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A comprehensive worksite cancer prevention intervention: behavior change results from a randomized controlled trial (United States)

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Abstract

Objective: Workplace cancer prevention initiatives have been least successful with blue-collar workers. This study assesses whether an intervention integrating health promotion with occupational health and safety results in significant and meaningful increases in smoking cessation and consumption of fruits and vegetables, compared to a standard health promotion intervention, for workers overall and for blue-collar workers in particular.
Methods: A randomized controlled design was used, with 15 manufacturing worksites assigned to a health promotion (HP) or a health promotion plus occupational health and safety intervention (HP/OHS), and compared from baseline (1997) to final (1999). The response rates to the survey were 80% at baseline (n = 9019) and 65% at final (n = 7327). Both groups targeted smoking and diet; the HP/OHS condition additionally incorporated reduction of occupational exposures.
Results: Smoking quit rates among blue-collar workers in the HP/OHS condition more than doubled relative to those in the HP condition (OR = 2.13, $p = 0.04$), and were comparable to quit rates of white-collar workers. No statistically significant differences between groups were found for mean changes in fruits and vegetables.
Conclusions: Integration of occupational health and safety and health promotion may be an essential means of enhancing the effectiveness of worksite tobacco control initiatives with blue-collar workers.

Introduction

Health behaviors, such as tobacco use and low consumption of fruits and vegetables, are important risk factors for various cancers [1]. Interventions targeting these health behaviors have had limited success with reducing disparities in the prevalence of these behaviors by socioeconomic status. For example, despite overall reductions in smoking prevalence in recent decades, disparities in smoking prevalence by occupation and education have persisted. In 1997 the smoking prevalence among blue-collar workers (including craftspersons and kindred workers, operatives, transportation operatives, and laborers) was 37% for men and 33% for women, compared to 33% for men and 32% for women in service jobs, and 21% for men and 20% for women in white-collar occupations [2]. In addition, blue-collar workers' rates of smoking are declining more slowly than those of other workers [3]. Similar disparities by socioeconomic status are seen for other health behaviors, including consumption of fruits and vegetables [4].

Worksites represent an important channel for addressing these occupational disparities [5–10]. Worksite cancer prevention interventions include health promotion efforts targeting individual health behaviors through educational or policy initiatives, and occupational health and safety efforts aimed at reducing the potential for exposure to health and safety hazards on the job. Worksite health promotion programs have been least successful, however, in influencing the health behaviors of blue-collar workers [11, 12]. Traditional

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worksite health promotion programs may be missing an important element important to success with blue-collar workers, that is, addressing job-related hazardous exposures. Despite legislation requiring worksites to protect employees from occupational hazards [13], the burden of occupational injury and disease remains high [14, 15]. In the US, for example, an estimated 60,000 Americans die of occupational diseases each year, including roughly 10% of annual cancer deaths [14]. Not surprisingly, there have been increasing calls for a comprehensive approach to worker health [16–22], and there are growing precedents for worksite programs that integrate efforts to reduce behavioral risk, including tobacco use, with occupational health efforts [23–27].

There are several important reasons for integrating messages on risk-related behaviors with occupational health and safety efforts. First, exposures on the job may be perceived by blue-collar workers as posing a greater risk than personal health behaviors. The risk communication literature indicates that risks are perceived as higher when they are characterized as involuntary, undetectable, outside personal control, and unfair [28–30], characteristics typical of job risks. Second, both individual health behaviors and hazardous exposures on the job represent important health risks, particularly for blue-collar workers. In some cases, as with smoking, there may be additive or synergistic effects with toxic agents found in the worksite, potentially resulting in a more profound effect than that which might be expected from the separate influences of either alone [31]. In addition, occupational exposures may contribute to explaining socioeconomic differences in mortality rates, and are an important component of efforts to reduce these disparities [32]. Third, the presence of hazardous exposures at work may increase workers' perceptions of vulnerability [33–35]. A prior study found that blue-collar smokers who were exposed to job hazards were three times as likely to be planning to quit smoking compared with their unexposed peers [36]. Thus, integrating messages on job and behavioral risks may be an effective means of enhancing motivation to change health behaviors. Indeed, because job risks are a high priority for workers, reduction of job risks may be required to gain credibility with this audience and to increase its receptivity to health education messages regarding individual health behaviors [23, 37].

