A Cost-Benefit Analysis of a California County's Back Injury Prevention Program

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Synopsis

Back-related injuries have become a major health problem in the workplace, affecting as many as 35 percent of the work force and accounting for about 25 percent of all compensation claims. This study evaluates a back injury prevention program among employees in a northern California county in 1989–90. Six divisions of the county government were selected for the study because they had the highest prevalence of back pain experienced and the most back-related injuries in recent years. Four of the six divisions were randomly selected as the intervention group and the remaining two, the control group. Overall, 77 percent or 205 of the targeted employees in the intervention group participated in the study.

The intervention group was given an identical health risk assessment (HRA) before and after the 1-year back injury prevention program that offered employees a combination of education, training, physical fitness activities, and ergonomic improvement. The control group was neither given the HRA nor offered the program. The back injury and cost data of both the control and intervention groups were collected before and after the 1-year intervention.

The results showed a modest overall decline in back pain prevalence rates, but significant improvement in satisfaction and reduction in risky behaviors. Cost-benefit analysis showed the net benefit of introducing back injury prevention program was $161,108, and the return on investment is 179 percent. Therefore, the study offers suggestive evidence for the initial benefits of a back injury prevention program and lends support to the widely held belief that health promotion in the workplace can reduce employee health risks, increase healthful behaviors and attitudes, and improve attitudes toward the employer organization. Whether such intervention will continue to reap benefits in future years depends, to a large extent, on a favorable work environment and the maintenance and continuation of positive behavioral changes.

BACK-RELATED INJURIES have become a major health problem in the workplace (*1*), affecting as many as 35 percent of the work force (*2*) and accounting for about 25 percent of all compensation claims (*3*). Among the factors contributing to back injuries, occupational factors are believed to be especially significant (*1*). They include prolonged work postures (especially sitting); inadequate back support when seated; exposure to vibration; driving heavy vehicles; and the degree of physical effort demanded on the job such as bending and lifting or pushing and pulling heavy loads (*4–7*). Although programs to prevent worksite back injuries have the potential of improving health and reducing the costs, the existing literature is mixed regarding the health impact (*8–11*) and meager in terms of cost savings.

This study tries to fill such a gap by evaluating a pilot program for the prevention of back injuries among employees of a county government in northern California. The first objective of the evaluation is to measure the effects of the program on employees' risk status. The second objective is to determine possible cost savings to the county from decreased injuries.

The county has been experiencing a high incidence of back-related injuries among its employees. A 1989 inhouse survey found that 66 percent of the employees had symptoms of back discomfort. In fiscal year 1987–88 alone, the county spent

$213,000 on workers' compensation claims for 84 back injuries. The back injury prevention program implemented in 1989–90 is part of the county's comprehensive back safety programs to contain health care costs by reducing risk factors of individuals and organizations.

'One of the purposes of the programs to prevent back injuries was to increase job satisfaction and reduce risk behaviors. . . . Progress was made in employees' satisfaction with both their specific jobs and employer.'

Methods

Six county divisions were selected for the study because they had the highest prevalence of back pain experienced and the most back-related injuries in recent years. In addition, the employees' demographic characteristics (that is, age, sex, race, education) among these divisions were similar and statistically nondifferent ($P > .1$). Then, four of the six divisions were randomly selected as the intervention group and the remaining two, the control group. The intervention group consisted of all employees from four divisions: Parks and Recreation, Public Works, and two county hospitals. Overall, 205 or 77 percent of the 267 targeted employees in the four divisions participated in both health risk assessments (HRA). Most of the nonparticipants were having their days off during the HRA, so there were no apparent selection biases. The control group included two divisions: Building and Grounds and the Sheriff's Department.

The intervention group was given an identical HRA before and after the back injury prevention program, which lasted for 1 year. The HRA produced a feedback report for each participant and was considered as part of the intervention component. It was withheld from the control group because it could act as an intervention and thus confound the outcome. The control group is not geographically close to the study group, and employees in these divisions did not know they were being used as controls. A limitation of this design is the inability to collect comparable data to assess the significance of risk status changes in the intervention group. However, since back injury and cost data of both the control and intervention groups were collected before and after the 1-year intervention, the comparison of these data could reveal the impact of the intervention program.

