# Stress Management in Highway Maintenance Workers

Lawrence R. Murphy, Ph.D.

*The efficacy of a work-based stress management training program was assessed in highway maintenance workers. Volunteers received training in electromyogram (EMG) biofeedback (n = 17) or muscle relaxation (n = 12) or served as wait-list controls (n = 9). Daily one-hour training sessions were conducted at the workplace for two consecutive workweeks. The biofeedback group showed significant posttraining decreases in forehead EMG levels compared with controls, while decreases found in the muscle relaxation group were not significant. All groups reported significant increases in quality of sleep and in feeling refreshed at work and decreases in subjective tension levels. A three-month follow-up study revealed regression of EMG levels toward baseline in all groups although the percentages of EMG reductions at follow-up were larger for the trained groups than for controls. All groups showed significant improvement on measures of anxiety, somatic complaints, sleep behavior, job satisfaction, and alcohol use. The results support other recent studies indicating the usefulness of work-site stress management programs, although the specificity of training effects and the durability of physiological effects over time remain questionable.*

While a number of studies have identified job demands and work environment factors that are associated with worker health consequences,[1-4] only a few have evaluated strategies for helping workers cope with stress and alleviate physiological and psychological symptoms of stress. In this regard, Peters et al[5,6] found significant decreases in systolic and diastolic blood pressure in office workers who were taught a meditation/relaxation technique[7] for creating a relaxation response. Other benefits reported by participants included reduced symptom activity and improvements in work performance, mood state, and satisfaction.

Manuso (cited in Schwartz)[8] found that muscle tension levels, clinic visits, stress symptoms, and symptom-induced interference with work were reduced in workers with chronic anxiety or recurring headaches after combined training in biofeedback, muscle relaxation, breathing exercises, and imagery. Also, Carrington et al[9] demonstrated that telephone company employees who learned clinically standardized meditation or Benson's relaxation response[7] at home reported dramatic reductions in psychological and somatic symptoms at approximately six months after training.

In 1978, the National Institute for Occupational Safety and Health (NIOSH) initiated a research program to evaluate the efficacy of work-based stress management training programs. Biofeedback and muscle relaxation methods were selected for initial study. Biofeedback has been used successfully in helping individuals control heart rate, muscle tension levels, blood pressure, skin temperature, and stomach activity[10] and has provided relief to patients with hypertension, migraine and tension headaches, asthma, chronic anxiety, and Raynaud's disease.[11] Muscle relaxation methods have demonstrated effectiveness in reducing general anxiety, insomnia, hypertension, asthma, tension headaches, and public-speaking anxiety.[12] Although these methods are effective modifiers of psychophysiological functions, particularly those related to stress, their utility outside clinical or laboratory settings remains to be determined.

The traditional clinical formats were modified to make the programs more attractive to employees and cost-effective to organizations. These modifications included a training *v* treatment orientation, a daily *v* weekly training schedule abbreviated from 12 or more sessions to six sessions, and the use of the work-site *v* clinical setting to conduct training.[13]

In the first NIOSH study,[14] hospital nurses trained in biofeedback or muscle relaxation showed significant benefits on physiological and self-report measures taken during, and immediately following, the training program. The muscle relaxation group showed the largest reduction in forehead muscle tension levels, along with improvements in the ability to cope with stress and decreases in the fre-

From the Applied Psychology and Ergonomics Branch, Division of Biomedical and Behavioral Science, National Institute for Occupational Safety and Health, 4676 Columbia Pkwy., Cincinnati, OH 45226.

Presented in part at the Third Annual Scientist/Practitioner Conference on Stress and Safety, Old Dominion University, Virginia Beach, Va., October, 1982.

quency of headaches. The biofeedback group showed significant increases in hand temperature, amount of work energy, and perceived effectiveness of stress coping when used at work. Both training groups and a self-relaxation comparison group reported significant improvements in sleep behavior and decreases in trait anxiety.

The purpose of the present study was to replicate and extend the findings of the first study in a blue-collar work group. In cooperation with the Public Employees Assistance Program, the Highway Maintenance Division, Department of Public Works, City of Cincinnati, agreed to participate in the study. The Division provided a quiet room in which to conduct the study and permitted all volunteering employees to participate during normal working hours without loss of pay. The study was in operation over the 13-month period from August, 1981, to September, 1982.

It was hypothesized that biofeedback and muscle relaxation groups would show greater reductions in physiological arousal levels and more pronounced improvements on self-report indices of well-being than did controls and that these benefits would be evident at a follow-up evaluation conducted three months after training.

