

Teaching and Social Support: Effects on Knowledge, Attitudes, and Behaviors to Prevent Low Back Injuries in Industry

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An educational program designed to reduce low back injuries was modeled after several well-known back schools and taught to postal workers in a randomized trial of about 4,000 workers. Physical therapists taught 3 hours of class sessions, including knowledge, skills, and individual work station assessment, to small groups of workers and supervisors, with reinforcement every 6 months afterward. At 2 1/2 years, a random sample of 209 workers was surveyed for program impact on intermediate outcomes.

We observed increased knowledge among experimental unit workers, but no significant improvements in behaviors associated with back health or in proportion of workers with

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tired backs. Experimental unit workers who had received training by the time of the survey were less likely to report helping/reinforcement for healthy behaviors than controls or untrained experimental unit workers. The program might have led trained workers to perceive a lack of support and reinforcement for back safety among coworkers and supervisors by sensitizing them to what is possible and raising expectations. There appeared to be group social effects in the dissemination of knowledge and perhaps of helpful behaviors; however, it is apparent that worker social support for change in health behaviors is a complex phenomenon that cannot always be relied upon to enhance program goals.

INTRODUCTION

We have recently completed a 6-year, randomized, controlled trial of an educational program designed to reduce low back injuries in an industrial population. In this paper we report on the design of our program and its impact on worker knowledge, attitudes, and behaviors as measured midway through the study. We focus on the impact of social modeling and reinforcement by coworkers and supervisors, which was an essential element of the program design whose impact has been described by others only rarely.

Low Back Pain and Injuries

Low back pain affects 60–90% of adults at some time in their lives¹ and accounts for 32 million doctor visits per year in the United States.² Low back injuries constitute 15–20% of Workers' Compensation injuries and 30–40% of Workers' Compensation costs.^{3–5} Back pain is the most costly ailment of working age adults, and its costs appear to be rising.⁶

Seventy-two percent of soft tissue (strain and sprain) back injury compensation claims are due to "overexertions" such as lifting and handling activities.⁵ Personal factors that put workers at risk for occupational back pain and injury include younger age, lack of experience on the job, smoking, heavy alcohol consumption, job dissatisfaction and negative attitude, and lack of strength or physical fitness. Workplace factors include heavy lifting, repetitive bending and twisting, prolonged sitting, and operation of vibrating machinery.^{7,8}

Back Schools

A widely used technique to reduce occupational low back pain and injury and to improve recovery is the back school.^{9–11} Although a variety of schools exist, most back schools focus on training in safe lifting and handling practices, good posture, and pain management. Grounded in clinical, biomechanical, and therapeutic research,¹² back schools were first developed by physical therapists for care of back pain patients. Four randomized, controlled trials have shown back schools to be beneficial for patients compared with control treatment,^{13–16} while three have shown no effect of the intervention.^{17–19} Despite these mixed

Other social support methods used in workplace health promotion include contracting, the buddy system, and competitions. Although these methods have been associated with successful programs,^{33,34} there has been little evaluation of the extent to which or mechanism by which these methods contributed to the overall program effect.

In sum, while there is growing evidence that naturally existing social support is associated with health and health behaviors of workers,³⁵⁻³⁷ and while there is agreement among theorists and program planners that employee health promotion programs could be made more effective by mobilizing coworker support, there has been little direct evaluation of the extent to which support is actually mobilized in such programs or of the impact such changes in support may have. Our low back injury prevention program provides an opportunity to examine these aspects of coworker and supervisor support.

METHODS

Population and Prospective Study Overview

The Boston postal workers comprise a relatively stable work force, with several occupational subgroups and with low back injury rates similar to the national average of about 2% per year.¹ The two major occupational groups studied were mailhandlers (with some maintenance workers), who do heavy lifting, such as loading 35-70 lb bags, and clerks, who do light work, such as sorting mail manually or sitting at automated sorting machines. Work units were matched in 17 pairs by craft and type of work; one unit of each pair was randomly assigned to be trained in techniques to improve back health; the other to control status. There were about 2,000 experimental unit workers and 2,000 controls. Training of workers and supervisors began in 1986 and ended in 1991.

Program Planning: The PRECEDE Model

In 1982-1983, we applied the PRECEDE model³⁸ to approach the problem of low back injuries among Boston postal workers. The model takes a planner through seven phases. In phases 1 and 2, social and epidemiological diagnoses establish the importance and dimensions of a health problem in a population. In phase 3, behavioral causes of the health problem are determined, as well as their importance relative to nonbehavioral causes. In phases 4 and 5, the determinants of key behaviors are identified and ranked by importance and changeability. In phase 6, an educational program is planned to address key behavioral determinants based on behavior change theories and administrative constraints. In phase 7, the program is evaluated.