The HRA was based on the Centers for Disease Control model (*12*). Beery and his colleagues examined the reliability and validity of HRA and found it "as being most relevant for white middle-class clients" (*13*). Its validity for minority groups was uncertain because epidemiologic data (from which the HRA was derived) on most risk factor-disease relationships in nonwhites were sparse. However, since most of the study participants (75 percent) were white, the use of HRA was considered appropriate. The core risk measures in the HRA have also been used for several other health promotion programs and published elsewhere (*14*). Professional staff members were responsible for taking the biometric measures.

Consistent with current literature on back injuries (*15–30*), the HRA also had 35 questions measuring risk factors for back injury. The health status risk factors included a fitness profile (four questions measuring the ability to do push-ups, sit-ups, sit and reach, and lateral bend above knee) and a back pain profile (eight questions measuring the frequency, location, intensity, progression, severity, causes, consequences, and treatment of the experienced back pain).

The occupational risk factors included work posture (whether the job requires sitting for at least half the time), driving profile (three questions on whether the employee is a truck driver, and whether he or she spends half the work time or more driving or sitting in a motor vehicle), and the physical demand of the job (four questions measuring the extent of physical activity required at work, the time spent at work bending and lifting, or pushing and pulling moderate to heavy loads, and the level of exposure to heavy vibrations at work).

The psychosocial risk factors included eight questions about satisfaction with current job function and with current employer, the degree of nervousness, anxiety, fatigue, tension, mental concentration, and the frequency of high responsibility required in the job. Finally, the demographic and behavior risk factors included seven questions about pregnancy and fertility history, age, smoking, driving, general and back specific exercises, and stress management. For example, to measure the history of back pain, the following question was asked:

When was the last time you experienced an episode of back pain?

Table 1. Employee participation in the health risk assessments by employees of a northern California county

Department	Employees	Participants	Percent
Parks and Recreation...	65	65	100
Public Works	44	41	93
Hospital A	104	56	54
Hospital B	54	43	80
Total	267	205	77

Table 2. Demographic characteristics of employees of a northern California county

Category	HRA participants (N = 205) Number	Percent	County employees (N = 4,398) Number	Percent	Chi-square
Sex:					
Males	109	53	1,772	40	14.3, P<.01
Females.....	96	47	2,626	60	
Age:					
20 or younger	0	0	17	0.4	58.3, P<.01
21–30.....	14	7	728	16.6	
31–40.....	43	21	1,351	30.7	
41–50.....	66	32	1,390	31.6	
51–60.....	55	27	712	16.2	
61 or older ...	27	13	200	4.5	
Mean	...	40.4	...	42	
Race:					
White	154	75	2,867	65.2	27.4, P<.01
Hispanic.....	21	10	498	11.3	
Black	8	4	472	10.7	
Asian, Pacific-Islander	16	8	480	10.9	
Native American....	0	0	10	0.2	
Other	6	3	71	1.6	

- Today—score 6,
- Less than 1 week ago—score 5,
- More than 1 week ago and less than 4 weeks ago—score 4,
- More than 4 weeks ago and less than 1 year ago—score 3,
- More than 1 year ago and less than 5 years ago—score 2,
- More than 5 years ago—score 1,
- Never—score 0.

The HRA generates a back injury risk score for each participant based on the summaries of answers to all 35 specific questions. Total possible scores range from a minimum of 0 to a maximum of 85. Each participant is then classified into one of the three risk categories: high risk, defined as those with 50 percent or more probability of back injury (that is, who scored 43 or more points on the HRA); medium risk, defined as those with 26–49 percent probability of back injury (that is, who scored 22–42 points on the HRA); and low risk, defined as those with 25 percent or less probability of back injury (that is, who scored 21 or fewer points on the HRA). The HRA was used as the data collection instrument for measuring risk status changes among the study population.