## Method

Sixty-eight workers volunteered to participate in the study and underwent a prestudy physical examination. Sixteen volunteers were excluded from the study because they were taking antihypertensive medication or had blood pressures in excess of 150/90 mm Hg. Of the remaining 52 volunteers who were randomly assigned to training or control groups, 14 either did not appear at their scheduled time ($n = 9$) or did not complete all training days ($n = 5$). Final group sizes were as follows: electromyogram (EMG) biofeedback, 17; muscle relaxation, 12; and wait-list controls, nine.

**Groups** — EMG biofeedback subjects received continuous feedback of forehead muscle tension levels in the form of a tone whose pitch rose as muscle activity increased and fell as muscle activity decreased. Subjects were instructed to notice how the pitch of the tone changed in response to various thoughts, images, and feelings and to concentrate on developing a strategy for reducing the tone as much as possible. A shaping procedure was used wherein the sensitivity of the feedback was adjusted as subjects became proficient at reducing the tone. At the start of each session, the sensitivity was set so that a 25% reduction in forehead EMG was required for the tone to disappear entirely. At five-minute intervals during the session, the experimenter checked the state of the tone and, if it had disappeared, increased the sensitivity, thus requiring participants to do progressively better.

Muscle relaxation subjects listened to a series of cassette tapes[15] that instructed them to alternatively tense then relax major muscle groups while attending closely to sensations of tenseness and relaxation in the muscles. As training progressed, the exercises were abbreviated to a point where workers would merely repeat a cue word like "relax" with each exhalation to create a state of muscle relaxation. The cassette tape series also contained autogenic phrases to supplement the muscle relaxation exercises.

Both training groups were asked to practice the relaxation methods at home for 20 minutes between sessions and to use the methods during actual stressful situations at work and home. No feedback equipment or cassette tapes were provided to participants for home practice.

Participants in the wait-list control group were told that they would receive training later. This group met on days 1, 8, and 10, at which time questionnaire measures and physiological recordings were obtained. These subjects later were given the opportunity to learn either biofeedback or muscle relaxation training.

**Training Program** — Training sessions were conducted in groups of two to four workers that met for daily one-hour sessions during two consecutive workweeks. The program contained three phases: (1) baseline (days 1 and 2), training proper (days 3 through 8), and application practice (days 9 and 10). At baseline, participants were provided with stress educational information in the 20-minute period between presession and postsession physiological recordings. Topics addressed included sources of stress at work, stress/health relationships, degree of control over perceived stressors, and the potential value of relaxation training for gaining greater control over psychophysiological reactivity.

During the training phase, participants received instructions in their respective techniques for 20 minutes each day. On day 4 and following, participants were given performance feedback in the form of a graph charting presession and postsession EMG levels. In addition to having motivating properties, this feedback also served to help participants more accurately gauge depth of physiological relaxation and compare subjective impressions with the EMG results.

During the application practice phase, participants were asked to use what they had learned to become deeply relaxed during the session. No external aid in the form of cassette tapes or feed back equipment was provided to the subjects on these days.

The training format described here differed significantly from that described in a previous study,[14] in that stress education information was provided on both baseline days, daily performance feedback was provided, and the muscle relaxation exercises contained an autogenic component in addition to the tensing and relaxing exercises. Finally, a wait-list (no instructions) comparison group was used in this study, as opposed to a self-relaxation group, to provide a zero-point against which to compare the effects of relaxation training.

**Follow-up** — Three months after training, participants were scheduled for one session at the same time of the day as during training. The instructions and procedures for the follow-up session were identical to those on days 9 and 10 of training. Presession and postsession physiological recordings were obtained as described earlier.

**Outcome Measures** — *1. Forehead EMG and Hand Temperature* — On each of the 10 program days, recordings of forehead EMG and hand temperature were taken after a 10-minute rest period at the start and again at the end of the session. Forehead EMG was recorded using disposable electrode strips that contained a ground electrode flanked by active electrodes. The distance between electrodes was 3 mm and the entire strip was centered directly above the nasion. Hand temperature was recorded with a Cyborg thermal probe taped to the center of the back of the hand. This placement did not restrict subject movement during the training exercises but represents a more conservative estimate of hand temperature changes relative to a fingertip placement.

Both physiological measures were monitored continuously during four consecutive one-minute trials using a microprocessor-based system. The unit contained eight recording channels and utilized a microprocessor for real-time acquisition and conditioning of the data. Recordings collected with this system were stored on floppy disk for later analysis. Each recording period required seven minutes to complete and the sampling rate was 10 samples per second. Subjects were asked to sit quietly with eyes closed and to restrict unnecessary movements during the recording periods.

2. *Work Environment/Job Stress* – A questionnaire was used to obtain measures of job satisfaction, work energy, work performance, job stress, coping ability, sleep patterns, and health complaints. Job satisfaction was rated via a scale taken from Quinn and Shepard,[16] while job stress, work energy, work performance, and stress coping were assessed using single items developed for this study. The sleep behavior scale was taken from a study by Tasto et al[17] and health complaints were measured on a 36-item four-point frequency rating scale. The entire questionnaire was completed at home after the session on day 1 and again at follow-up.