Social and Epidemiological Diagnoses

In Boston postal workers, low back injuries accounted for 17% of Workers' Compensation injuries, and 35% of Workers' Compensation costs, or about \$3.5

million annually. Two major occupational subgroups, mailhandlers and clerks, tended to have either high injury rates or long time off per injury, and their injuries were behaviorally related (lifting and handling) about 70% of the time. We chose the clerks and mailhandlers as the focus for our program.

Although nonbehavioral (ergonomic) approaches may be useful in reducing low back injuries,^{7,39} these were not always practical from our vantage point. First, the Postal Service had variable loads to be handled, so the potential for automation was limited. Second, most ergonomic changes must be effected at the national, not the local level. Third, many changes intended to improve ergonomics may reduce one risk while increasing another; there is risk to the back in sitting and operating machinery as well as in manual labor. Therefore, behavioral changes seemed most feasible to address locally, while major ergonomic changes were addressed by others.

Behavioral and Environmental Diagnoses

We used a model of back disability to isolate behavioral risk factors (Figure 1). Low back disability is the social behavioral manifestation of physical impairment caused by an overload to the back. The overloading can be cumulative or traumatic, and can result from (1) excessive loads, above a worker's reasonable capacity to handle; (2) physical deficits, such as fatigue or weakness, that make workers susceptible to overloading their backs at low levels of work; and (3) unsound biomechanics (lifting, handling, and posture), whereby an otherwise manageable load places a person at risk of injury or places undue forces on the back elements. A variety of behaviors is associated with each of these.

We conducted in-depth individual and small group interviews with 25 postal managers, medical personnel, supervisors, craft workers, and union stewards, in order to identify behaviors that contributed to the three causes of overloading described above. Rephrased positively (as behaviors to encourage in a program), worker behaviors believed to reduce excessive loads included dividing the workload, helping each other with heavy lifts, using available equipment, not overloading equipment or containers, and slowing the work pace. The supervisor in particular controlled the work pace. An excessive pace could result in sloppy lifting technique, piled up mail bags, overloaded conveyor belts (that were sometimes pushed manually), and worker fatigue.

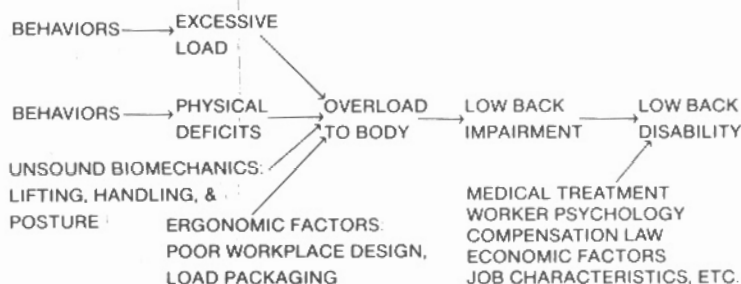


Figure 1. Selected factors contributing to low back disability.

Behaviors that reduced physical deficits included exercise to promote conditioning, strength, and flexibility, stress management, alcoholism counseling, and possibly weight control. Each of these in turn was a composite of many other behaviors, most of which had to be done away from work at the individual worker's initiative.

The final general behavioral class included sound lifting and handling techniques and good posture. These consisted of using good body mechanics, that is, using the back in its natural position (upright, with no twisting), using the strongest muscles (legs rather than arms or back), and reducing the force moment of the load by keeping it close to the body. Good posture consisted of standing with a knee elevated and sitting with one or both knees raised to hip level, and alternating position to reduce fatigue. These principles must be applied hundreds of times daily in a variety of work situations.

In the PRECEDE model, the next step is to classify behaviors by impact and changeability. In Boston, about 70% of Worker's Compensation injuries were lifting and handling related. Therefore, we concentrated our effort on lifting and handling factors and ergonomic adjustments (e.g., proper chairs, shelf heights) at the local level, while making recommendations (based on observation) for other changes that could eventually be implemented by the Postal Service Administration. Contributing behaviors, such as exercise and eating to reduce obesity, were beyond our resources, or were already targeted by other programs (e.g., reduced alcohol consumption via the Employee Assistance Program).

Educational Diagnosis

The next planning step was to identify the causal factors for each behavior. These can be grouped into those that predispose action (such as knowledge, attitudes, values), enable action (skills, resources, accessibility), or reinforce action (attitudes and behaviors of others, rewards). We illustrate this typology with the set of lifting and handling techniques.