An integrated back injury prevention program was implemented in the four targeted divisions; offered was a combination of education, training, physical fitness activities, and ergonomic improvement. All four divisions received identical intervention. The education modules concentrated on fitness, reduction of backache, weight control, stress management, smoking cessation, cholesterol reduction, nutrition, and interpersonal communication. Three back safety training sessions were offered that focused on body mechanics, hazardous tasks, injury prevention methods, and strength building.

The fitness module emphasized participation in regular physical exercises. All intervention modules were managed and conducted by professional staff members with the help of outside consultants. The ergonomic improvement component was based on reports by outside consultants summarizing the work environment, employee attitudes, specific hazardous tasks, and recommendations to reduce workplace risk factors. Specific recommendations included making safety equipment (hoy lift, safety belts, step stools, and guerneys) more available; improving the design of facilities (replacing skid flooring in showers, improving seating for computer operation, using footstools underneath desks and lumbar seat cushions, rearranging storage places to minimize transporting distance); and training staff on safety procedures in a variety of circumstances (for example, in transferring heavy patients, driving long distances, and paving roads).

Cost-benefit analysis was performed at the end of the pilot program by comparing the costs of the program with the benefits obtained. Specifically, the costs included payments to outside consultants and providers who designed and implemented the program, the materials for the program, and the wages of company staff involved in the program. The benefits had both qualitative and quantitative components. Qualitatively, participants' satisfaction and risk reduction (obtained from the HRA) were two major indicators. The quantitative assessments included reductions in workers' compensation and medical claims and sick day costs related to back injuries.

The injury and claims data for both the study

and control groups were taken from the county files and from the files of the insurance carrier. Ideally, the quantitative components should also include other back-related expenses including long-term disability claims and such opportunity costs as retraining, turnover, and participation time. However, the county information system was unable to provide those relevant data. Therefore, in terms of completeness, this cost-benefit analysis was limited and focused only on the available data. The potential future benefits of the program were not included either.

Results

Active participation by employees in both HRAs was critical to the evaluation of the study. Table 1 summarizes employee participation rates in both HRAs (approximately 1 year apart) among the four targeted divisions. Participants in only one HRA were excluded from the analysis. The total participation rate was 77 percent. Parks and Recreation (100 percent) and Public Works (93 percent) had very favorable rates. Participation rates in the two hospitals (80 and 54 percent) were lower because most of the nonparticipants were having their days-off during the HRAs. Overall, participation rates were sufficiently high to represent the research population of the four selected divisions.

Even though there were no significant demographic differences between employees of the intervention and control groups, demographic differences were found between the study group and all county employees. Table 2 compares the demographic characteristics of the employees who completed the HRAs with all county employees. Fifty-three percent of the participants were male and 47 percent female, whereas 40 percent of all employees were male and 60 percent female ($\chi^2 = 14.3$; $P < .01$). Since more males had back injuries than females employed by the county, the overrepresentation of male employees could account for the relatively higher back injury rate in the study group than in the rest of the county employees. About 35 percent of men and 24 percent of women had back pain during the year.

The average age of the participants was 40.4 and the most likely age group was 41–50 (32 percent). In comparison, the average age of the employees was 42, and the most likely age group was also 41–50 (31.6 percent) ($\chi^2 = 58.3$; $P < .01$). Since the middle-ageds are more likely to have back injuries, the overrepresentation of the middle-aged employees (ages 41–60) in the study group (59 percent versus 48 percent) could be another explanation of its relatively higher back injury rate.

