Work-Site Cardiovascular Risk Reduction: A Randomized Trial of Health Risk Assessment, Education, Counseling, and Incentives

ABSTRACT

Objectives. This study reports an efficacy trial of four work-site health promotion programs. It was predicted that strategies making use of behavioral counseling would produce a greater reduction in cardiovascular disease risk factors than screening and educational strategies.

Methods. Twenty-eight work sites were randomly allocated to a health risk assessment, risk factor education, behavioral counseling, or behavioral counseling plus incentives intervention. Participants were assessed before the intervention and at 3, 6, and 12 months.

Results. Compared with the average of the health risk assessment and risk factor education conditions, there were significantly higher validated continuous smoking cessation rates and smaller increases in body mass index and estimated percentage of body fat in the two behavioral counseling conditions. The behavioral counseling condition was associated with a greater reduction in mean blood pressure than was the behavioral counseling plus incentives condition. On average among all groups, there was a short-term increase in aerobic capacity followed by a return to baseline levels.

Conclusions. Work-site interventions that use behavioral approaches can produce lasting changes in some cardiovascular risk factors and, if implemented routinely, can have a significant public health impact. (*Am J Public Health.* 1993;83: 1231–1238)

Michelle Gomel, PhD, Brian Oldenburg, PhD, Judy M. Simpson, PhD, and Neville Owen, PhD

Introduction

Cardiovascular disease remains a major cause of premature mortality and morbidity in most industrialized countries.[1] A major aim of cardiovascular disease prevention has been to modify those factors, such as cigarette smoking, serum cholesterol, elevated blood pressure, physical inactivity, and overweight, that are associated with an increased risk of developing cardiovascular disease.[2,3]

It has been argued that work-site health promotion is an important component of a communitywide approach to the prevention of cardiovascular disease.[4,5] Because such a large proportion of the community is employed and individuals spend over a third of their waking hours at work,[5] the potential public health benefits of work-site health promotion are far reaching. However, to make a significant public health impact, it is important to identify those interventions that are most effective in achieving health behavior change at the work site. These can include approaches that are directed at organizational and environmental change, as well as those that are directed at promoting individual change. The latter can include screening, educational, behavioral counseling (incorporating self-monitoring, goal setting, and relapse prevention training), and incentive-based strategies.[4,5]

For work-site weight reduction and smoking cessation intervention studies, programs making use of behavioral strategies and/or incentives have resulted in greater changes than less intensive programs.[6,7] There are, however, methodological problems associated with much work-site research.[5,8] Many studies have failed to obtain objective validation of self-reported behavior changes, particularly for smoking status and physical activity levels. Furthermore, most of the research used for evaluating program effectiveness has involved quasi-experimental or case study designs.[5,8]

There are a number of arguments in favor of multiple risk factor approaches,[9] but most work-site intervention trials have addressed single risk factors, such as smoking or hypertension. To date, only two large work-site multiple risk factor interventions have been evaluated in a randomized controlled design.[10,11] Both evaluated the effectiveness of brief counseling and follow-up contact with a health professional. Only the World Health Organization trial[11] demonstrated a significant effect of the intervention on risk factor change.

We conducted an efficacy trial of four work site–based cardiovascular disease risk factor interventions: health risk assessment, risk factor education, behavioral counseling, and behavioral counseling plus incentives. Work sites were randomly allocated to the intervention conditions, and biochemical and physical measures were used to validate self-reported behavioral changes. It was predicted that the behavioral counseling interventions would produce greater changes in cardiovascular disease risk factors than would the health risk assessment and the risk factor education interventions.

Michelle Gomel, Brian Oldenburg, and Judy M. Simpson are with the Department of Public Health, University of Sydney, Sydney, Australia. Neville Owen is with the Department of Community Medicine, University of Adelaide, Adelaide, Australia.

Requests for reprints should be sent to Michelle Gomel, PhD, Department of Psychiatry, University of Sydney, 2006, New South Wales, Australia.

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TABLE 1—Characteristics of Participants in Each of the Four Interventions

Demographics	Health Risk Assessment (n_1 = 10, n_2 = 130)	Risk Factor Education (n_1 = 8, n_2 = 82)	Behavioral Counseling (n_1 = 6, n_2 = 124)	Behavioral Counseling plus Incentives (n_1 = 4, n_2 = 95)
Mean age, y	31	33	33	31
Sex, %				
Male	85	82	81	85
Female	15	18	19	15
Marital status, %				
Never married	32	28	27	26
Married or living together	58	55	61	61
Other (separated, ivorced, or widowed)	10	17	13	13
Educational level, %				
Some high school (7–12 y)	20	18	18	20
High school (12 y)	53	51	56	55
Further education	27	31	27	25
Job title, %				
Ambulance officer	79	76	73	59
Paramedic	18	18	18	30
Manager/administrator	3	6	9	11

Note. n_1 = the number of stations within each group; n_2 = the number of individuals within each group.