Predisposing factors for safe lifting included attitude, especially acceptance of responsibility. Workers frequently complained that management was to blame for low back injuries, because the environment could be made safer; thus, workers might refuse to accept responsibility for their own actions. Motivation was another predisposing factor. Many workers may have lacked motivation because they had been lifting incorrectly for years and had not been hurt yet, because they had adapted successfully to their jobs' lifting requirements, or because they felt their actions to be of little importance relative to the environment. Alcoholism, depression, and dissatisfaction with the job could also lead to poor motivation.

Enabling factors for safe lifting included knowledge of how to lift, skills in safe lifting and handling, physical fitness (fatigue could lead to poor lifting), and ergonomics (workflow and equipment). We found that most postal workers knew how to lift correctly, but a third to a half reported frequent incorrect lifting because they thought it would take too much time or their supervisors would

disapprove. Workers knew very little about good posture and exercises to reduce back problems.

Supervisors could reinforce lifting and handling techniques by praising safe practices and responding to worker complaints about work pace or unsafe equipment. Fellow workers could reinforce each other's safe lifting behavior by helping with heavy loads, modeling sound practices, complimenting safe lifting in each other, and resetting norms (e.g., making it acceptable to ask for help). A back school physical therapist could also provide verbal reinforcement. Finally, workers may have the ultimate reinforcement of feeling better at the end of a day of proper lifting and good posture.

The Brigham Back Program

Based on our behavioral and educational diagnoses and a review of existing back schools,^{9,10,40} we developed an educational intervention, taught in two sessions of 90 minutes each, 1 week apart. Subjects were taught (1) biomechanics of the back, and common causes of back pain and injury; (2) proper lifting and carrying techniques for common lifts and lifts peculiar to postal work occupational specialties; (3) exercises for relaxation, strengthening, and stretching to overcome deficits in muscular fitness; and (4) techniques to reduce overall biomechanical stress on the lower back. Secondary topics such as stress reduction, weight reduction, and aerobic exercise were discussed briefly and literature was made available.

Subjects were taught by trained physical therapists in groups of 10-12. Methods included film ("It's Your Back" ref. 40), slides, lecture and discussion, demonstration and practice, and feedback on-the-job. To engage workers and supervisors in mutually constructive approaches to safe lifting, they were asked, in group sessions, to identify barriers to performing the recommended behaviors and to suggest means by which they might overcome these barriers. Frequently mentioned barriers included lack of support from supervisors and coworkers, unsafe equipment, and situations in which correct lifting was not possible. Workers and supervisors were trained together in natural work units to reduce the likelihood of cross-group contamination, and more importantly, to allow workers and supervisors to reset norms and to reinforce each other in maintenance of new behaviors. The norms and mutually reinforcing behaviors were specifically discussed. Mutual identification of problems and possible solutions was designed to help empower workers to change their environment as well as their own behaviors.

In addition to back school instruction, supervisors received training from the physical therapist, in supervisor-only groups, on how to recognize unsafe lifting practices and how to reinforce and support lifting practices among workers. This was reinforced with a videotape, made in collaboration with postal service personnel, that showed correct and incorrect behaviors and featured supervisors modeling positive and reinforcing behaviors. Finally, the physical therapists observed lifting practices by trained workers on the workfloor, using a checklist. Frequently observed unsafe practices were discussed with the supervisor, and addressed by the therapists through the regular safety meetings held for workers

by each supervisor. Each floor supervisor's area was reviewed and was reinforced every 6 months for the duration of the study.

Within the framework of Postal Service Management initiatives to improve employee safety, attendance at the program was made mandatory, on paid company time, for workers in the experimental group. Union representatives were given management's assurance in writing that participation would not be cited punitively in any disciplinary procedure arising from an occupational injury. The protocol for data collection and safeguards for protection of worker privacy were negotiated jointly with Postal Service Management and union representatives, and approved by our hospital's Committee to Protect Human Subjects from Research Risks.

Although major ergonomic changes were left to others, we facilitated local environmental changes where possible (new chairs, shelf heights changed, etc.), and submitted periodic written recommendations to the postal service administration for more far-reaching changes based on our physical therapist's worksite observations and discussions with workers.

Evaluation of Intermediate Outcomes: Study and Sampling Design

In this paper, we report on a cross-sectional survey of a random sample of the study population to assess differences between experimental and control units in worker knowledge, attitudes, and self-reported behaviors midway through the study (September 1988). We hypothesized that the intervention would work to reduce back injury, at least in part, via these variables.

At the time of the survey, about 1,800 workers and 100 supervisors had received training and reinforcement. A sample size of 200 was chosen in order to provide at least 90% power to detect a moderate program impact (20% improvement in average score) on each of several outcomes, including worker knowledge and behavior, and worker and supervisor encouragement of safe behavior. Protection against false rejection of the null hypothesis (α) was set at 0.01. Baseline means and standard deviations for these variables were estimated from pilot test scores. We decided to sample at least 300 listed worker positions so that a minimum of 200 on-duty workers would be surveyed, after sample loss due to nonresponse, temporary absence, or empty positions (i.e., there is currently no worker in the listed position).