Table 3. Back pain prevalence for 205 participants before and after 1-year intervention program

Time	Initial		Followup		Difference		χ^2
	Number	Percent	Number	Percent	Number	Percent	
Daily back pain	14	7	10	5	−4	−2	1.2
Monthly back pain	22	11	20	10	−2	−1	0.8
Annual back pain	61	30	41	20	−20	−10	[1]9.4
No back pain	108	53	134	65	26	12	[1]13.2

[1] $P < .01$

Table 4. Evaluation of categorical variables for 205 participants using chi-square analysis

Category	Initial (percent)		Followup (percent)		Chi-square	P-value
	Yes	No	Yes	No		
Satisfaction:						
With job	61	39	70	30	3.405	.0650
With employer	69	31	77	23	2.992	.0837
Smoking	30	70	25	75	1.190	.2752
Physical exercise	30	70	36	64	1.714	.1904
Back exercise	37	63	53	47	10.982	.0009
Stress management	69	31	78	22	3.787	.0517

Seventy-five percent of the participants were white; 10 percent, Hispanic; 4 percent, black; 8 percent, Asian and Pacific Islander; and 3 percent, other. In contrast, among county employees, 65.2 percent were white; 11.3 percent, Hispanic; 10.7 percent, black; 10.9 percent, Asian and Pacific Islander; 0.2 percent, Native American; and 1.6 percent, other ($\chi^2 = 27.4$; $P < .01$). The slight overrepresentation by white and underrepresentation by minority groups could bias the outcome. Since minorities are generally less healthy than whites, the results could underestimate the true health status of county employees. Because of the significant demographic differences between participants and the total county employees, the results of this study may not be generalizable to all employees of the county government.

Back pain prevalence. The self-reported back pain prevalence rates declined between the two HRA measurements (table 3). Specifically, among all employees surveyed, 7 percent reported daily experience of back pain in the first HRA compared with

Table 5. Back injury risk status for 205 health risk assessment participants (percent) in four county departments

Status	Parks and Recreation (N=65)	Public Works (N=41)	Hospital A (N=56)	Hospital B (N=43)	Total
High risk:					
First health risk assessment	9.2	7.3	14.3	20.9	12.7
Second health risk assessment	3.9	2.4	8.3	6.3	4.5
Change (percent)[1]	-58	-67	-42	-70	-64
Medium risk:					
First health risk assessment	70.8	56.1	55.4	67.4	62.9
Second health risk assessment	76.9	65.9	54.2	75.0	69.2
Change (percent)[1]	9	17	-2	11	10
Low risk:					
First health risk assessment	20.0	36.6	30.4	11.6	24.4
Second health risk assessment	19.2	31.7	37.5	18.8	26.3
Change (percent)[1]	-4	-13	24	61	8

[1] P-value <.01.

Table 6. Cost savings due to back injury decline among employees of a northern California county

Category	1989	1990
Total savings[1]	0	$251,108
Injuries	109	68
Sick day costs	$366,240	$228,480
Savings due to fewer sick days	0	137,760
Medically related claims	393,127	330,492
Savings due to decline in claims	0	113,348

[1] Savings due to fewer sick days plus savings due to decline in claims.

5 percent who reported such experience in the second HRA. Eleven percent reported back pain a couple of times monthly in the first HRA compared with 10 percent who reported such experience in the second HRA. The declines in the daily and monthly back pain experience were not significant. Thirty percent reported back pain a couple of times yearly in the first HRA compared with 20 percent who reported such experience in the second HRA ($\chi^2 = 9.4$; $P < .01$). Overall, 53 percent of the participants reported no back pain experience in the first HRA compared with 65 percent of the participants in the second HRA ($\chi^2 = 13.2$; $P < .01$). The overall decline in prevalence rates is encouraging, especially given the short intervention period.

Changes in satisfaction and behavior. One of the purposes of the programs to prevent back injuries was to increase job satisfaction and reduce risk behaviors. Table 4 summarizes changes in satisfaction and behavior reported between the two HRA measurements. Progress was made in employees' satisfaction with both their specific jobs and employer. Specifically, 70 percent of the participants were satisfied with their jobs ($\chi^2 = 3.405$; $P = .0650$) and 77 percent with their employer ($\chi^2 = 2.992$; $P = .0837$) compared with 61 percent and 69 percent, respectively, before the intervention. There was a 5 percent decline in smoking, a 6 percent increase in exercising one to two times per week, and a 9 percent increase in stress management. The most significant improvement was back exercise: 53 percent of the participants took part in regular back exercises compared with 37 percent a year ago ($\chi^2 = 10.982$; $P = .0009$).