Methods

The study was carried out in the Sydney metropolitan area of the Ambulance Service in the state of New South Wales, Australia. Twenty-eight stations (seven from each of the four regions of the Sydney metropolitan area) with 12 or more employees were randomly selected for this study. All employees from each of these stations were approached to participate, and consent was obtained. The exclusion criteria were an anticipated absence from work of more than 4 weeks during the 3 months following recruitment, imminent transfer to another station not included in the study, and serious health problems that would have precluded involvement in the health risk assessment. Four hundred thirty-one participants were recruited from 488 eligible staff, a participation rate of 88%.

Design and Implementation

A cluster randomization procedure, in which ambulance stations rather than individuals were assigned to each of the four conditions, was used to limit potential contamination between the conditions. Once a station was randomized to a condition, all staff within that station received that intervention. Study recruitment and interventions were conducted sequentially in five waves over an 18-month period. The number of stations allocated to each condition is presented in Table 1. As a result of resource limitations, fewer stations were assigned to the two conditions involving behavioral counseling. Because the incentive condition involved competition between stations, these programs were run in the first wave.

A workplace steering committee, with representatives drawn from management, the unions, and the research team, was established to oversee the implementation of the study. To assist with the recruitment of employees into the study and the dissemination of information, an ambulance officer from each station was appointed as an on-site coordinator. Staff within an ambulance station who were reluctant to participate, following an initial approach from the on-site coordinator, were then approached by a member of the research team.

Intervention Conditions

Health risk assessment. Major risk factors for cardiovascular disease were assessed and feedback provided to each participant on his or her risk factor profile through the use of standardized norms in the form of tables and graphs. The criteria used to define each risk factor are described in the measures section. Participants with cholesterol readings greater than 250 mg/100 mL and/or diastolic or systolic blood pressure readings of greater than 105 mm Hg or 159 mm Hg, respectively, were referred to their family physician. No other information or advice was provided to participants in this condition. The assessment and feedback session lasted approximately 30 minutes.

Risk factor education. These participants received the same health assessment as those in the health risk assessment condition. In addition, during the health risk assessment session, standardized advice on the life-style changes required to reduce heart disease risk factors was provided to those participants with risk factors. The advice was general and was not delivered in the context of a personalized program. An educational resource manual (M. Gomel, B. Oldenburg, A. Bauman, and M. Booth, unpublished manual, 1988) and videotapes containing information on how to modify risk factors for heart disease were also provided to participants. The session, including the health risk assessment, lasted 50 minutes.

Behavioral counseling. Participants received the same components as those in the risk factor education condition. If risk factors were identified, participants were offered up to six life-style counseling sessions over a 10-week period following the baseline assessment. A self-instructional life-style change manual (M. Gomel, B. Oldenburg, A. Bauman, and M. Booth, unpublished manual, 1988) containing programs for modifying the major cardiovascular disease risk factors (smoking, overweight, elevated cholesterol, blood pressure, and exercise) was also provided. The behavioral counseling and the life-style change manual were based on a four-stage model of behavior change involving preparation for change, action to change, maintenance of change, and relapse prevention.[12] In the preparation stage, reasons for and barriers to changing risk factors were identified. Participants also monitored behaviors contributing to their risk factors and identified high-risk situations and coping strategies for dealing with these situations. In the action stage, short- and long-term goals for risk factor change were determined, as well as strategies for achieving these goals. In the maintenance stage, participants reviewed the positive effects of behavior change and likely high-risk situations. In the relapse prevention stage, selected components from previous stages of the program were reviewed. Ongoing assessment and feedback on risk factor status was also provided during the individualized sessions. On average, participants received 2 hours, 20 minutes of counseling (three sessions) from a psychologist during the 10-week program, in addition to the 30-minute health risk assessment session.

Behavioral counseling plus incentives. Participants received the same components as those in the risk factor education condition. In addition, they were provided with a life-style change manual and were offered a goal-setting and follow-up counseling session, as well as a range of incentives. Incentives were provided to participants for making life-style changes conducive to cardiovascular disease risk factor reduction and for achieving 3- and 6-month risk factor reduction targets. For the first incentive, two lottery draws for a $40 voucher were held over the 10-week period following the baseline assessment. Each week, lottery tickets were issued to participants reporting that they had made life-style changes from a specified list. For example, those who stopped smoking for a week received five tickets for the lottery draw. The second incentive was a $40 voucher for those who met their projected 3-month goals, negotiated in the first individualized session. The final incentive was a $1000 prize for the station that achieved the largest percentage of participants meeting their projected 6-month goals. Participants in this program received, on average, 2 hours of counseling in addition to the 30-minute health risk assessment session.

Measures

Participants were assessed at baseline and at 3, 6, and 12 months following the baseline assessment. Assessments were conducted during work time in a gymnasium room attached to each ambulance station. A standardized measurement protocol was developed, and the research staff conducting the health risk assessments received comprehensive training in the use of this protocol. Self-completed questionnaires were used to obtain information on sociodemographic factors, family history of cardiovascular disease and risk factors, and intention and confidence in modifying health behaviors.