The first 12 matched pairs of trained and control units enrolled in the study were selected for the survey and divided into four waves in order of study entry, to balance on recency of training. A list of worker positions was generated. For each craft (mailhandler and clerk), a study group was randomly chosen, probability proportionate to size, from each wave. Administrative subdivisions (pay locations) of each study group were in turn sampled, probability proportionate to size, until 16 samples of size 20 were generated for a total of 320 listed positions.

Statistical Methods: Analyses

For each outcome (see measures), we used backward stepwise regression to select the best predictors from gender, craft, education, history of low back pain

of at least 3 days duration, and year of initial training. Those with an F statistic significant at the 0.10 level were retained as covariates. History of low back pain, year of training, and their interaction with the experimental intervention were added to all models, as those with a history of low back pain may pay more attention to training and those trained earlier may revert to baseline status. Then for each outcome we added the training intervention plus hypothesized interactions and estimated their impact using general linear models.

At the time of the survey, some workers in each experimental unit had not yet received training. These workers may have differed systematically from trained workers, but we believe that they were basically similar. Their only exposure to the program was indirect, via modeling, encouragement, and support of their trained coworkers and supervisors. Thus, we were able to analyze the effect of reinforcement and the diffusion of the program among untrained workers by comparing 3 groups, controls, trained experimentals, and untrained experimentals, using general linear models with the same covariates as for the main analyses (experimental vs. control).

All analyses were performed on IBM or IBM-compatible personal computers, using the SAS statistical package.⁴¹

Measures

Back injuries were generally considered to be caused by cumulative stress due to multiple behaviors, including lifting and handling activities; posture while sitting, standing, or reclining; work pace; individual fit with the ergonomics of the workstation; and recreational exercise. In short, virtually all activities during or out of work affect back health; it was possible to select only a few of those we thought most important.

We designed a questionnaire, using published measures (actual or adapted) when possible, and creating our own when necessary. After pretesting on postal employees, the questionnaire assessed:

1. Knowledge. Four multiple-choice questions assessed knowledge about the relationship of back health with sleep, twisting, lifting, and sitting. Half or full credit was given for each, and the scores summed to produce a scale ranging from 0–8.
2. Perceived helping and reinforcement by coworkers and supervisors. Workers were asked how frequently they got help with a heavy lift, observed a worker helping someone else, or whether, in the last month, coworkers had encouraged them to lift more safely, showed them specific ways to do so, or talked about how to make their jobs safer for their backs. Similar questions were asked regarding supervisors' actions, approval for getting help in lifting, and concern with worker safety. A total of 10 questions were standardized and summed to produce a scale ranging from 0 (no perceived helping/reinforcement) to 10. The internal reliability of this scale (Cronbach's coefficient alpha) was 0.75.
3. Controllability of back health. This was calculated as the mean of two 5-point Likert type questions on the degree to which back health depended on personal behavior and modifiable work conditions. High scores indi-

cated greater perceived controllability of back health. The internal reliability of this scale (coefficient alpha) was 0.58.

4. Lifting and posture on the job. Two indices were created from four multiple-choice questions covering frequency of correct lifting from the floor and from the side to the front, and correct posture (sitting and standing) on the job. Higher scores indicated healthier behaviors for the back.
5. Health behaviors off the job. An index was created from questions about behaviors off the job that were advocated as a means of improved back health. They included regular performance of a moderate to vigorous exercise program (adapted from ref. 42), situps (performed correctly), regular performance of a stress reduction program, and good posture during sleep. High scores indicated behaviors healthy for the back.
6. Tired back. Subjects were asked how often their backs got tired when they worked (almost none of the time, less than half, about half, more than half, or almost all of the time). This question about having a tired back has been associated with low back injury in another industrial population¹³ and was therefore an intermediate outcome of interest.
7. Other variables measured included participation in the training and reinforcement sessions, year of training, craft (clerk or mailhandler), gender, age (≤ 40 years vs. > 40),⁴³ years employed by the postal service (< 3 years vs. ≥ 3), frequency of stress (rarely or never to always, on a 5-point scale), lifetime history of back stiffness or backache lasting at least 3 days (yes or no), and job satisfaction (not satisfied at all to completely satisfied, on a 10-point scale). Self-reported lifetime history of back troubles has demonstrated 84% reproducibility at 1 year,⁴⁴ and single-question assessments of job satisfaction have demonstrated reliability.⁴⁵

Survey Administration

To enhance workers' perception of confidentiality, we distributed and collected the survey in person to entire work units as they began shifts. The survey questionnaires were identified only by unit (precluding individual follow-up of absent workers) to maximize honesty and response rates among the workers, who were reporting their own behaviors and those of their supervisors concerning back health and safety. We expected that this procedure would not bias the comparison of trained and untrained groups.