This article reports the results of the WellWorks-2 study, which was designed to provide a stringent test of a worksite cancer prevention intervention integrating health promotion and occupational health and safety. Specifically, this study tested the primary hypothesis: In comparison to a standard health promotion intervention, an intervention integrating health promotion *plus* occupational health and safety will result in significant and meaningful increases in smoking cessation and consumption of fruits and vegetables, both in the population of all workers, and more specifically, among blue-collar workers. We expected that the integrated health promotion–occupational health and safety intervention would be most effective in influencing health behavior change among those with the highest hazardous exposures: blue-collar workers.

Materials and methods

Design

The WellWorks-2 study used a randomized, controlled design with the worksite as the unit of assignment and intervention; analyses were conducted controlling for worksite. After baseline assessments, 15 worksites were randomly assigned to one of two conditions: (1) Worksite health promotion only (HP Group; eight worksites); and (2) Worksite health promotion integrated with an occupational health and safety intervention (HP/OHS Group; seven worksites). Worksites were randomized within blocks: unionized versus non-unionized; single versus multiple buildings; and three worksites that were part of a single large company. Worksites were randomly assigned by the study biostatistician using a process conducted independently from the intervention team.

Study population

Sites were identified using Dun and Bradstreet listings of manufacturing businesses within eastern Massachusetts. A total of 89 worksites was contacted; 41 were assessed to be eligible for the study. Eligibility criteria for worksites recruited to the study included the following: (1) employ between 400 and 2000 workers, (2) probable use of chemical hazards, and (3) turnover rate less than 20% (to prevent excessive loss to follow-up). In addition, worksites agreed to: (1) be randomly assigned to intervention condition, (2) allow completion of surveys on work time at baseline and final, and (3) participate in an Occupational Hazards Assessment conducted by the study's industrial hygienist at baseline and final. Of 41 eligible worksites, 15 agreed to participate in the full study. The types of manufacturing conducted at the recruited worksites included adhesives, food, technology, jewelry, motor controls, paper products, newspaper, abrasives, automobile parts, and metal fabrication.

At baseline, worksites ranged in size from 424 workers to 1585 workers (mean: 741 per site). All workers were eligible to participate in the intervention. Workers were eligible to participate in the surveys if they were non-contractual workers employed on a permanent basis for 15 hours per week or more, and worked on-site.

Data collection

Data were collected from individual workers using self-administered surveys in each worksite at baseline (1997) and final (1999). Baseline and final surveys were conducted at approximately the same time of year in each worksite in order to avoid seasonal differences in eating patterns, and were administered to a census of all workers. The surveys were conducted in group settings during work time at the worksites in 12 of the 15 worksites at baseline, and were distributed through company mail or to employees' homes in the remaining sites. At final, the survey was conducted through group administration in combination with worksite distributions in seven of the 15 sites, and solely through worksite channels in the remaining sites. The response rate was 80% at baseline (range 64–92%; total n = 9019) and 65% at final (range 31–89%; total n = 7327). A total of 5156 subjects responded to both the baseline and final surveys. This subgroup constituted an embedded cohort of respondents.

Intervention methods

In order to avoid confounding due to the introduction of between-group differences unrelated to the incorporation of occupational health and safety, we based the interventions for both conditions on the same two key theoretical constructs: (1) principles of community organization [38–41], operationalized in this study as joint worker–management participation, and (2) a socio-ecological model [42–45], with interventions at the individual, organizational, and environmental levels of influence. Intervention delivery was guided by process objectives that specified tested behavior change and worker-centered educational strategies and intervention activities, and structured a relatively equivalent "dose" of intervention across the two conditions. A brief description of the intervention methods used in this study is presented below; further details are presented elsewhere [46].

Joint worker–management participation
In both conditions Employee Advisory Boards (EABs) were formed to serve as channels for worker–manager input into WellWorks programs. EABs included representation from workers, management, and various departments, and met for approximately one hour each month. EABs in the HP/OHS condition also included health and safety representation, and in some cases their efforts were incorporated into the health and safety committee. The EABs worked with project staff in planning and delivering the interventions within the worksites.

