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Sun Safe Workplaces: Effect of an Occupational Skin Cancer Prevention Program on Employee Sun Safety Practices

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Abstract

Objective: Occupational skin cancer prevention is a priority because outdoor workers are exposed to high levels of ultraviolet radiation, the primary risk factor for skin cancer.

Methods: A two-year follow-up assessment of the impact of Sun Safe Workplaces (SSW), a workplace sun safety program that promoted policy adoption and education, on employee sun safety behavior was conducted. 63 of 98 local government organizations from the original study participated.

Results: Outdoor workers (n=1724) completed surveys on personal sun protection practices. Employees' sun protection improved statistically significantly in the intervention group receiving the SSW program. SSW's effect was mediated by the number of workplace actions to implement elements of the policy including sun protection messages and equipment and employee reports of sun safety training.

Conclusion: Policy promotion is a feasible approach to occupational skin cancer prevention.

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Keywords

Sun safety; skin cancer; workplace health; occupational sun safety; workplace policy; employee safety

Skin cancer is one of the most common cancers globally. The World Health Organization estimates that up to three million cases of keratinocyte skin cancers (i.e., basal and squamous cell cancers) and approximately 132,000 cases of melanoma are diagnosed annually.¹ One in every five Americans is expected to be diagnosed with skin cancer. Solar ultraviolet radiation (UV) is the primary and most modifiable risk factor for skin cancers.^{2–8} Workers laboring outdoors have elevated risk for skin cancer because they are exposed to dangerous UV over many years.^{9,10} While melanoma is related less with outdoor work than keratinocyte skin cancers,^{8,11,12} higher risk of melanoma has been observed for outdoor work.^{13,14} Further, many outdoor workers do not practice sun safety.^{15–21} Health authorities in the United States, Australia, and Canada recommend comprehensive workplace sun protection that combines administrative policies, environmental controls, and sun safety education to reduce this environmental hazard for employees.^{22–26}

An Affordable Care Act goal is to build a national culture of prevention and wellness with workplace initiatives. The workplace offers unique resources for health promotion such as access to employees, communication channels, social supports, and organizational infrastructure to impact health behaviors of working adults.²⁷ Workplace programs that develop policies that integrate aspects of health prevention (i.e., safety and work environment) and health promotion (i.e., wellness and chronic disease management) are considered optimal.²⁸

Policy development in all sectors, including workplaces, is increasingly identified as a critical factor in improving safety and chronic disease prevention outcomes such as increasing physical activity and reducing obesity and tobacco use.^{29–34} According to social ecological models,³⁵ environmental features such as policies can have direct effects on behaviors by, for example, requiring training in skin cancer prevention, providing personal protection equipment such as sunscreen, protective clothing, and hats, creating sun protective environments such as temporary shade, and regularly reminding employees to take sun precautions. Policy also should motivate protection by groups of individuals (e.g., younger employees³⁶) who are generally resistant to doing so on their own. Workplace policies have been successful in changing behavior in tobacco control,^{29,37–40} physical activity, and diet^{41–43} by addressing environmental changes, provision of health education programs, and transportation options.

However, most studies of workplace safety and health interventions have focused mainly on education to improve worker knowledge and behavior change^{44,45} including those on sun protection.⁴⁶ Occupational sun safety programs have been undertaken for road/construction workers, aquatic staff, farmers, and postal workers⁴⁷ and have demonstrated that workplace education can improve workers' sun protection^{46–52} including our *Go Sun Smart (GSS)* education program.^{50,53–55} The National Institute on Occupational Health and Safety has

issued an advice card on sun protection for outdoor workers but there are no formal national guidelines for workplace sun safety.

Limited information also exists on whether workplace sun protection policy impacts employee health behavior. Currently, only a small number of organizations have sun safety policies and the existing policies primarily focus on personal protection and seldom deal with environmental controls or administrative procedures.⁵⁶ Also, existing policies generally encourage personal protection, not require it, even though protection requirements have improved workers' sun safety.^{16,57} Policies have had mixed results. For example, sun protection policies increased lifeguards' sun protection habits and decreased their sunburning,⁵¹ however, a study in New Zealand found no effect of policy on outdoor workers' sun protection.⁵⁸ A knowledge gap also exists between the development of successful evidence-based programs and their successful implementation.⁵⁹ A concern exists that "if public health programs and policy interventions are not implemented effectively, they will not have their intended effects on improving population health or reducing health inequities."⁵⁹

The Sun Safe Workplaces (SSW) program, based on principles of Diffusion of Innovations Theory,⁶⁰ was developed and tested in a randomized controlled trial enrolling local government organizations in Colorado with outdoor workers in public works, public safety and/or parks and recreation. SSW advocated that senior managers adopt formal sun safety policies and provide training and printed/electronic messages for outdoor workers. Initial follow-up showed that SSW increased policy adoption at intervention worksites and senior managers' implementation of actions to support employee sun safety.⁵⁶ In this paper, we report the results of a follow-up study on the impact of the implementation of SSW on employee sun safety practices. Analyses reported elsewhere showed that the local government organizations had implemented a number of sun safety actions and communication during the 2-year follow-up period.⁶¹

Methods

Sample

A sample of cities, counties, and special districts in Colorado (n=98) were enrolled in the trial. Eligible employers included local government organizations with outdoor workers who were employed in at least one of the following service areas: public works, public safety, and parks and recreation.⁵⁶ Two-years after the intervention was completed, project staff invited the key contact managers at these organizations to participate in a second follow-up assessment on the implementation of workplace sun safety and personal protection practices by employees. This invitation was made by email or over the telephone.