RESULTS

Recruitment

On the day of questionnaire distribution, there were 221 workers on duty in sampled units, and 219 returned questionnaires, of which 209 (95%) were useable. As shown in Table 1, the experimental and control groups were similar on craft, gender, age, duration of employment, and lifetime history of one or

Table 1. Characteristics of Experimental and Control Unit Respondents

Characteristic (<i>N</i>)	Experimental <i>N</i> = 120	Control <i>N</i> = 89	TOTAL <i>N</i> = 209
Craft: mailhandler (vs. clerk)	41%	50%	45%
Gender: male	67%	59%	64%
Age: >40 years (207)	51%	56%	53%
Duration of employment <3 years (207)	17%	27%	21%
Lifetime history of low back pain ≥ 3 days	44%	44%	44%
Program participation (203)	73%	5%	44%
Education: \leq high school (207)	50%	36%	44%
Trained in first year of study (vs. second)	57%	—	57%

more low back pain episodes of at least 3 days. More experimental unit than control unit subjects returned questionnaires, but this was due to differences in unfilled positions and absences, not in response rates. Thirty-one experimental unit workers had not yet been trained; 2 subjects who did not answer the question on back program attendance were presumed not to have attended the program. Four control subjects had attended the program before transferring into a control unit. Inclusion of these 6 subjects did not change any conclusions in analyses, and would add a conservative bias, if any. Separation of work units by area or shift served to minimize cross-contamination other than occasional transfers.

Outcome: Knowledge about Safe Lifting and Posture

Craft, education, history of low back pain, and year of training were selected as covariates by stepwise backward regression. To these we added program and interaction terms for program by history of low back pain and program by year of training (Table 2). When program was entered as a dichotomous variable (experimental or control unit, as randomized), experimental group members were seen to know significantly more about safe lifting and posture than controls (Tables 2, 3) (mean score 4.2 correct out of 8, vs. 2.8; $p < .0001$). Modeling the program effect as "control, untrained experimental, or trained experimental" also yielded a significant main effect (Table 2). The controls scored 2.8 correct, untrained experimentals 3.2, and trained experimentals 4.6 (Table 3), which is consistent with the hypothesis that there was a diffusion of knowledge from trained to untrained experimental group workers. We found that mailhandlers, who do the heavy lifting, knew significantly more than clerks, that college-educated people knew more than those with less than college education, and that those with a history of low back pain knew more than those with no history of low back pain. There were no significant interaction effects.

Table 2. General Linear Model for Predicting Worker Knowledge

Predictor	Program Model			
	Intention to Treat (2 groups) ^a		Training Received (3 groups) ^b	
	<i>F</i> (<i>df</i>) ^c	<i>p</i> -Value	<i>F</i> (<i>df</i>) ^c	<i>p</i> -Value
Model	3.9 (7)	.0005	3.8 (10)	.0001
Craft: Mailhandler	6.9 (1)	.01	7.9 (1)	.005
Education: some college	3.3 (1)	.07	4.8 (1)	.03
History of low back pain	2.9 (1)	.09	4.0 (1)	.05
Year of training	0.5 (1)	.5	1.6 (1)	.2
Program	19.2 (1)	.0001	13.4 (2)	.0001
Program by history of low back pain	0.0 (1)	.9	0.1 (2)	.9
Program by year of training	1.4 (1)	.2	0.5 (2)	.6

^a Randomized to receive training or not.

^b Splits experimental group into those who did or did not receive training.

^c Numerator degrees of freedom in parentheses. Denominator *df* = 195 for 2 groups and 192 for 3 groups.

Outcome: Perceived Controllability of Back Safety

History of low back pain, year of training, and duration of employment were selected as covariates by stepwise backward regression, and we added program participation and its interactions with each term. The average score was 4.1 out of 5, or "very controllable." No main effect approached statistical significance

Table 3. Mean Knowledge, Beliefs, and Behaviors by Study Group by Training Experience^a

Outcome	Possible Range	Mean Scores			Root Mean Square Error
		Control Subjects (<i>N</i> = 89)	Experimental Subjects		
			Total (<i>N</i> = 120)	(Untrained/ Trained) (<i>N</i> = 31/ <i>N</i> = 89)	
Knowledge	0-8	2.8	4.2	(3.2/4.6)	2.16
Control	1-5	4.0	4.1	(4.1/4.1)	0.78
Helping/reinforcement	0-10	4.1	3.8	(4.1/3.5)	1.65
Lift on the job	1-5	3.7	3.7	(3.7/3.8)	1.04
Behavior off the job	0-10	3.6	4.1	(4.4/4.0)	1.04
Posture	1-5	3.2	3.1	(3.4/3.0)	1.08
Tired back	1-5	2.4	2.5	(2.4/2.6)	1.29

^a Means reported and root mean square errors (standard deviations) are taken from the general linear models, adjusted for covariates.