3. *Brief Symptom Index (BSI)*[18] – A 53-item abbreviated version of the Symptom Checklist 90 (revised), which generates scores on nine symptom dimensions (somatization, SOM; obsessive-compulsive, O-C; interpersonal sensitivity, I-S; depression, DEP; anxiety, ANX; hostility, HOS; phobic anxiety, PHOB; paranoia, PAR; and psychoticism, PSY) and three summary scales (general severity index, GSI; positive symptom distress index, PSDI; and positive symptom total, PST), was administered at the prestudy physical examination and again at follow-up.

4. *Trait Anxiety*[19] – A 21-item test that evaluated the extent to which anxiety proneness is an enduring trait of the individual was administered on days 1 and 10.

5. *Personal Habits* – A 17-item scale was developed by NIOSH to assess alcohol and caffeine consumption, tobacco use, sleep behavior, job and home stress, and physical exercise for the 24-hour period immediately prior to a training session. The scale was given before the session on days 1, 8, and 10 and at the follow-up session.

6. *Treatment Credibility*[20] – A seven-item scale that measured perceived credibility of the training methods was administered on day 3 after participants had experienced one training session.

## Results

Hand temperature data are not reported since this measure was confounded with ambient temperature. A majority of workers performed their usual job duties outdoors, often when it was significantly cooler or warmer than in the training room. Especially during the winter months, it was impossible to stabilize hand temperatures within the 15-minute period prior to data collection.

The three groups were statistically equivalent on sociodemographic variables, systolic and diastolic blood pressure taken at the physical examination, psychological state, and pretraining measures of job satisfaction and work performance levels ($p > .10$).

The average participant was 42 years old, married, and had 17 years of service with the city. Ninety percent of the participants were male and 64% were white. The annual income ranged from $14,000 to $20,000 and participants were in good health. The participants were primarily nonsupervisory employees (64%) and were field (67%) as opposed to office workers.

**Before Training** – Table 1 shows correlation coefficients among select pretraining measures for all participants. Age did not correlate with any of these measures and EMG levels on day 1 correlated only with levels of nonwork stress. Higher levels of reported job stress were associated with higher trait anxiety, more job dissatisfaction, more psychological and physical strains, poor quality of sleep, and higher caffeine consumption ($p < .05$).

**Table 1 – Spearman Rank Order Correlation Coefficients Among Pretraining (Day 1) Measures**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Age | ... | | | | | | | | | | | |
| 2. EMG (day 1) | -.25 | ... | | | | | | | | | | |
| 3. Job stress | .07 | .10 | ... | | | | | | | | | |
| 4. Nonwork stress | -.21 | .33* | .23 | ... | | | | | | | | |
| 5. Stress coping | .18 | -.27 | -.19 | -.11 | ... | | | | | | | |
| 6. Job dissatisfaction | .11 | -.16 | .42* | .19 | -.09 | ... | | | | | | |
| 7. Health complaints | .02 | -.04 | .43† | .40* | -.16 | .42† | ... | | | | | |
| 8. BSI-PSDI | -.11 | .31 | .33* | .31 | -.03 | .08 | .38* | ... | | | | |
| 9. Trait anxiety | .14 | .05 | .42† | .44† | -.22 | .36* | .71‡ | .57‡ | ... | | | |
| 10. Quality of sleep | 0 | -.16 | -.47† | -.36* | -.17 | -.34* | -.54‡ | -.59‡ | -.69‡ | ... | | |
| 11. Sick leave | -.15 | .06 | .03 | .27 | -.26 | .18 | .12 | .17 | .16 | 0 | ... | |
| 12. Caffeine use | -.02 | .22 | .33* | .33* | -.44† | .41* | .29 | -.12 | .24 | -.17 | -.22 | ... |

* $p \leq .05$
† $p \leq .01$
‡ $p \leq .001$

An analysis of variance (ANOVA) on day 1 EMG levels indicated no group differences ($p > .10$) and no significant relationship between day 1 EMG levels and post-training EMG reductions ($p > .10$).

Finally, credibility of training in biofeedback and muscle relaxation groups was not associated with any pretraining measures or with the magnitude of EMG reductions over program days ($p > .10$).

Training and Application Phases – Figs. 1 and 2 depict comparative EMG levels for each group during baseline (day 1), after training (day 8), and during application practice (day 10) days for presession and postsession recording periods, respectively. A 3 x 2 x 3 (group x session x day) ANOVA revealed no effects for group ($p > .10$) but significant effects for session ($F[1, 34] = 23.73, p < .001$), day ($F[2, 68] = 6.56, p < .003$), and group x day interaction ($F[4, 68] = 2.63, p < .04$), with a trend for a group x session interaction ($F[2, 34] = 3.11, p < .06$).