Interventions targeting the worksite organization and environment
The HP condition provided consultation to management on tobacco control policies, food catering, and cafeteria policies. The HP/OHS condition additionally recommended changes to reduce workers' exposures to hazardous substances used in work processes. These recommendations were based on baseline walk-through assessments of exposures and occupational health and safety programs, conducted by the program's industrial hygienist, using the Occupational Hazards Assessment. These contacts included one-to-one consultation and technical assistance, group educational sessions, and educational communication with written materials. The management intervention for occupational health and safety was based on industrial hygiene principles that delineate a hierarchy of controls for the reduction of workplace hazards [21, 47]. WellWorks encouraged companies to adopt a pro-active, preventive approach, going beyond compliance with legal standards set by the Occupational Safety and Health Administration.

Interventions for individual workers
Interventions for individual workers were based on theories of health communications and behavior change [48–50]. In the HP condition the individual interventions focused on nutrition and tobacco use. In the HP/OHS condition each intervention activity addressed both occupational health and safety (exposure to hazardous substances) and at least one health behavior (smoking and/or nutrition). For example, as a means of addressing worker concerns regarding exposure to occupational hazards, worksite tobacco control programs incorporated messages concerning occcupational health and safety, and occupational health and safety programs incorporated messages concerning smoking or nutrition. These interventions were structured by process objectives setting targets for the amount of intervention to be delivered through a range of intervention components, including: self-assessment with feedback, self-help activities, contests, demonstrations or displays with personal interactions, opportunities to try behaviors and set goals, and group discussion.

Measures

We assessed worksite smoking prevalence at baseline and final. Current smokers were defined as individuals who had smoked at least 100 cigarettes in their lives and defined themselves as current smokers. Smoking quit rates were measured among the cohort of baseline smokers who responded to the final survey. Quit rates were assessed by self-reported abstinence for the six months prior to the survey.

Fruit and vegetable intake was measured using a seven-item fruit and vegetable screener. This screener was developed for use in the National Cancer Institute's Five-A-Day for Better Health research projects, based on the national Five-A-Day survey [51] and other fruit and vegetable screeners [52–54]. The seven items assessed the usual number of servings per day of orange or grapefruit juice; other fruit juices; green salad; French fries or fried potatoes; baked, boiled, or mashed potatoes; vegetables other than salad or potatoes; and fruit, not counting juices. Servings of fruits and vegetables included the summary of these items, excluding French fries and fried potatoes.

Worker characteristics were assessed using standard items, and included gender, age, race/ethnicity, and education. "Blue-collar" occupations *versus* other occupational groups were defined by whether workers were paid by the hour or on salary.

Data analysis

The unit of randomization and intervention was the worksite, while the unit of measurement was the employee. Analyses were computed by taking into consideration the nesting of employees in worksites. We used mixed-effects linear modeling to test hypotheses concerning the intervention groups controlling for the clustering of respondents in worksites [55]. The linear logistic regression analyses were computed iteratively re-weighted likelihoods [56]. All analyses were conducted using the personal computer version of SAS statistical software [57]. Reported *p*-values are for two-sided alternative hypotheses.

We first tested whether one intervention condition was more effective than the other in changing behavior in the cross-sectional samples. For the numerical outcome (servings of fruit and vegetables), we computed a mixed-effects linear model with intervention condition and time of survey (baseline or final) as fixed effects and worksite as a random effect. The test of the intervention by survey interaction effect is the test of no difference between the two conditions on change in the outcome measure. We also tested for a significant change over time (survey effect) within each intervention group. Mixed-model logistic regression analysis was used for the dichotomous outcome (smoking status), and comparable effects were tested. We reported the adjusted means or percentages for the groups and times.

