming this as well as other exercise deterrents. Later in training, headache reduction may have been instrumental in exercise maintenance for 4 subjects, as indicated by their exercise and headache data as well as by their attributions of headache relief to aerobic exercise (reported via posttraining consumer satisfaction assessment).

A combination of factors promotes confidence in the reliability and validity of the self-reported exercise data. First, acceptable levels of interobserver agreement were obtained between self-recorded data and both investigator observation during all scheduled and several home exercise sessions and the reports of significant others on home exercise behavior. Further, aerobic fitness measures for the 2 subjects who were free of vasoactive medication showed clear improvements, thus indicating that actual aerobic exercise had occurred. Although fitness data for the other 3 subjects were confounded by vasoactive medication, they were observed to tolerate exercise at relatively demanding intensities and durations, an achievement that suggests they were also exercising during the prescribed home exercise sessions.

This experimental analysis extends our knowledge of exercise promotion and vascular headaches in several important ways. First, a rigorous experimental design was used in which bidirectional criterion changes allowed a convincing demonstration of functional control over exercise for the first time. Second, the behavioral package was unique in its combination of the components of contracting, clinic and home sessions, relapse inoculation training, performance feedback and praise, cognitive strategies such as distraction, and use of significant others as mediators of social reinforcement. However, despite the documented efficacy of this treatment package, additional studies are warranted. For example, it is critical that a component analysis, with appropriate sample size and methodology, be conducted to identify the relative contribution that each component makes toward modifying exercise behavior (Martin & Dubbert, 1982b). Third, this study represents the first time that an adherence package has been applied to the exercise behavior of vascular headache sufferers, thus providing initial data on ways in which aerobic exercise may benefit this clinical population. Four of the subjects, who reported long histories of vascular headache that were generally unresponsive to other treatments, reported clinically significant headache reductions only after participating in the aerobic exercise program.

Exercise-mediated cardiovascular changes and/or stress modulation may have accounted for the reported headache relief. Still, other possible mechanisms must be considered. For example, it is possible that the subjects, in response to demand characteristics, were biased toward reporting headache improvements. This, however, appears untenable in view of the fact that they continued reporting headache activity during the early part of training at levels that were comparable, and in some cases, higher than baseline levels. In fact, Eileen continued to report no headache improvement throughout the program. Furthermore, reported headache activity from the other 4 subjects began to decrease only during the latter part of the program, coinciding with the approximate time one would expect to begin observing specific aerobic training effects.

Medication-related phenomena, such as paradoxical headache associated with analgesic abuse (Isler, 1982; Kudrow, 1982) or medication rebound headache associated with ergotamine tartrate abuse (Saper & Jones, 1986) can significantly confound headache data (Holroyd, Holm, & Penzien, in press). However, subjects' self-records of medication use revealed no medication abuse, except for Beth's overuse of analgesics. Furthermore, a close inspection of Beth's daily headache and medication data indicated that reduction in headache activity was not preceded by reduced analgesic use, suggesting that decreased analgesic use was a function of decreased headache activity rather than vice versa.

Although the data appear to relate headache improvement to the specific cardiovascular and/or stress modulating effects of aerobic exercise training, future studies are needed to replicate the functional relationships between aerobic exercise programs and vascular headache activity, as well as to identify the precise mechanisms by which exercise adherence results in collateral decreases in vascular headache activity. For example, nonspecific effects such as a placebo effect or a compliance effect (Epstein, 1984) could singly or in combination contribute to headache changes. To examine specific versus nonspecific effects of aerobic exercise on vascular headache activity, a future study might employ a beween-group design in which one group receives aerobic exercise training with the adherence package while a control group receives nonaerobic exercise training (e.g., stretching) with the same adherence package (see Martin, Dubbert, & Cushman, 1986). Further, studies that focus on more detailed and comprehensive discriminations among headache and subject variables might explain why a subject like Eileen, in contrast to the others, did not report headache relief.

In summary, this study has shown the efficacy of a unique behavioral package to produce adherence to an activity (viz., aerobic exercise) shown to have a wide range of therapeutic benefits, but noted for high nonadherence and dropout rates. As such, it represents an important extension of recent experimental studies on modifying exercise adherence (e.g., Epstein et al., 1980; Martin et al., 1984; Wysocki et al., 1979). Additionally, social validity data (consumer satisfaction reports from both subjects and significant others) suggested that the intervention package was perceived as being practical and effective in producing significant changes in both exercise behavior and headache activity. Finally, although additional studies are needed to assess the reliability and generality of these findings, we believe this study provides a sufficient basis for future exploration of aerobic exercise training as an alternative (or adjunctive) nonpharmacological treatment for vascular headache.

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