Breakdown ANOVAs indicated larger EMG reductions on day 8 in the biofeedback group than in controls for both presession ($F[1, 24] = 5.16, p < .04$) and postsession ($F[1, 24] = 4.71, p < .05$) recording periods. The muscle relaxation group did not differ from controls on day 8 EMG reductions during either recording period ($p > .10$). Also, the difference between biofeedback and muscle relaxation groups approached significance ($F[1, 26] = 3.27, p < .08$).

On day 10, group differences fell below acceptable significance levels for many comparisons but trends were apparent. Presession EMG reductions in the biofeedback group were greater than among controls ($F[1, 24] = 3.05, p < .09$) but similar to those in the muscle relaxation group ($p > .10$). There was a trend toward larger postsession EMG reductions on day 10 in biofeedback than in muscle relaxation subjects ($F[1, 26] = 3.18, p < .09$) but results for biofeedback and control groups were similar ($p > .10$).

Repeated measures ANOVAs performed on post-training self-report measures indicated significant time effects (day 10 *v* day 1) for tension level ($F[1, 34] = 10.64, p < .003$), feeling refreshed ($F[1, 34] = 9.59, p < .004$), and quality of sleep ($F[1, 34] = 20.77, p < .001$) but group x time interactions were not significant ($p > .10$). No significant changes over time or between groups were obtained immediately after training on measures of trait anxiety, job stress level, work load, or nonwork stress level ($p > .10$).

## Follow-up

Results – Two subjects in the biofeedback group and one subject in the muscle relaxation group were unavailable at follow-up, resulting in group sizes of 15, 11, and eight for biofeedback, muscle relaxation, and control groups, respectively.

Presession EMG levels at follow-up compared with day 10 are depicted in Fig. 3 for each participant. Compared with post-training levels, EMGs at follow-up were similar in biofeedback (+1%) and muscle relaxation (–1%) groups and higher in the control group (+20%), but a repeated measures ANOVA revealed no group, time, or group x time interaction effects ($p > .10$). Sixty-seven percent of biofeedback subjects, 45% of muscle relaxation subjects, and 50% of controls did not maintain day 10 EMG decreases into the follow-up period. Relative to day 1, however, follow-up EMG levels were lower in 80% of biofeedback subjects, 82% of muscle relaxation subjects, and 50% of controls, as shown in Fig. 4. The percentage of reduction in presession EMG levels at follow-up relative to day 1 was 21% for the biofeedback group and 16% for the muscle relaxation group; a 10% increase was found among controls. Duncan multiple range tests (adjusted for unequal group sizes) indicated larger percentages of EMG reductions (follow-up/day 1) in biofeedback and muscle relaxation groups compared with controls ($p < .05$) and larger reductions in the biofeedback group compared with the muscle relaxation group ($p < .05$).

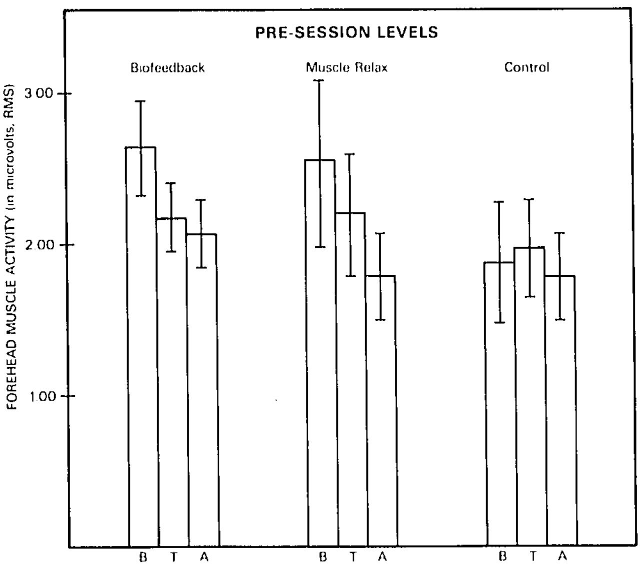


**Fig. 1 – Mean presession forehead muscle activity levels for each group during baseline (B), training (T), and application practice (A) periods.**