We computed a repeated-measures analysis of change in behavior in the embedded cohort. For servings of fruits and vegetables we computed the change score for each subject and then a mixed-effects linear model on the difference with intervention group as a fixed effect, worksite as a random effect, and baseline level of the variable as a covariate. We tested whether the mean changes in the two conditions were significantly different from each other, as well as whether the mean change in each intervention group was significantly different from zero. Job type and the other worker characteristics were added to the basic models as covariates and the effects of the covariates on mean change and the difference in change between intervention conditions were tested. For these analyses we reported the adjusted mean outcome at final and the mean change from baseline.

For analyses of smoking cessation in the embedded cohort we restricted the analysis to workers who reported being current smokers at baseline and compared the percentage of those who reported quitting at least six months prior to the final survey. For this analysis we used the mixed-effects logistic regression analysis with intervention condition as a fixed effect and worksite as a random effect. We tested whether the adjusted quit rates differed significantly between the two intervention conditions. The worker characteristics were added as covariates and the effects of the covariates on quit rates and on the difference in quit rates were tested. We reported the adjusted quit rates by intervention condition.

Results

Characteristics of the sample

Characteristics of respondents included in both cross-sectional surveys and in the cohort followed from baseline to final are presented in Table 1. This table demonstrates that the randomization was generally effective in creating comparable groups, although there were several differences between groups. In the two cross-sectional surveys, compared to those in the HP/OHS group, respondents in the HP condition were somewhat younger, had somewhat less education, were somewhat less likely to be white, and were somewhat less likely to work in jobs paid by the hour rather than on salary. Proportionately fewer men were represented

Table 1. Selected characteristics of respondents by intervention group and time: cross-sectional samples and embedded cohort (percentages)

	Cross-sectional sample				Embedded cohort	
	Baseline		Final		Baseline	
	HP/OHS* (n = 4636)	HP** (n = 4383)	HP/OHS (n = 3617)	HP (n = 3710)	HP/OHS (n = 2644)	HP (n = 2512)
Age (years)						
30 or younger	12.4	15.6	12.0	16.1	10.5	12.3
31–40	27.0	32.7	24.2	30.3	25.5	33.2
41–50	32.0	28.1	32.7	28.7	34.8	30.4
51–60	23.5	18.6	25.3	20.2	25.8	20.6
61–70	5.1	4.4	5.5	4.3	3.3	3.2
71 or older	0.1	0.6	0.3	0.4	0.1	0.4
Education						
Did not finish HS	9.3	14.7	7.8	11.2	8.7	13.9
HS or GED	26.1	26.9	24.6	26.4	27.0	28.1
Some post-HS	39.8	31.0	39.7	31.6	39.1	31.6
College graduate	24.9	28.2	27.9	30.8	25.3	26.5
Race/ethnicity						
White	84.9	78.3	83.2	79.3	85.6	81.1
Asian	3.1	6.0	4.3	6.2	3.6	5.2
Latino/a	2.6	5.8	3.2	5.1	2.3	4.5
African American	2.9	3.4	3.1	3.2	2.4	2.9
Native American	2.7	2.1	2.2	1.8	2.6	2.2
Other	2.7	3.6	2.9	3.0	3.5	4.1
Job type						
Hourly	71.0	65.2	67.5	62.3	69.8	64.6
Salary	29.0	34.8	32.5	37.7	30.2	35.4
Sex						
Men	66.4	56.9	62.9	60.2	63.0	57.5
Women	33.6	43.1	37.1	39.8	37.0	42.5
Smoking status						
Smoker	20.4	18.6	16.3	17.0	17.7	17.0
Non-smoker	79.6	81.4	83.7	83.0	82.3	83.0

* HP/OHS = Health Promotion and Occupational Health & Safety.
** HP = Health Promotion only.

in the HP condition compared to the HP/OHS condition. Similar trends are seen in the between-group differences in the cohort, indicating that the two samples are similar.

Changes in outcomes by intervention group in cross-sectional comparisons

Table 2 presents differences by condition from baseline to final in smoking prevalence and mean servings of fruits and vegetables in the two cross-sectional samples. The overall decrease in smoking prevalence was somewhat greater in the HP/OHS condition than in the HP condition, although this difference was not statistically significant. Small and statistically non-significant differences were observed for mean servings of fruits and vegetables.