The major outcome indices presented in this paper are body mass index, percentage of body fat, systolic and diastolic blood pressure, serum cholesterol, smoking status (validated by cotinine), and aerobic capacity. Examination of the effectiveness of the interventions using composite outcome measures of risk (M. Gomel, B. Oldenburg, J. M. Simpson, and N. Owen, unpublished data, 1993), such as the Framingham logistic regression equation and costing outcomes (B. Oldenburg, N. Owen, M. Parle, and M. Gomel, unpublished data, 1993), will be reported elsewhere.

Overweight. Body mass index (kg/m^2) was calculated. Height and weight were recorded with participants in light clothing and with shoes removed. A body mass index between 20 and 25 kg/m^2 for both men and women was considered to be in the healthy weight range.[13] Body fat was measured with calipers and estimated from skinfold thickness at the biceps, triceps, subscapular, and suprailiac sites. Two readings were taken and an average calculated at each of the four sites. Standardized norms were used to estimate the percentage of body fat from the sum of the four readings.[14]

Serum cholesterol. In the week prior to each of the four health assessments, a blood sample was drawn from each participant by an ambulance paramedic for analysis of serum cholesterol and cotinine. The blood was placed into heparinized tubes and sent in a cold box to the biochemistry department of a large Sydney hospital within 6 hours of being taken. In addition, a whole-blood capillary sample was analyzed immediately during the health risk screening session by the Boehringer-Mannheim Reflotron system with cholesterol reagent carriers that use a cholesterol oxidase/peroxidase method.[15] Cholesterol was regarded as normal if below 200 mg/100 mL.[13]

Cigarette smoking. Information on the average number of cigarettes smoked per day was obtained. Cotinine (a metabolite of nicotine) was measured from the blood sample for those who reported being smokers at baseline. Cotinine was extracted from the plasma and analyzed by means of gas chromatography.

Blood pressure. A sphygmomanometer and stethoscope were used to record blood pressure. Systolic and diastolic readings were taken with the participant seated and the cuff placed at heart level. Two readings were taken and the average recorded. Blood pressure was classified as normal if below 140 mm Hg for systolic and below 90 mm Hg for diastolic.[16]

Aerobic capacity. Participants were excluded from the exercise component of the assessment if they had preexisting heart disease or were on medication for hypertension. An estimate of aerobic capacity (oxygen consumption) was determined by a standardized 7-minute test on a Repco bicycle ergometer.[17] The bicycle ergometer was calibrated before each testing session. Heart rate response (measured by an exercentry) to increasing workloads on the ergometer was used to determine the critical exercise test workload. Heart rate at the sixth and seventh minute was recorded, and the average was used to determine maximum oxygen uptake from standardized norms.[17] Aerobic capacity was calculated as estimated maximum oxygen consumption × 1000 × age correction/weight (kg). An acceptable level of fitness was determined on the basis of the Scandinavian aerobic capacity norms for age and sex.[18]

Statistical Analyses

Because of equipment calibration problems at baseline, the data for aerobic capacity for one station in the health risk assessment condition and the data for body fat for another station in the behavioral counseling plus incentives condition were treated as missing data. For these stations missing data were replaced by the grand mean for all stations at baseline, adjusting for age and sex. All other missing data for continuous variables, including those at follow-up, were replaced by the mean of that participant's available scores for the variable in question. For smoking cessation, all smokers who did not complete the follow-up assessment or who had reported quitting but had missing cotinine readings were considered nonabstinent and included in the follow-up data for calculating cessation rates.

An average cholesterol level was derived from the Reflotron and laboratory-based blood analyses. Mean blood pressure level was calculated as (2 × diastolic + systolic)/3.[19] To derive normally distributed variables for analyses, the values for body mass index and average cholesterol were logarithmically transformed, and square roots were taken of aerobic capacity. Back-transformed means are presented in tables and figures unless otherwise indicated.

Univariate repeated measures analysis of variance (SPSS) was used to assess the short-term and longer term effects of the four cardiovascular disease risk reduction strategies for each outcome measure except smoking. A two-tailed test with a 5% significance level was used for all analyses. A nested design structure was incorporated into the analyses of variance to account for the cluster randomization. Thus, variability between stations within interventions was used as the denominator in testing for differences between interventions. The major contrasts of interest were those that examined the interactions between intervention condition and time. Three main group contrasts were examined: (1) the effect of risk factor education alone (a comparison of the health risk assessment and risk factor ed-

TABLE 2—Mean Raw Values for the Sample on Outcome Measures and Percentage of Smokers at Baseline, by Intervention Subsample