Trial Design and Two-year Follow-up Procedures

The public employers were originally enrolled in a pretest-posttest randomized controlled trial. Pretest assessment of written workplace policies and surveys with senior managers occurred in 2010–2011; next, fifty-percent of the employers were randomly assigned to receive the SSW intervention while the remaining fifty-percent received basic information

on sun protection. At the end of the 24-month intervention period, all employers were post-tested, again by evaluating written workplace policies and surveying senior managers. Two-years after the completion of the intervention period, public employers were re-contacted for a second follow-up. Key contact managers were identified and worked with study staff to distribute self-administered surveys on sun protection practices and exposure to sun safety communication to front-line line supervisors and employees who worked outdoors. Surveys were collected by project staff and/or mailed to the study office by key contact managers using pre-paid courier shipping packets. Also, project staff visited each employer and conducted semi-structured interviews with key managers (results will be reported elsewhere) and audited the workplace for sun protection messages and equipment. The Institutional Review Boards of the study investigators approved all study procedures.

Sun Safe Workplaces (SSW) Intervention

The SSW program was designed to promote workplace sun safety policy adoption and to provide sun safety education to outdoor workers. The program was guided by propositions from Diffusion of Innovations Theory (DIT),⁶⁰ Social Penetration Theory⁶² and the Stages of Relational Development model.⁶³ The intervention consisted of personal meetings with senior managers that were intended to highlight the need for sun safety education and policy adoption for outdoor workers, sun safety training, a Sun Safe Workplaces website with material on skin cancer prevention and policy development, and sun safety educational materials such as stickers, posters, brochures, and tip cards (4 mailings per year). Organizations in the attention-control condition received annual mailings of occupational sun safety printed materials. Additionally, presentations on sun safety were made at professional conferences in the state where intervention and control organizations may have been present. A complete description of the eligibility requirements, SSW program, and attention control condition has been previously published.⁵⁶

Workplace Policy Assessment

Presence and content of occupational sun protection policies were measured for each employer by trained research assistants, blind to experimental condition, using a previously published coding protocol^{56,64} that was modified from an evaluation of sun protection policies in public school districts.⁶⁵ The policy assessment included three domains (environmental controls, administrative procedures, and personal protection practices) with fifteen content categories. For the present analysis, a summed score indicating the presence of a best-practice sun protection policy was also employed using codes for each content category of 0 = not addressed and 1= addressed. To meet the requirements of the addressed category, directives based on recommendations of public health authorities^{66,67} had to be present including: scheduling of work to avoid midday hours outdoors; sun safety training provided by supervisors; sunscreen with SPF 15 or higher; wide-brimmed hats; long sleeved shirts and long pants; ultraviolet protective eyewear; and, clinical skin examination.⁵⁶

Policy Implementation Measures

Implementation of sun safety communication, training, actions, and equipment to implement various elements of the occupational sun protection policies were assessed in three ways. Senior managers and line supervisors reported whether the employer communicated or

provided training about sun safety to employees, using questions from our evaluation of sun safety education in a large outdoor recreation industry.^{50,53–55} Senior managers also reported whether the employer had provided six types of personal sun protection equipment for employees: sunscreen, wide-brimmed hats, sunglasses, long-sleeved shirts, long pants, or outdoor shade.⁵⁶ Finally, using procedures from our previous evaluations,^{55,68} project staff inspected the workplace, recording sun protection messages provided in the SSW intervention or created by the employer and personal sun protection equipment (i.e., sunscreen, use of shade). Effects of SSW on the implementation of sun safety actions are reported elsewhere⁶¹; in the current analysis, implementation was examined as a mediator of changes in employee sun protection.

Employee Sun Protection

Front-line supervisors and employees reported on their a) frequency of sun protection at work, i.e., sunscreen with SPF 15+, long-sleeved shirts, long pants, wide-brimmed hat, sunglasses, shade use, limit midday exposure, and have sunscreen, hat and eye protection at all times (1=never, 5=always^{68,69}) and b) prevalence of sunburn in the past 12 months on the job (yes/no; number of times). These items had been used in our previous evaluations of occupational sun protection education.^{50,53–55} Respondents' attitudes toward occupational sun safety, self-efficacy for sun safety on the job were assessed with 5-point Likert-type scales. All respondents provided job and demographic information and attitudes toward workplace health and sun safety policy.