Quit rates in the cohort

As shown in Table 3, we examined quit rates among baseline smokers in the embedded cohort. For all smokers the quit rates were somewhat higher in the HP/OHS condition compared to the HP group, but the difference was not statistically significant. We hypothesized *a priori* that the integrated health promotion–occupational health and safety intervention would have the most relevance to workers in blue-collar positions, measured here as hourly wage earners, where exposures to hazards on the job were more common than among those in white-collar jobs, defined here as being paid on

Table 2. Adjusted means at baseline and final by intervention: Cross-sectional sample

	HP/OHS		HP		*p*-Value
	Baseline	Final	Baseline	Final	
Smoking prevalence					
n	4561	3558	4303	3621	
Adjusted prevalence (%)	20.3	16.2	18.7	16.8	
Change		−4.1		−1.9	0.18
Mean servings of fruits and vegetables (screener)					
n	4430	3409	4119	3423	
Adjusted mean servings	3.45	3.42	3.53	3.56	
Change		−0.03		+0.03	0.54
Mean perceived exposure					
n	4624	3609	4356	3698	
Adjusted mean	6.82	6.96	6.09	6.34	
Change		+0.14		+0.25	0.61

Table 3. Adjusted 6-month quit rates at final by intervention: overall and by job type (embedded cohort of smokers at baseline: n = 880)

	HP/OHS final	HP final	OR	*p*-Value
All workers				
n	436	389		
Quit rate	11.3	7.5	1.57	0.17
Hourly workers				
n	365	319		
Quit rate	11.8	5.9	2.13	0.04
Salaried workers				
n	71	70		
Quit rate	9.9	12.7	0.76	0.63

p-Value for difference between hourly and salaried workers in intervention effect = 0.13.

salary. For this reason analyses also examined changes in outcomes by job type. Smoking quit rates among hourly workers in the HP/OHS condition more than doubled relative to those in the HP condition (11.8% *vs* 5.9%; $p = 0.04$), and were comparable to quit rates of salaried workers. We found no differences in quit rates between groups for salaried workers.

Changes in fruit and vegetable consumption in the cohort

As shown in Table 4, only small and statistically non-significant changes were observed in the embedded cohort overall. We found no differences by job type (data not shown).

Discussion

High rates of smoking and low fruit and vegetable intake pose particular risks for blue-collar workers. Prior worksite interventions have had little success in motivating blue-collar workers to participate in health promotion programs or in influencing the health behaviors of this population [11, 12, 58–62]. A primary focus of this study was to develop and test a cancer prevention intervention that would be particularly effective for blue-collar workers. This study demonstrated that an intervention addressing both health promotion and occupational health and safety resulted in a quit rate among blue-collar workers comparable to that observed among white-collar workers, a rate that was over double that observed among blue-collar workers in the health promotion only group. To our knowledge this is the first population-based worksite smoking cessation intervention trial to produce markedly high rates of quitting smoking among blue-collar workers.

This study tested an integrated health promotion–occupational health and safety intervention in direct comparison to a standard health promotion program. These findings reinforce the promising preliminary

Table 4. Adjusted mean changes in fruits and vegetables at final by intervention: overall and by gender (embedded cohort n = 5156)

	n	Adjusted mean at final	Mean change from baseline	*p*-Value
HP	2214	3.51	+0.05	0.59
HP/OHS	2413	3.37	−0.10	0.26
Difference between HP & HP/OHS				0.24

p-Value for difference between men and women in intervention effect = 0.31.

evidence previously reported by this research group on the efficacy of an integrated health promotion–occupational health and safety intervention. The WellWorks-1 study was conducted as part of the National Cancer Institute's Working Well Trial, which included four research intervention sites that tested the effects of a worksite cancer prevention model aimed at nutrition and smoking [63]. In WellWorks-1, worksites were randomized to intervention or non-intervention control conditions. The WellWorks-1 site was the only research site to incorporate occupational health and safety into the standard health promotion protocol delivered across the four study centers, and the only study center in which a significant result for smoking cessation was observed [64].