Outcome Measure	Health Risk Assessment	Risk Factor Education	Behavioral Counseling	Behavioral Counseling plus Incentives
Mean body mass index, m/m^2 (SD)	25.2 (3.8)	25.5 (3.7)	25.5 (4.0)	25.7 (3.9)
Percentage of body fat, mean (SD)	21.9 (5.4)	22.8 (5.6)	22.5 (6.1)	22.4 (6.0)
Mean cholesterol, mg/100 mL (SD)	198.7 (42.3)	196.9 (30.8)	199.3 (42.3)	192.3 (38.5)
Mean systolic blood pressure, mm Hg (SD)	126.1 (12.3)	127.4 (11.6)	130.1 (12.6)	124.6 (12.5)
Mean diastolic blood pressure, mm Hg (SD)	81.8 (10.0)	82.6 (9.3)	81.1 (11.5)	81.5 (11.1)
Mean blood pressure, mm Hg (SD)	96.5 (9.4)	97.6 (8.9)	95.1 (10.5)	95.8 (10.4)
Mean aerobic capacity, $mL/Kg^{-1}/min^{-1}$ [a]	34.4 (8.0)	36.1 (12.3)	34.8 (9.5)	36.2 (11.6)
No. of cigarettes per day for smokers, mean (SD)	16.0 (8.0)	18.7 (10.0)	17.5 (13.2)	19.4 (9.8)
Smokers, % (n)	31 (40)	34 (28)	25 (30)	32 (30)

[a]Milliliters of oxygen per kilogram per minute, in terms of estimated maximal oxygen uptake.

TABLE 3—Number and Percentage of Participants in the Four Interventions

	Health Risk Assessment		Risk Factor Education		Behavioral Counseling		Behavioral Counseling plus Incentives		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
No. approached	143	...	106	...	138	...	101	...	488	...
Baseline[a]	130	91	82	77	124	90	95	94	431	88
3 mo[b]	121	93	78	95	120	97	84	88	403	94
6 mo[b]	114	88	72	88	108	87	75	79	369	86
12 mo[b]	115	88	70	85	102	83	77	81	364	84

[a]Number of employees participating in baseline assessment expressed as a percentage of those employees approached to participate.
[b]Number of employees participating in the follow-up assessment expressed as a percentage of those employees participating in the baseline assessment.

ucation interventions), (2) the effect of incentives (a comparison of the behavioral counseling and behavioral counseling plus incentives interventions), and (3) the effect of behavioral counseling strategies (a comparison of the average of the health risk assessment and risk factor education interventions with the average of the behavioral counseling and behavioral counseling plus incentives interventions). Two other contrasts examined linear and quadratic trends to test for short-term and longer term changes over time.

Analyses of smoking cessation outcomes did not test for differences between stations within interventions because of the small number of smokers at each station. Those smokers at baseline who, at any follow-up, did not have a cotinine reading or had a cotinine reading of 100 or more were considered nonabstinent for the analyses. Chi-square tests and Fisher's Exact Test, where appropriate, were used for assessing differences between groups for smoking cessation at each of the follow-ups.

Because intracluster correlations were not known prior to the study, the power of the trial to detect differences between groups in the change of a risk factor was calculated retrospectively. Power calculations took into account the cluster randomization procedure by multiplying the estimated variance by an inflation factor, $1 + (n - 1)\rho$, where ρ is the average intracluster correlation for change from baseline to 3 months and n is the average station size of 15; an average sample size of 100 per group was assumed.[20] The trial had 80% power to detect absolute differences (0.25 for square root of aerobic capacity, 1.13 for percentage of body fat, and 5.39 for mean blood pressure) and multiplicative differences (1.1% for body mass index and 7.2% for mean cholesterol) between two intervention conditions at the 5% two-sided significance level.

Results

Baseline Characteristics of Participants

A summary of demographic characteristics by group is presented in Table 1. Chi-square tests showed no significant differences between groups for gender, marital status, or educational level. There was a significant baseline difference between groups for age, $F(3, 24) = 2.98$, $P = .05$, and job description, $\chi^2 = 13.9$, $df = 6$, $P = .03$. Age was not used as a covariate because the differences between groups were small and unlikely to interact with interventions over time.

There were no significant baseline differences between groups on the major outcome measures at baseline, with the exception of systolic blood pressure, $F(3, 24) = 5.27$, $P = .006$. Baseline values of the major outcome measures for the four intervention groups are presented in Table 2.

Participation and Follow-up Rates

Four hundred thirty-one individuals (88% of eligible employees) were recruited into the study and participated in the baseline assessment. Of these, 94%, 86%, and 84% completed the 3-, 6-, and 12-month assessments, respectively. Table 3 presents participation rates for each condition. Participation rates differed significantly between groups at baseline, $\chi^2 = 16.82$, $df = 3$, $P = .0008$, using the individual as the unit of analysis. This resulted from the lower level of participation for individuals in the risk factor education group. There were, however, no significant differences in participation between groups at the follow-ups.

Major Outcomes

Body mass index. Although body mass index increased significantly overall over the four assessment occasions, $t = 2.04$, $df = 72$, $P = .04$, the increase

was significantly greater for the average of the health risk assessment and risk factor education groups than for the average of the behavioral counseling and behavioral counseling plus incentives groups, $t = 2.12$, $df = 72$, $P = .04$. The increase in body mass index from baseline to the 12-month follow-up for the average of the health risk assessment and the risk factor education groups was 4% higher than the average increase in the behavioral counseling and behavioral counseling plus incentives groups (see Figure 1).