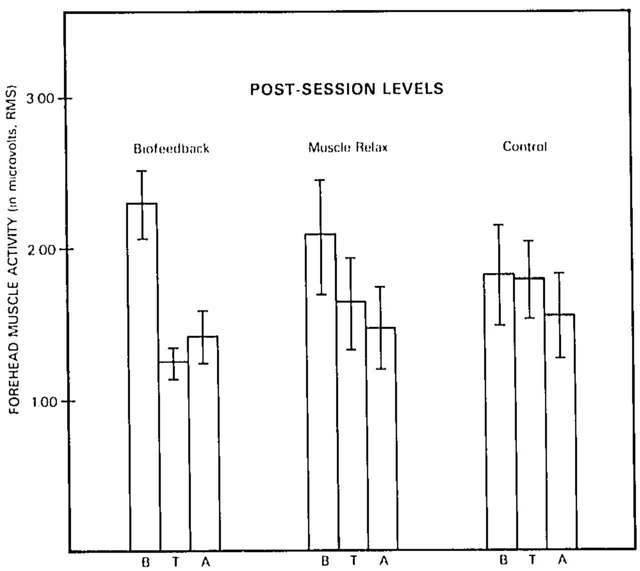


**Fig. 2 – Mean postsession forehead muscle activity levels for each group during baseline (B), training (T), and application practice (A) periods.**

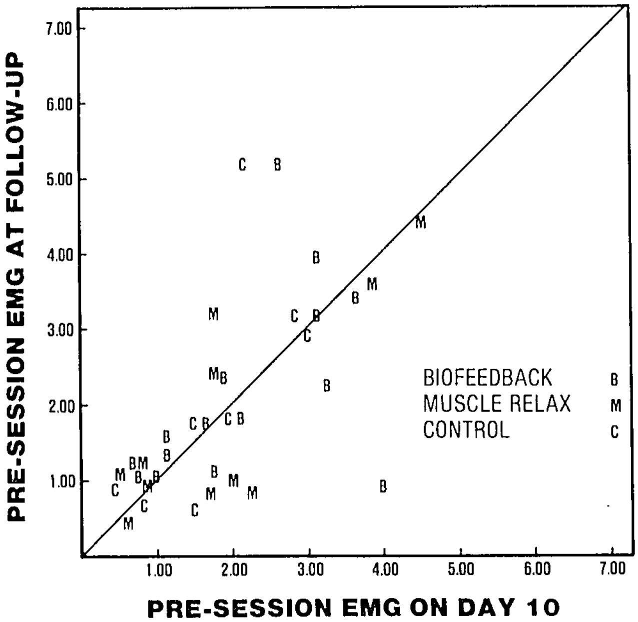


Fig. 3 – Presession EMG levels at follow-up plotted against EMG levels on day 10 for each participant. (Subjects below diagnoal indicate lower EMGs at follow-up.)

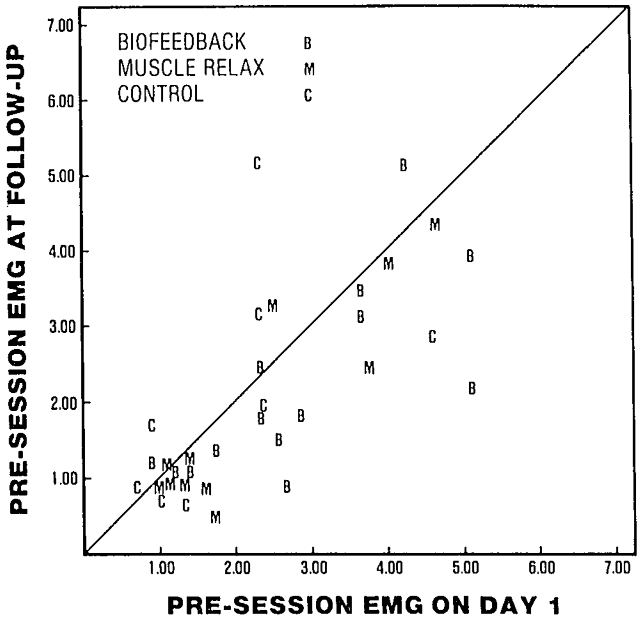


Fig. 4 – Presession EMG levels at follow-up plotted against day 1 EMG levels for each participant. (Subjects below diagonal indicate lower EMGs at follow-up.)

Regarding postsescion EMG levels, a similar pattern of results was found except the increase in EMG levels relative to day 10 was statistically significant ($F[1, 31] = 4.18$, $p < .05$). Sixty percent of biofeedback subjects, 55% of muscle relaxation subjects, and 62% of controls did not maintain day 10 postsession EMG decreases at follow-up. Relative to day 1 post session levels, 67% of biofeedback, 55% of muscle relaxation, and 38% of controls showed lower EMG levels at follow-up. Duncan multiple range tests on postsession EMG reductions (follow-up/day 1) indicated significant differences between both trained groups compared with controls ($p < .05$) and between the two trained groups, the biofeedback group showing lower EMG levels at follow-up ($p < .05$). However, the effect primarily reflected an increase in EMG levels in the control group (+32%) as opposed to significant decreases in the biofeedback (−15%) and muscle relaxation (−1%) groups.