(all $p > .5$), although there was a strong interaction between year of training and program participation ($F = 5.08$; 2, 206 df ; $p = .007$). Workers trained in 1986 perceived less controllability over back health than control unit workers, while workers trained in 1987 perceived greater controllability; there was no difference between trained and untrained experimental group workers.

Outcome: Worker and Supervisor Helping and Reinforcement of Safe Lifting Behaviors

History of low back pain, year of training, job satisfaction, and sex were selected as covariates by stepwise backward regression. To these we added program participation and its interactions with job satisfaction, history of low back pain, and year of training (Table 4). The average score was 3.8 on a scale of 10. We deleted one influential outlier, a subject who gave perfect ratings to fellow workers and supervisors. Women reported significantly higher helping/reinforcement ratings than men, and those satisfied with their jobs reported higher helping/reinforcement ratings than those who were not satisfied. When program was entered as a dichotomous variable (control vs. experimental unit assignment), there was no significant main effect of training; contrary to expectations, the experimental unit reported somewhat lower levels of perceived helping and reinforcement. When the experimental unit was broken down into trained and untrained workers, a significant program effect was seen. Control and untrained experimental workers had the same average scores (4.1), whereas trained experimental workers had lower scores (3.5) (Table 3). This effect was greatest for those with lowest job satisfaction (Figure 2).

Table 4. General Linear Model for Predicting Approval and Reinforcement of Safe Lifting Behaviors by Coworkers and Supervisors

Predictor	Program Model			
	Intention to Treat (2 Groups) ^a		Training Received (3 Groups) ^b	
	<i>F</i> (<i>df</i>) ^c	<i>p</i> -Value	<i>F</i> (<i>df</i>) ^c	<i>p</i> -Value
Model	6.6 (8)	.0001	5.7 (12)	.0001
History of low back pain	0.2 (1)	.66	0.7 (1)	.4
Year of training	0.4 (1)	.55	0.6 (1)	.4
Sex	14.1 (1)	.0002	11.6 (1)	.0008
Job satisfaction	27.4 (1)	.0001	16.1 (1)	.0001
Program	1.4 (1)	.24	5.9 (2)	.003
Program by job satisfaction	0.5 (1)	.49	3.6 (2)	.03
Program by history of low back pain	4.8 (1)	.03	1.9 (2)	.16
Program by year of training	0.3 (1)	.59	0.6 (2)	.5

^a Randomized to receive training or not.

^b Splits experimental group into those who did or did not receive training.

^c Numerator degrees of freedom in parentheses. Denominator $df = 197$ for 2 groups and 185 for 3 groups.