Percentage of body fat. Figure 2 presents the mean values for body fat for the intervention groups over the 12-month period. There were no significant changes between groups for estimated percentage of body fat from baseline to 12 months. However, there was a significant decrease in body fat, followed by a return to baseline levels over the 12 months, for the average of the behavioral counseling and behavioral counseling plus incentives groups compared with the average of the health risk assessment and risk factor education groups, $t = 2.38$, $df = 72$, $P = .02$.

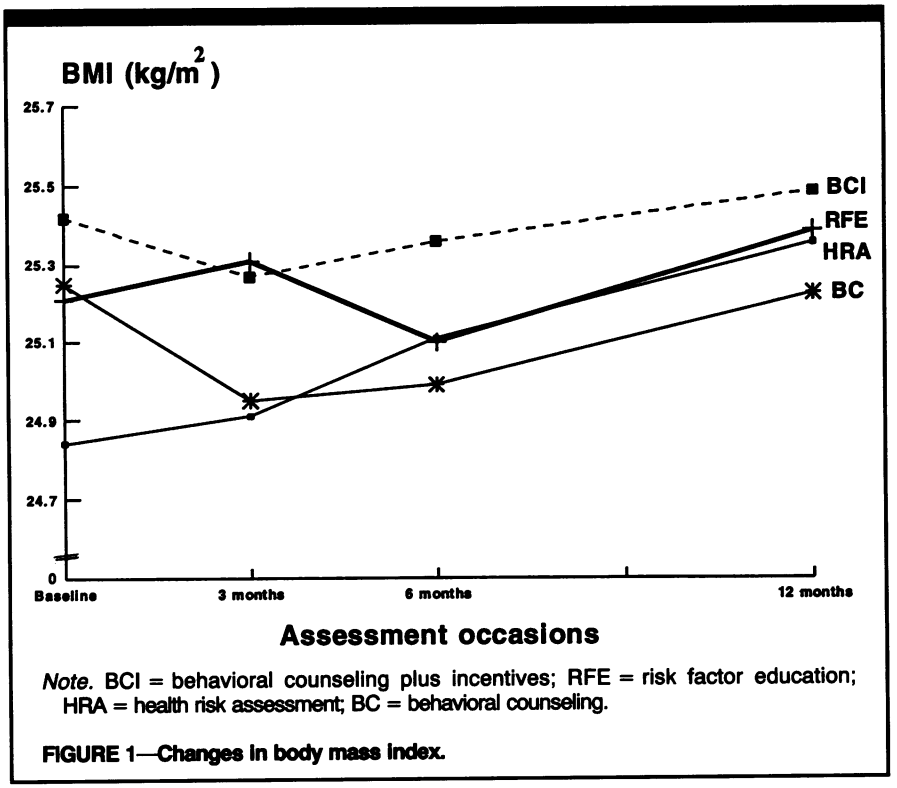
Mean cholesterol changes. Averaged over all groups, there were no significant changes in mean cholesterol over the 12-month assessment period. There were also no significant differences between groups on this outcome over the assessment period.

Mean blood pressure changes. There was a significant short-term decrease in blood pressure followed by an increase for the behavioral counseling plus incentives group compared with the behavioral counseling group, $t = 2.78$, $df = 72$, $P = .01$. There was also a significant overall decline in mean blood pressure from baseline to 12 months for those in the behavioral counseling group compared with those in the behavioral counseling plus incentives group, $t = 4.3$, $df = 72$, $P = .0002$ (Figure 3).

Aerobic capacity. Averaged over all groups, there was a significant increase in aerobic capacity, followed by a return to baseline levels, $t = 2.1$, $df = 72$, $P = .03$ (see Figure 4). However, there were no significant differences in aerobic capacity between groups over the 12 months.