Changes in risk status. The back injury risk status measured through the HRA is presented in table 5. Changes in risk status between the first and second HRA were remarkable. There was a significant decrease (-64 percent) in high-risk employees. This decline was observed in all four study divisions ranging from 42 to 70 percent. The increase of medium-risk employees (10 percent) was largely due to the decline in the high-risk group. The majority of the employees (69.17 percent) were in medium-risk status. The risk status changes within each division are also summarized in the table.

Cost-benefit analysis. The figure shows the average per employee medical claims for the intervention and control groups between 1988 and 1990. In the intervention group, the average per employee medical claims due to back injuries were $1,304 in 1988, $1,472 in 1989 (a 12.9 percent increase), and $1,238 in 1990 when the injury prevention program was being introduced (a 15.9 percent decline). In the control group, the average per employee medical claims due to back injuries were $1,295 in 1988, $1,495 in 1989 (a 15 percent increase), and $1,750

in 1990 (a 17 percent increase). It is clear from the data that medical claims spending was reduced significantly in the intervention group relative to the control group.

The potential cost savings may be measured by assuming a 12.9 percent increase for 1990 (the actual rate of increase observed in the previous year) in medical claims without injury prevention. In the intervention group, total medical claims were $393,127 in 1989 and $330,492 in 1990. A 12.9 percent increase from 1989 would be $443,840. Thus, the calculated savings were $113,348 ($443,840 – $330,492). This assumption was justified because it was conservative compared with the actual cost increase in the control group. Thus, subtracting the current medical claims costs from the potential costs without injury prevention, a cost savings of $113,348 was realized from medically related claims alone.

Total cost savings should also include sick day costs. Back injuries not only produce huge medically related claims, they also cause many sick days. In 1987–88, the average number of sick days per injury was 24 in the county government. Sick day costs were measured by multiplying the number of sick days per injury by the total number of injuries, and then by the wages per sick day.

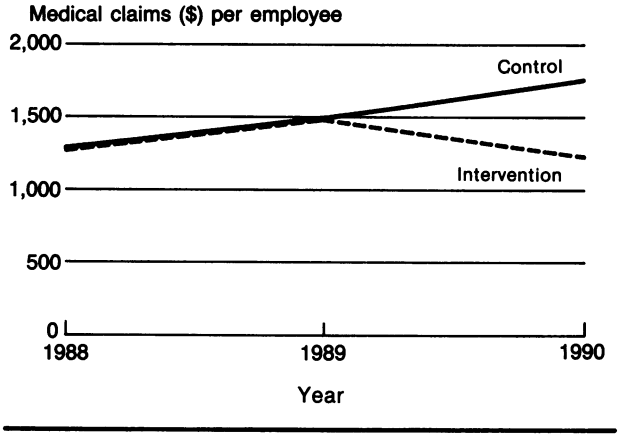
Table 6 summarizes the total potential cost savings attributable to the back injury prevention program. Two components of the savings included savings due to fewer sick days and the decline in medically related claims. In 1990, when the injury prevention program was introduced, a total savings of $251,108 was realized, including $137,760 from fewer sick days and $113,348 from the decline in medically related claims.

The major costs of the injury prevention program included payments to outside consultants and providers who designed and implemented the program including spending related to ergonomic improvement (about $60,000), estimated materials related to health promotion and ergonomics (about $10,000), and the wages (about $20,000) of company staff involved in the program. After subtracting these three components, the net benefit of introducing the back injury prevention program was $161,108 ($251,108 – $90,000). The return on investment was 179 percent ($161,108 ÷ $90,000).