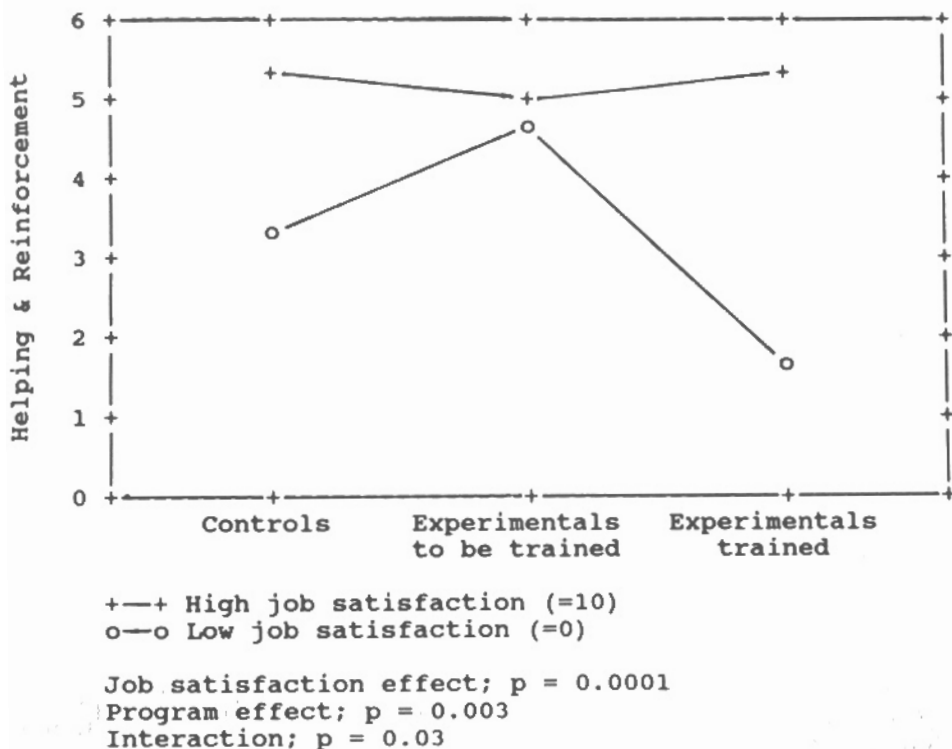


Figure 2. Predicted worker and supervisor helping and reinforcement of back safety by training by job satisfaction.

Outcomes: Lifting on the Job, Posture on the Job, and Exercise/Stress Reduction off the Job

Covariates were selected by stepwise backward regression and general linear models used to test the program effect for each set of back health-related behaviors encouraged in the program. In brief, none of the models explained more than 10% of the variance, and the program showed no significant effect on any of these outcomes, whether program was modeled as a dichotomous or trichotomous variable. Mean scores for all outcomes are shown in Table 3. Of some interest are the findings that younger workers and those employed more than 3 years reported more exercise and stress reduction behaviors off the job ($p = .004$ and $.03$, respectively), those employed more than 3 years reported better lifting behaviors on the job ($p = .05$), and clerks reported better posture on the job than mailhandlers ($p = .01$).

Outcome: Having a Tired Back at the End of the Day

Covariates selected by stepwise backward regression included history of low back pain, year of training, perceived stress, and duration of employment; to

which we added the program effect and its interaction with history of low back pain, duration of employment, and year of training. Workers with a history of low back pain ($p = .0002$) and those who considered themselves stressed ($p = .0001$) were more likely to report having a tired back at the end of the day, but there was no program effect ($p = .6$); workers with longer duration of employment were also less likely to report tired backs ($p = .03$).

Correlations among Outcomes

To help confirm the construct validity of our outcome measures, we examined their correlations with each other. We expected that knowledge of back safety, sense of control, group and individual self-protective behaviors, and not having a tired back at the end of the day would all be correlated at modest levels. The weak correlations that appeared were all in the directions expected. Knowledge was correlated with perceived controllability of back safety ($r = .24$) and with self-reported safe lifting on the job ($r = .18$). Perceived helping/reinforcement of safe lifting was correlated with perceived controllability of back safety ($r = .15$) and lifting on the job ($r = .14$). Having a tired back was negatively correlated with lifting on the job ($r = -.14$) and with exercise and stress reduction behaviors off the job ($r = -.15$). Posture was correlated with nothing. Although all correlations reported above were significant at the .05 level, the only correlation significant at a Bonferroni-adjusted level ($p = .0024$) was that between knowledge and controllability of back health.

DISCUSSION

In this paper we have described the development of an educational program to reduce low back injuries among postal workers. Based on the PRECEDE model, the program attempted to change the behaviors, both individual and collective, of workers and their supervisors. Workers and supervisors were taught in work-based groups so that, in accordance with social learning theory, they might model and reinforce desirable behaviors for each other (e.g., by showing and praising safer behaviors), as well as help each other physically (e.g., by offering to help with lifts, or by loading bags and equipment so that it would be safer for the next person to handle it).

The questionnaire response rate was high (95%) for workers present and on duty. Overall, the mean scores on seven outcome variables (Table 3) indicated considerable room for improvement. For example, on average, workers knew only 45% of what they should know regarding behaviors affecting back health, scored 55% for on-the-job posture, and 71% for on-the-job lifting. Perceived helping and reinforcement for safe lifting was low, averaging 3.8 on a scale of 10. Twenty-two percent of workers reported that their backs got tired more than half the time at work, although most workers believed they could control their own back health a lot.

Results of regression models indicated that the educational program transmitted information, because the trained units scored 50% higher than the con-

trols on the knowledge test. Greater knowledge was weakly correlated with greater perceived controllability of back health and self-reported correct lifting on the job. Analysis of the intent-to-treat model (comparing subjects in control units with those in experimental units regardless of training received) indicated no other program effects, whether for perceived control, behaviors and attitudes of coworkers and supervisors, workers' own behaviors on or off the job, or frequency of back fatigue.

When we modeled the intervention by work unit assignment and training actually received, a significant effect was seen in two variables, knowledge and perceived helping/reinforcement from others. The average knowledge level for untrained experimental unit workers was intermediate between trained coworkers and untrained controls.