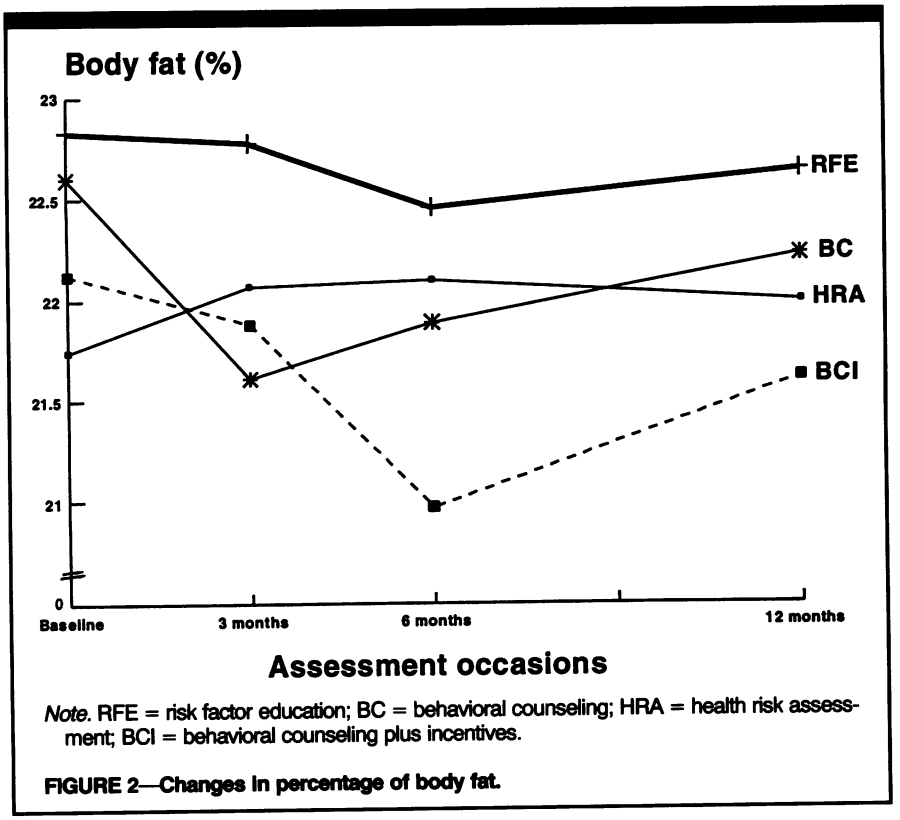
Cigarette smoking. Cessation rates were derived from those who were smokers at baseline. One person from each of the treatment groups, with the exception of the behavioral counseling group, commenced smoking during the year; these participants were excluded from the analyses. Point prevalent cessation rates did not differ significantly between the health risk assessment and risk factor education groups, or between the behavioral counseling and behavioral counseling plus incentives groups, at 3, 6, or 12 months. However, a significantly higher percentage of individuals in the pooled behavioral counseling and behavioral counseling plus incentives groups (18%) than in the pooled health risk assessment and risk factor education group (3%) had quit smoking at 3 months, $\chi^2 = 8.27$, $df = 1$, $P = .004$, but not at 6 or 12 months (see Figure 5).

An analysis of continuous cessation rates from baseline to the 6- and 12-month



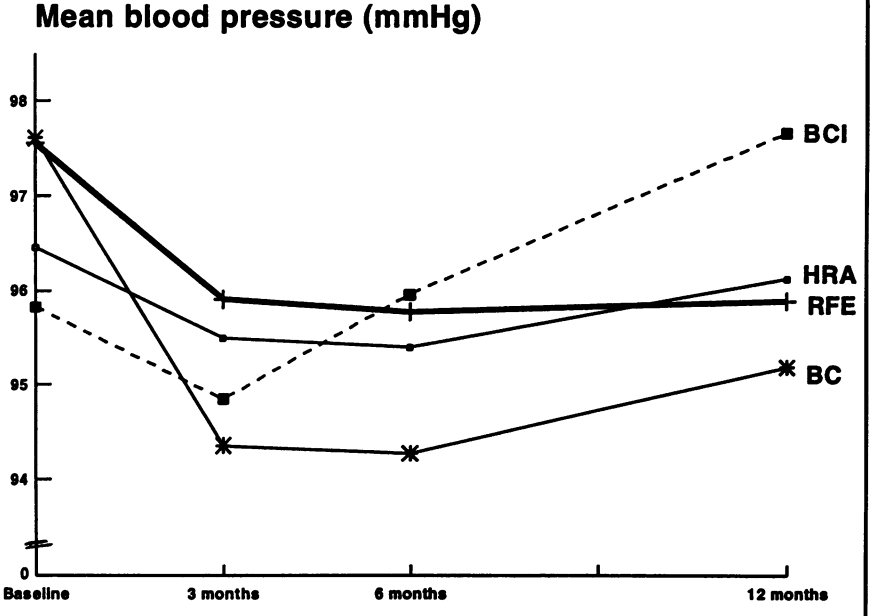
Note. BCI = behavioral counseling plus incentives; RFE = risk factor education; HRA = health risk assessment; BC = behavioral counseling.

FIGURE 1—Changes in body mass index.



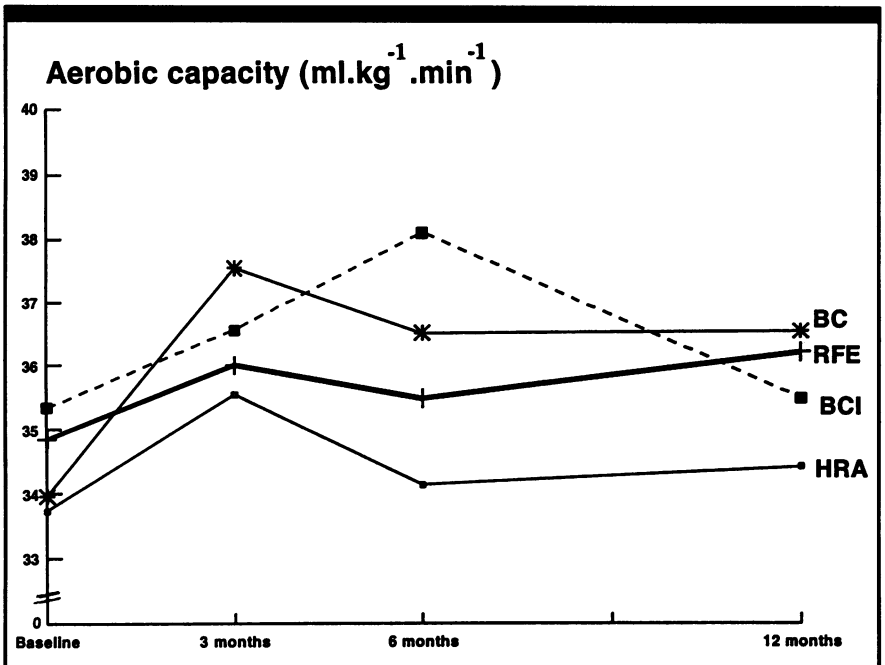
Note. RFE = risk factor education; BC = behavioral counseling; HRA = health risk assessment; BCI = behavioral counseling plus incentives.