Repeated measures ANOVAs computed on questionnaire scales administered before training and at follow-up revealed only one statistically significant group x time interaction effect for number of hours of sleep ($F[2, 29] = 3.86$, $p < .04$). The biofeedback group showed the largest increase, followed by the muscle relaxation and then the control group ($p < .05$). On a number of survey scales, significant effects were found over time for all groups. Table 2 shows mean scores on select survey items on day 1 and at follow-up along with ANOVA results for time effects. Significant decreases were found on three BSI symptom subscales (SOM, O-C, and ANX), trait anxiety, feeling tired or sleepy at work, job dissatisfaction, and alcohol use with increases in the quality of sleep. Trends toward decreases in two other BSI subscales (GSI and PST) and increases in work performance levels were also found. In all cases, however, the group x time interactions were not statistically significant ($p > .10$).

The group means (Table 2) show that the biofeedback group displayed the largest numerical decreases in BSI symptom scales, followed by the muscle relaxation and control groups, although the latter showed numerically larger changes on measures of quality of sleep and reported job dissatisfaction levels compared with the trained groups.

Reported practice rates during the follow-up period did not differ between the biofeedback and muscle relaxation groups. Participants reported practicing an average of 1.8 days per week for an average of 17 mintues at a sitting over the entire three-month follow-up period. Fifty percent of the participants reported practicing twice per day and 33 did so only rarely. Seventy-three percent of the biofeedback group and 50% of the muscle relaxation group indicated that they were still practicing the relaxation methods periodically at follow-up and that the skills were effective "often" or "always" in helping them relax. Both groups reported using the methods more frequently and with greater success at home than at work. Reported mastery of the relaxation skills was moderate (mean = 5.00; scale, 1 through 9) and more than 75% of the participants reported that a booster session was "probably" or "definitely" needed at follow-up.

Finally, reported practice rates did not correlate with the magnitude of EMG reductions during training or at follow-up and did not correlate significantly with changes on questionnaire measures ($p > .10$). The most common reasons given for not practicing the relaxation methods more frequently at follow-up were that participants forgot to practice (39%), preferred to do other things (26%), had no time to practice (26%), or did not feel the need (17%). Thirteen percent of the participants reported not practicing because they perceived no noticeable benefits.

## Discussion

The results of the present experiment partially replicate a previous study[14] indicating that relaxation training

Table 2 – Means (and SDs) of Questionnaire Scales on Day 1 and at Follow-up*

| Scale | | Biofeedback (n = 15) | Muscle Relaxation (n = 11) | Control (n = 8) | ANOVA Results |
|---|---|---|---|---|---|
| BSI-SOM | Day 1 | 55.1 (13.52) | 55.6 (6.69) | 55.1 (12.62) | $F = 4.77$ |
| | Follow-up | 45.6 (6.52) | 52.8 (10.65) | 52.6 (15.17) | $p < .04$ |
| BSI-O/C | Day 1 | 59.9 (8.32) | 61.4 (5.58) | 59.3 (12.16) | $F = 5.82$ |
| | Follow-up | 52.6 (9.60) | 54.8 (11.74) | 58.1 (8.15) | $p < .03$ |
| BSI-ANX | Day 1 | 60.9 (10.36) | 57.9 (7.65) | 58.8 (15.6) | $F = 6.43$ |
| | Follow-up | 48.7 (10.03) | 52.1 (12.60) | 58.3 (14.62) | $p < .02$ |
| BSI-GSI | Day 1 | 60.9 (10.36) | 60.2 (6.27) | 60.6 (11.61) | $F = 3.47$ |
| | Follow-up | 51.6 (12.21) | 55.6 (12.62) | 60.6 (12.68) | $p < .07$ |
| BSI-PST | Day 1 | 67.8 (10.12) | 61.8 (5.61) | 59.5 (8.38) | $F = 3.30$ |
| | Follow-up | 52.5 (14.77) | 55.5 (13.5) | 62.0 (10.17) | $p < .08$ |
| Trait | Day 1 | 41.9 (9.66) | 40.1 (4.25) | 43.3 (9.69) | $F = 8.53$ |
| anxiety | Follow-up | 37.2 (9.50) | 37.6 (4.53) | 42.4 (8.45) | $p < .007$ |
| Quality of | Day 1 | 3.60 (0.74) | 3.70 (1.16) | 3.62 (1.30) | $F = 8.48$ |
| sleep (1-7) | Follow-up | 4.00 (1.41) | 4.80 (1.40) | 4.87 (1.96) | $p < .007$ |
| Sleepy at | Day 1 | 3.93 (1.21) | 4.00 (1.05) | 4.25 (1.17) | $F = 11.67$ |
| work (1-7) | Follow-up | 3.14 (1.17) | 3.70 (0.95) | 3.63 (1.51) | $p < .002$ |
| Job dissatisfaction | Day 1 | 6.86 (2.48) | 7.30 (2.36) | 8.00 (2.56) | $F = 4.54$ |
| (4-13) | Follow-up | 6.50 (1.65) | 6.80 (1.81) | 6.87 (2.23) | $p < .04$ |
| Alcohol use | Day 1 | 2.00 (1.93) | 4.80 (4.43) | 2.80 (0.84) | $F = 6.98$ |
| (No. of drinks) | Follow-up | 1.12 (0.99) | 1.20 (1.64) | 1.40 (1.34) | $p < .02$ |