Discussion

The study has shown the short-term impact of a 1-year back injury prevention program in a northern California county. The overall risk status of the participants has improved significantly. However, sustained health promotion programs are needed to maintain the achievements or further reduce participants' risk status, or else some of them could soon return to high-risk status. Even though there was little improvement in the number of employees experiencing daily and monthly back pain, significantly more people no longer experienced back pain annually and some not at all. This means that health promotion could have greater initial impact on people with fewer risk factors presumably because they could overcome bad habits much more easily than those already at high risk.

Comparison of medical claims savings for intervention and control groups of employees of a California county



The results of the study lend support to the widely held belief that health promotion in the workplace can significantly reduce employee health risks, increase health behaviors and attitudes, and improve attitudes toward the employer organization. On the basis of our estimates and assumptions, back prevention programs can be very cost-effective and produce net economic savings. This finding is consistent with previous studies in which researchers concluded that health promotion and disease prevention programs can be more cost-effective than therapeutic medical care (*31–37*).

The rapid rise of health care costs in the United States has become a major concern to benefit managers and medical directors in both public and private sectors. Because back injury is so prevalent in the workplace and predominantly affects workers in their 30s and 40s who are in the most productive period of their employment, it has significant cost implications for employers as well as for the nation. Some of these costs could surely be saved through back injury prevention programs, if they were well-designed and cost effective.

'Because back injury is so prevalent in the workplace and predominantly affects workers in their 30s and 40s who are in the most productive period of their employment, it has significant cost implications for employers as well as for the nation.'

Moreover, unlike some areas of health promotion, such as smoking cessation, the area of back injury prevention is likely to have more immediate payoff for employers. This factor is important because it suggests back injury programs are more likely to yield positive net benefits for employers, other things equal, than other worksite health promotion programs whose benefits which occur in future years have to be discounted up front. The analyses contained in this study can be viewed as a small step in the development of a health care management and disease prevention strategy aimed at controlling costs. Accurate and timely information on how much is being spent, for what kinds of services, and how these expenditure patterns change over time is required.

The workplace is an ideal domain for implementing back injury prevention not only because there has been an exponential increase in total expenditures for health care paid out by employers, but also due to a relatively stable population in the workplace, so that large-scale longitudinal studies can be conducted to assess the impact of health promotion interventions. The combination of culture-shaping incentives and peer influence, which may contribute to behavior change, also make the worksite a potentially effective setting for health promotion efforts.

This study contains a number of limitations. First, the reliability and validity of the HRA for measuring back injury risk needs to be further examined and empirically tested. Even though the HRA was based on the literature delineating the determinants of back injuries, the relative importance of the risk factors remains uncertain. That the risk scores, as calculated, showed a significant decrease in workers classified in the high-risk category after the intervention, but no decrease in those reporting daily or monthly episodes of low back pain, underscores the insensitivity of these measures. While HRA is an appealing technique heavily used in risk measurement, it is imperative that the assumptions used be tested, the determinants of health-related behaviors and the factors that sustain them be peer reviewed, and the weighting of relative risks be adequately assigned to enhance the sensitivity of the measures.

Second, the study design is incapable of differentiating the individual effects of the major components of the intervention program. This information is important because some businesses could not afford to implement the entire program, but only the most effective components. Participants and observers believe that the approach which seems to be most effective in risk reduction is ergonomic intervention. This approach focuses on changing environmental and structural factors in the workplace that put workers at risk for back injury. However, its true impact relative to other components of the injury prevention program, that is, health education and fitness, needs to be assessed by a better designed study with the appropriate control. Moreover, if the ergonomic intervention was in fact most beneficial, it detracts from any credence given to the more traditional health promotion elements emphasizing personal lifestyle and behavior factors.

There also exists the possibility of a Hawthorne effect among the participating units in that employees knowing they are being studied react unusually and their reported behavior change may be more a result of their enthusiasm rather than that of an injury prevention program. Since previous risk data were not available, we could not rule out the bias due to history.

In view of these considerations, the study offers suggestive evidence for the initial benefits of a back injury prevention program. Whether such interventions will continue to reap benefits in future years depend, to a large extent, on a favorable work environment and the maintenance and continuation of positive behavioral changes.

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