FIGURE 2—Changes in percentage of body fat.



Note. BCI = behavioral counseling plus incentives; HRA = health risk assessment; RFE = risk factor education; BC = behavioral counseling.

FIGURE 3—Changes in blood pressure.



Note. BC = behavioral counseling; RFE = risk factor education; BCI = behavioral counseling plus incentives; HRA = health risk assessment.

FIGURE 4—Changes in aerobic capacity.

follow-ups was also conducted. There were no significant differences for continuous cessation rates between the health risk assessment and risk factor education groups or between the behavioral counseling and behavioral counseling plus incentives groups from baseline to each of the follow-ups. Continuous cessation rates (see Figure 6) were significantly higher for the pooled behavioral counseling and behavioral counseling plus incentives condition than for the pooled health risk assessment and risk factor education condition from baseline to 6 months (Fisher's Exact Test, $P = .05$) and from baseline to 12 months (Fisher's Exact Test, $P = .05$). Six-month continuous cessation rates were 10% for the behavioral counseling and behavioral counseling plus incentives condition and 1% for the health risk assessment and risk factor education condition. Twelve-month cessation rates were 7% for the behavioral counseling and behavioral counseling plus incentives condition and 0% for the health risk assessment and risk factor education condition.

Discussion

Although it has been argued by many that the work site provides an ideal opportunity for intervening with cardiovascular disease, there has been little methodologically rigorous research investigating the efficacy of such interventions.[5] The current study provides evidence that interventions making use of behavioral counseling strategies produced larger changes in some cardiovascular disease risk factor measures when compared with risk factor education or health risk screening alone.

A higher proportion of those in the two behavioral counseling conditions than of those in the health risk assessment and health education conditions had quit smoking by 3 months (18% vs 3%). Continuous cessation rates for the two behavioral counseling conditions were also significantly higher than those for the health risk assessment and risk factor education conditions from baseline to 6 and 12 months (10% vs 1% and 7% vs 0%, respectively).

Although there appeared to be an overall increase in weight over the 12-month period, this increase was not as great for the behavioral counseling and behavioral counseling plus incentives groups. Changes in body fat did not reflect the same pattern of effect as for body mass index. The interventions incorporating behavior change strategies achieved larger reductions in body fat than did the health risk assessment and risk factor education interventions. However, this was only a short-term effect; there were no differences between groups from baseline to 12 months.

In relation to mean blood pressure, the behavioral counseling group achieved greater long-term reductions over the 12-

month period than the behavioral counseling plus incentives group. This may be attributable to the negative effect of incentives, to the additional counseling, or to the more frequent contact that participants in the behavioral counseling group received.

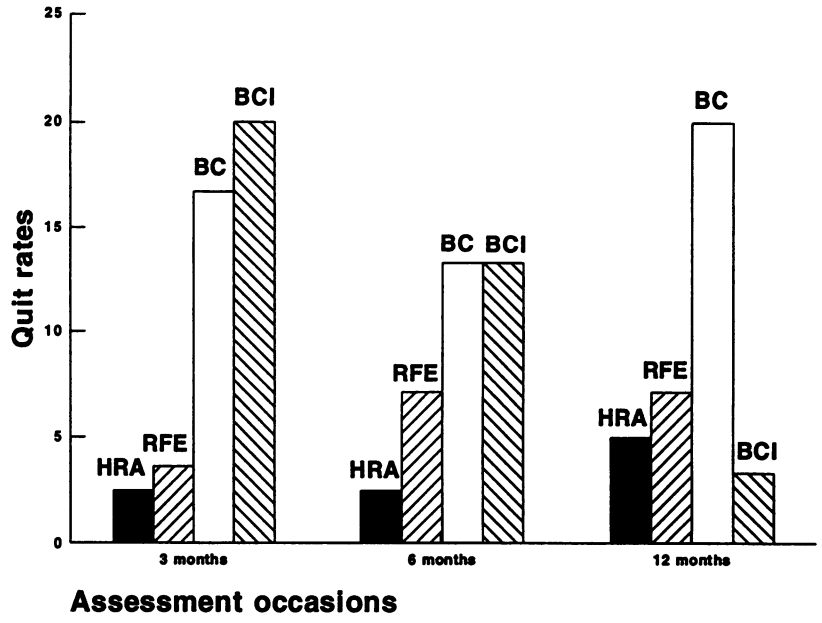
Aerobic capacity increased significantly for all groups, but this increase was not maintained at 12 months. Furthermore, the short-term improvement in aerobic capacity was similar across all intervention groups. None of the interventions in this study, however, appeared to affect serum cholesterol levels.