* $F$ Ratios and $p$ Values Refer to ANOVA Time effects only (BSI scales are in standardized T units; ranges of other scales are given below scale)

results in significant reductions in worker EMG levels and extend those results showing that the magnitude of post-training EMG reductions are not well maintained three months later. However, a larger percentage of trained workers *v* controls still showed lower than baseline EMG levels at follow-up. Although significant improvements on some survey measures were found for biofeedback and muscle relaxation groups in the first study,[14] both trained and control groups evidenced such improvements in the present study.

The small post-training EMG reductions in the muscle relaxation group relative to the biofeedback group may have been a function of providing too much learning material to these participants. The cassette tape series[15] used in this study included instruction in differential relaxation, conditioned relaxation, and autogenics in addition to progressive muscle relaxation. The manual associated with the cassette tapes suggests that the listener master each relaxation exercise before attempting to learn another. The abbreviated training format used in the present study precluded this type of mastery. It is suggested, therefore, that either fewer relaxation techniques be taught in a short training program or that the length of the program be extended to obviate the potentially counter-productive effects of overtraining on EMG reductions and, perhaps, the low compliance rate observed in the present study.

The relatively poor maintenance of post-training reductions in EMG levels in the trained groups at follow-up may have been due to the very low reported practice rates in this study, averaging less than two days per week with 50% of participants practicing twice per day. However, the research literature is unclear on the relationship between post-training practice rates and benefits to participants. For example, Peters[21] found that practice rates during the follow-up period were higher among participants who experienced more noticeable benefits but even participants who stopped practicing regularly maintained some benefits over time. Likewise, while Carrington and others[9] found differences between practicers and stopped-practicers on some outcome measures, they concluded that frequent practice was not necessary to obtain symptom reduction and that frequency of practice did not predict stress reduction.

The latter study did achieve high compliance rates into the follow-up period with workers learning the relaxation techniques at home via recordings and instructional materials. Perhaps the fact that workers learned the techniques at home served to improve compliance and facilitated the generalization of training skills to other situations. The use of a training room at the work site in the present study may have worked against compliance by conditioning workers to become relaxed in only one setting. Additional research is needed to examine factors related to compliance and the maintenance of relaxation skills over time. Peters[21] found that the best predictor of skill maintenance six months after training was perceived benefit of the training skills and the best predictor of perceived benefit was whether workers taught the relaxation technique to someone else. This factor may explain the high compliance rates achieved in the Peters and Carrington studies.

Since both trained and control groups showed significant benefits on survey measures, it is probable that nonspecific factors inherent in the study design contributed importantly to the observed outcomes. Examples of such factors include taking time out of the workday to sit in a comfortable chair and the motivation of participants who were self-selected.

The problem of nonspecific factors in stress management research has been noted in other reports,[5,6,9,14,22] and additional research is needed to determine the relative contribution of training-specific and nonspecific factors in work-site stress management studies.

The present results confirm other reports supporting the feasibility of work-site stress management training programs and their usefulness for producing reductions in worker arousal level and subjective responses to stress.[5,6,14,22-25] The durability of post-training physiological effects remains questionable based on the present results, although those of another recent study[23] indicate a more sustained effect of relaxation training. In terms of self-report measures, several studies have found durable effects four to six months after training.[9,21,24]

The effects of work-site stress management training on organization-relevant variables such as absenteeism, tardiness, performance ratings, and symptom interference with work need to be evaluated so that cost/benefit figures can be computed. Although such programs are not designed to influence such variables, indirect effects on these measures might be evident. In this regard, Kohn[26] has shown that workers trained in progressive muscle relaxation made fewer performance errors under conditions of high noise stress than did controls. Thus, beyond health-related benefits, relaxation training may directly improve work performance under conditions of elevated stress.

Although individual-oriented strategies for helping workers cope with stress do not attempt to reduce or eliminate the job stressors themselves, a clear limitation, such techniques may warrant a place in job stress reduction efforts by virtue of their potential for reducing arousal levels, anxiety, somatic complaints, sleep distrubances, and, possibly, alcohol use.[27] Stress management methods also address the issue of individual differences in the perception of events as stressful[28] and can be useful in reducing reactions to both work and nonwork stressors that interact with individual characteristics in producing health consequences.