There are several likely reasons for the apparent value of the integrated health promotion–occupational health and safety intervention in smoking cessation for blue-collar workers. Blue-collar workers may perceive greater health risks arising from their job risks than from their tobacco use. Indeed, for many blue-collar workers, hazards on the job represent tangible and immediate dangers that they cannot afford to ignore. Failure to address these risks is likely to reduce the credibility of health promotion interventions focused exclusively on health behaviors. Interventions targeting both occupational health and tobacco control may also be able to capitalize on a significant motivator for behavior change, that is, the potential synergistic effects of exposures to both tobacco and hazardous substances at work. Addressing occupational health concerns may also serve to engage management in worker health issues.

The integrated health promotion–occupational health model relies on several premises. First, interventions focus on organizational and environmental improvements to occupational health and safety, tobacco control, and nutrition, in addition to individual health behavior change. This prioritization of action steps rests on the hierarchy of controls model typically used in control of occupational exposures [47]. Second, the intervention recognizes that workers and management are responsible for different aspects of risk and exposure control [37], and the intervention targets both groups. Third, interventions aim to increase workers' awareness of management actions to improve occupational health and safety through organizational and environmental interventions that parallel individual-level interventions [65]. Fourth, interventions recognize the political realities commonly associated with occupational health and safety; workers' and managers' priorities may conflict because of the economic costs associated with implementing occupational health and safety interventions of choice, including substitution of materials or installation of engineering controls. Joint labor–management action may be needed to facilitate progress, including collaboration with labor unions when present.

We did not observe similar improvements in fruit and vegetable consumption, finding no increase in the sample overall, between conditions or by job type. The perception of a connection between diet and occupational exposures may be weaker than that for smoking and occupational exposures, perhaps contributing to the lack of an effect for the health promotion–occupational health intervention on this outcome. Further research is needed to identify strategies to expand the effectiveness of this model beyond tobacco control. For example, it may be possible to develop messages about the ways in which dietary patterns may help workers be fit for work, particularly work requiring physical labor.

This article focuses on two primary outcomes for this study: smoking cessation and change in servings of fruits and vegetables. An additional outcome, changes in the potential for exposure to occupational hazards, was measured primarily through an Occupational Hazards Assessment, conducted by an industrial hygienist, with supplementary data provided by employee reports. These results are beyond the scope of this article, and will be presented in forthcoming publications.

This study has numerous strengths. This study addressed an important question for public health – how to increase the effectiveness of interventions targeting cancer risk-related behaviors among blue-collar workers. We employed a rigorous study design to assess the effectiveness of incorporating occupational health and safety and health promotion, compared to a standard health promotion program. The intervention implemented for both conditions incorporated the same theoretical constructs and addressed smoking and nutrition, thus enabling a full test of the integration of occupational health into a worksite wellness program. Following the initiation of the intervention no worksites were lost to follow-up. We conducted analyses in a cohort of workers present for the entire intervention period, as well as in two cross-sectional surveys conducted prior to and after intervention delivery.

There are, however, several limitations that must also be noted in the interpretation of these results. We relied on self-reports to assess change in the outcomes. We did not conduct biochemical validation of smoking cessation. However, the need for biochemical validation of smoking cessation in trials such as this one has been increasingly challenged, and it is generally thought that in population-based studies such validation is unnecessary [66]. Although the response rate to the baseline cross-sectional survey was favorable at 80%, the response rate to the final survey was 65%. Finally, worksites participating in this trial may represent a self-selected group more interested in the health of workers than the general population of worksites of this size and type of business. Future research is needed to continue to explore the potential gains of integrating occupational health and safety and health promotion.

In conclusion, this study provides evidence of an important advance in worksite interventions to influence tobacco use among blue-collar workers. Results from this randomized controlled trial indicate that a program integrating health promotion and occupational health and safety efforts can significantly improve smoking quit rates among blue-collar workers, compared to health promotion alone. Worksite interventions must move beyond a focus on individual worker behavior, to address the role of management in workers' health. Worksite wellness programs that fail to address the hazards of work may miss significant sources of health-related problems and costs, both to individual workers and employers. Yet occupational health and safety programs that ignore personal risk factors may be underestimating workers' understanding of the complexities of health and well-being [16, 65].

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