The results of many studies[5] underscore the difficulty of achieving long-term cardiovascular disease risk factor changes. The present study, while finding some relapse, did show lasting changes at 1 year with interventions that are considerably less intensive than others reported in the literature, particularly in the areas of smoking[21] and overweight.[22]

Two factors may have decreased the effect size of the major comparison between the two conditions incorporating behavioral strategies and the two less intensive conditions. The first relates to the lower initial participation rates of the risk factor education group. An initial negative reaction by staff from two of the stations assigned to this condition largely contributed to these lower participation rates. Within these stations there was some pressure not to participate in the study, so that those who did were likely to be a select group of more motivated employees. The second factor related to contamination between intervention conditions. Although random assignment of stations was used to minimize such contamination, movement and transfer of individuals between the different ambulance stations did occur. Again, this would have the effect of reducing differences between the intervention groups.

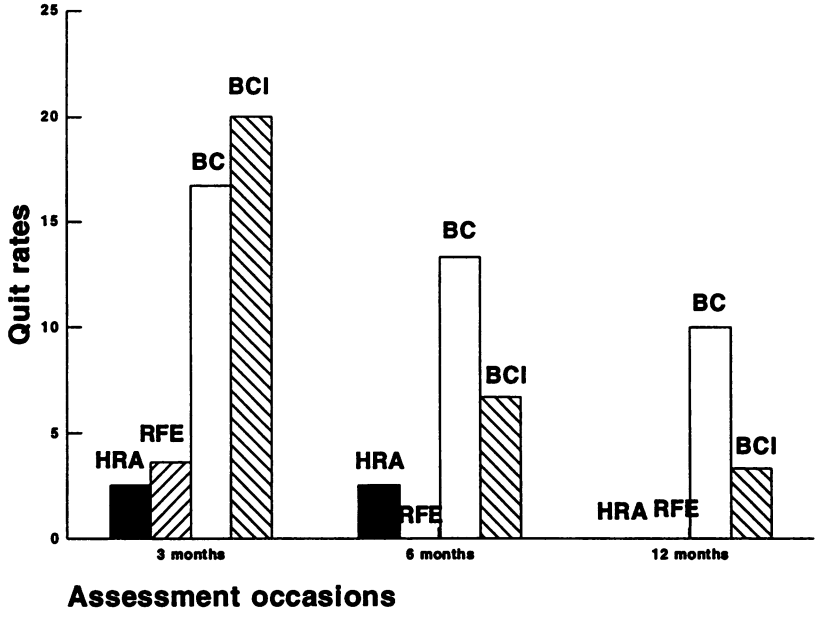
There are four important methodological features of this trial. First, work sites were randomized to the different intervention conditions, and the analysis dealt with this appropriately. In a recent review of studies using a cluster randomization procedure, it was found that half the studies failed to take into account between-cluster variation in the analyses.[23] Such an omission inflates the type 1 error rate.[20] Second, physical and biochemical measures were obtained to validate self-reported life-style changes. Failure to include such measures has been a weakness of much previous research in this area. The third feature was the high participation and low attrition rates achieved and the treatment of data from dropouts: there was an initial participation rate of 88%, and the attrition rate was less than 10% at the 12-month follow-up. Furthermore, data from dropouts were not excluded from the analyses. The final feature was the comparison of four different intensities of interventions to modify cardiovascular disease risk factors.

Because of the methodological features described above, the change in risk factors achieved by each intervention in the current study is likely to be smaller



Note. HRA = health risk assessment; RFE = risk factor education; BC = behavioral counseling; BCI = behavioral counseling plus incentives.

FIGURE 5—Smoking cessation rates.



Note. HRA = health risk assessment; RFE = risk factor education; BC = behavioral counseling; BCI = behavioral counseling plus incentives.

FIGURE 6—Continuous smoking cessation rates.

than that observed in other studies. For example, the use of intensive recruitment strategies meant that many employees who were not motivated to change participated in the baseline and follow-up assessments. Although the magnitude of change achieved, for example, by those in the behavioral counseling condition was not large across all risk factors, such an intervention is likely to have a significant public health impact if observed across the wider working population. Furthermore, because reductions occurred across a number of risk factors, assessment of the combined effect of risk factor changes is likely to reveal larger effects (M. Gomel, B. Oldenburg, J. M. Simpson, and N. Owen, unpublished data, 1993).

In conclusion, we have reported on an efficacy trial of four work-site health promotion interventions, using a controlled research design, validation measures, and intensive recruitment strategies that were successful in achieving high participation rates throughout the trial. Interventions making use of behavioral counseling strategies were found to be more effective in modifying cardiovascular disease risk factors than screening and educational interventions. Further research is needed to replicate these findings with different study populations. In addition, it needs to be examined whether targeting the work-site environment for change as well promotes better maintenance of the change achieved by behavioral counseling strategies alone. □

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