Job redesign and organizational change are ultimately the preferred approaches for reducing job stress but relaxation methods might find utility in work settings as a preventive training strategy, where stressors cannot be designed out of the job, or as components of company training, medical, or employee assistance programs to help workers deal with the stresses and tensions of modern-day life and work.

## Acknowledgment

Elwood Cromwell, Director of Training, Highway Maintenance Division; Joan Blumberg, Director, Public Employees Assistance Program; James Jester, Superintendent, Highway Maintenance Division, and volunteers from the Highway Maintenance Division, City of Cincinnati, cooperated in this study.

## References

1. Sharit J, Salvendy G: Occupational stress: Review and appraisal. *Hum Factors* 24:129-162, 1982.

2. Caplan RD, Cobb S, French JRP Jr, et al: Job Demands and Worker Health, publication 75-160, Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1975.

3. Cooper CL, Marshall J: Occupational sources of stress: A review of the literature relating to coronary heart disease and mental ill health. *J Occup Psychol* 49:11-28, 1976.

4. Hurrell JJ, Colligan MJ: Psychological job stress, in Rom W (Ed.): Environmental and Occupational Medicine. Boston: Little Brown & Co., 1982, pp 425-430.

5. Peters RK, Benson H, Porter D: Daily relaxation response breaks in a working population: I. Effects on self-reported measures of health, performance, and well-being. *Am J Public Health* 67:946-953, 1977.

6. Peters RK, Benson H, Peters JM: Daily relaxation response breaks in a working population: II. Effects on blood pressure. *Am J Public Health* 67:954-959, 1977.

7. Benson H: The Relaxation Response. New York: William Morrow, 1976.

8. Schwartz GE: Stress management in occupational settings. *Public Health Rep* 95:99-108, 1980.

9. Carrington P, Collings GH, Benson H, et al: The use of meditation-relaxation techniques for the management of stress in a working population. *J Occup Med* 22:221-231, 1980.

10. Birk L: Biofeedback: Behavioral Medicine. New York: Grune & Stratton Inc., 1973.

11. Shapiro D, Surwit RS: Biofeedback, in Pomerleau OF, Brady JP (Eds.): Behavioral Medicine: Theory and Practice. Baltimore: Williams & Wilkins Co., 1979.

12. Tarlo-Benlo L: The role of relaxation in biofeedback training: A review of the literature. *Psychol Bull* 85:727-755, 1978.

13. Murphy LR: Stress management. Current NIOSH research. *Occup Health Safety*, November/December, 1983, pp 14-17.

14. Murphy LR: A comparison of relaxation methods for reducing stress in nursing personnel. *Hum Factors* 25:431-440, 1983.

15. Budzynski TH: Progressive Relaxation Training. New York: BMA Audio Cassette Programs, 1974.

16. Quinn RP, Shepard LJ: The 1972-1973 Quality of Employment Survey. Ann Arbor, Mich.: Survey Research Center, 1974.

17. Tasto D, Colligan MJ, Skjei EW, et al: Health Consequences of Shiftwork, publication 78-154. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1978.

18. Derogatis LR: SCL90R Manual-I. Baltimore: Johns Hopkins University School of Medicine, 1977.

19. Speilberger CD, Gorush RL, Lushene RE: STAI Manual for the State-Trait Anxiety Inventory. Palo Alto, Calif.: Consulting Psychologists Press, 1970.

20. Borkovec TD, Nau SD: Credibility of analogue therapy rationales. *J Behav Therapy Exp Psychiatry* 3:257-260, 1972.

21. Peters RK: Daily Relaxation Response Breaks; Follow-up of a Work-Based Stress Management Program, PB 83-175364. Springfield, VA.: National Technical Information Service, 1981.

22. Drazen M, Nevid JS, Pace N, et al: Worksite-based behavioral treatment of mild hypertension. *J Occup Med* 24:511-514, 1982.

23. Forman SG: Stress management training: Evaluation of effects on school psychological services. *J School Psychol* 19:233-241, 1981.

24. Ganster DC, Mayes BT, Sime WE, et al: Managing occupational stress: A field experiment. *J Appl Psychol* 67:533-542, 1982.

25. Steinmetz J, Kaplan RM, Miller GL: Stress management: An assessment questionnaire for evaluating interventions and comparing groups. *J Occup Med* 2:923-931, 1982.

26. Kohn JP: Stress modification using progressive muscle relaxation. *Profess Safety* 26:15-19, 1981.

27. Murphy LR: Occupational stress management: a review and appraisal. *J Occup Psychol* 57:1-15, 1984.

28. Lazarus R: Psychological Stress and the Coping Process. New York: McGraw-Hill Book Co., 1966.