Analysis of perceived helping and reinforcement for safe lifting behaviors uncovered an unexpected effect of exposure to training and exposure to trained coworkers and supervisors. Trained workers reported the lowest perceived helping/reinforcement, whereas untrained workers in experimental units reported higher scores, similar to untrained controls. It is probable that the scale taps a set of perceptions that are highly susceptible to expectations; for example, workers, coworkers, and supervisors model safe behavior, help each other, encourage each other to lift correctly, talk about safe lifting techniques, and feel that safety is important to their supervisors.

The overall program effect on helping/reinforcement was the opposite of what we expected, but the similarity of control and untrained experimental worker scores is telling. It is consistent with the hypothesis that workers who learned all that could be done to improve safety (trained experimentals) had their expectations raised and reported lower helping/reinforcement scores out of disappointment or frustration at what was not being done, even if the behaviors were performed more often. If this is so, then the experimentals not yet trained ought to report higher helping/reinforcement than both trained experimentals and controls, as they would see improved behaviors by coworkers and supervisors, unbiased by raised expectations from the classes. The susceptibility of these ratings to expectations is supported by the strong effect of job satisfaction, and its interaction with program participation. Those with high job satisfaction reported high levels of helping and reinforcement, whether trained or not (see Figure 2); among those with low job satisfaction, only untrained experimental unit workers reported high helping/reinforcement.

These results suggest, in line with social cognitive theories,²⁹ that perception of phenomena such as helping/reinforcement behaviors may be of greater importance than "objective" reality. To enhance the effectiveness of future programs using social reinforcement, one would have to pay more attention to how such behaviors are framed. For instance, greater or more visible management efforts to change the environment (ergonomics) might, in addition to directly improving safety, frame the educational program's behavioral changes as "another way management is trying to help" instead of "something we're asked to do instead of management action."

Workers trained in 1986 perceived less controllability over back health than control unit workers, while workers trained in 1987 perceived greater controllability; there was no difference between trained and untrained experimental

group workers. The meaning of this result is unclear, as a variety of effects may be operating, including dilution or intensification of a program effect over time; changes in the script; change of therapists or worker perception of them and the program; or the fact that the workers randomized in 1986 and 1987 differed in seniority and may in fact have had different levels of control over back health.

Limitations

Because virtually all activities, including sedentary ones, may increase the likelihood of low back pain if done incorrectly, by necessity we focused on a few in our teaching and evaluation. It is possible, but unlikely, that we chose to focus on the wrong ones. It is also possible that ergonomic factors and/or habit were too strong to be overcome by our intervention.

Another possibility is that our measures were invalid or insensitive to meaningful differences in outcomes. The pattern of regression and correlation results attests to construct validity among the measures. Correlations among outcomes, although weak, were all in the directions expected, that is, consistent with other study findings. Further, a number of covariates were significantly associated with outcomes in expected ways, such as education and history of low back pain with knowledge about back safety, stress and history of low back pain with tired back, greater seniority on the job with better lifting behaviors and less frequent tired back. Also, power to detect a difference of 20% of the observed mean at $\alpha = 0.01$ exceeded 90% for all outcomes. Thus, it appears that insensitive or invalid outcome measures are unlikely to account for the lack of intermediate program results, although it is possible that incomplete training in the experimental group (a constant reality in the workplace) weakened our power somewhat. Conclusions about effects on untrained experimentals versus trained ones are of course limited by the nonrandom nature of such group membership.

Failure of the program to train individuals is unlikely, because knowledge was increased in trained individuals, even as measured up to 2 years later, and workers in each class were easily able to demonstrate the simple physical skills learned. It is possible that workers and supervisors failed to practice these new behaviors until they became habitual, and failed to reinforce each other for lifting and postures consistent with back health. Workers might have failed to change their behaviors because they perceived that new techniques would take too much time, or that their supervisors would disapprove. Both opinions were expressed during our educational diagnosis prior to development of the intervention.

Conclusions

An educational program designed to reduce low back injuries was modeled after several well-known back schools, and taught by physical therapists in a randomized trial. Halfway through a 6-year study, we observed increased knowledge among experimental workers, but no significant improvements in self-reported back-healthy behaviors or proportion of workers with tired backs. The

program might have inadvertently led trained workers to perceive a lack of helping behaviors and reinforcement for back safety among coworkers and supervisors by sensitizing them to what is possible, thereby raising expectations. There appeared to be group social effects in the dissemination of knowledge and perhaps of helpful behaviors; however, as with other reports,^{30-34,36,37} it is apparent that social support for change in health behaviors in the workplace is a complex phenomenon that cannot always be relied upon to enhance program goals. The impact of the program on low back injury rates will be evaluated in a subsequent paper.

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