Statistical Analysis

Frequency of individual sun protection practices and number of sunburns at work were examined. Differences between experimental condition (SSW intervention v. control) and presence of a best-practice occupational sun protection policy or not in changes in these behaviors were modeled using multilevel analysis. Employee demographics and employer characteristics were included as covariates using stepwise model selection at $p < 0.15$, two-tailed. PROC MIXED in SAS was employed for continuous sun protection practices and PROC GLIMMIX in SAS was used for binary sunburn prevalence. Moderators of the impact of experimental conditions and presence of policy were also tested by examining two-way interactions in the multilevel models. Multilevel mediation was conducted in Mplus to explore the indirect effects of workplaces' sun safety actions on the relationship between experimental conditions and the outcomes. Alpha criterion levels were set at 0.05 (two-tailed) for all tests.

Results

A total of 63 public employers [64% of the original trial sample] agreed to participate in the 2-year follow-up – $n=33$ in intervention and $n=30$ in control (see Table 1 for employer characteristics). There were few differences between employers by follow-up status, with the exception of that more were located in the Denver metropolitan area and fewer in other Front Range locations or Eastern Colorado. No differences occurred between intervention and control conditions in types of employers participating in the follow-up.

Surveys were completed by 1,784 outdoor workers across these employers – n=913 in intervention worksites and n=871 in control worksites (see Table 2 for employee characteristics). Nearly half of employees worked mostly outdoors and the sample averaged about 20 hours of work outdoors per week in the summer and winter months. They were relatively long-tenured and a plurality worked in public works. About one-quarter had sun sensitive skin and 1 in 12 reported a history of skin cancer. The sample was middle-aged on average and predominately male. Most employees had less than a 4-year college degree; 11% were racial minorities; two-thirds were married; and 2 in 5 had children living in their home. A few differences by experimental condition were evident, with intervention employees more likely to be in public works, older, male, and married than control employees (Table 2).

Effect of SSW Intervention on Employee Sun Protection

Employees' sun protection practices improved statistically significantly in the intervention group of employers receiving the SSW (Table 3). Specifically, employees in intervention employers compared to control employers reported more total composite sun protection practices and more frequently using sunscreen on the body, wearing wide-brimmed hats, and having sunscreen, sunglasses, and a hat with them when at work. Also, employees in the intervention workplaces reported a lower prevalence of sunburns than those in control workplaces.

There was no evidence of moderation of the treatment effect by employee demographics on the composite sun protection measure. Moderation was evident, though, in some of the individual sun protection behaviors. More educated employees in the intervention group were most likely to have sunscreen, sunglasses, and a hat with them at work ($p=0.025$; control: <4-year college graduate $M=3.98$, 4-year college graduate or more $M=3.91$; intervention: <4-year college graduate $M=4.06$, 4-year college graduate or more $M=4.27$). Employees who spent more hours working outdoors in the summer in the intervention group were most likely to wear a wide-brimmed hat ($p=0.036$; control: 20 hours $M=2.55$; 30 hours $M=2.54$, 40 hours $M=2.52$, 50 hours $M=2.49$, 60 hours $M=2.47$, 70 hours $M=2.45$; intervention: 20 hours $M=2.79$; 30 hours $M=2.83$, 40 hours $M=2.88$, 50 hours $M=2.93$, 60 hours $M=2.97$, 70 hours $M=3.02$) while married employees in the controls were least likely to wear a wide-brimmed hat ($p=0.038$; control: single/widowed/divorced $M=2.76$, married/living with partner $M=2.49$; intervention: single/widowed/divorced $M=2.84$, married/living with partner $M=2.85$). Age moderated the effect of the intervention on prevalence of sunburns at work: Younger employees in the intervention group reduced their sunburning the most ($p=0.018$; control: 20 years old $M=0.85$, 35 years old $M=0.66$, 40 years old $M=0.58$, 60 years old $M=0.25$; intervention=20 years old $M=0.73$, 35 years old $M=0.58$, 40 years old $M=0.52$, 60 years old $M=0.31$). See Table 3.

Effect of Presence of Sun Protection Policy on Employee Sun Protection

Table 3 also presents comparisons of sun protection by employees between employers who had a best-practice occupational sun protection policy and those that did not at posttest. The total composite sun protection score for employees at employers with a best-practice policy was statistically significantly higher than in the no-policy group. Looking at the individual

behaviors, employees at employers with best-practice policies also reported more frequently using sunscreen on the face and other exposed body parts and having sunscreen, sunglasses, and a hat with them while at work compared to those at no-policy employers. However, there was no effect of policy on prevalence of sunburns among the employees.

This effect of best-practice policy on the sun protection composite score and use of sunscreen in aftershave, face lotions, and makeup was moderated by gender and personal history of skin cancer. Among men, the overall sun protection composite score was higher in workplaces with policies ($M=3.42$) than no policies ($M=3.26$) but composite sun protection appeared high among women regardless of policy (no policy $M=3.47$; policy $M=3.44$; $p=0.018$). Policy increased use of sunscreen on the face in aftershave, face lotion, and make up among males (no policy $M=2.70$; policy $M=2.97$) but had little impact on females who already used it much more than men (no policy $M=4.18$; policy $M=4.09$; $p=0.038$). The policy appeared to increase this use of sunscreen in aftershave, face lotions, and make-up among workers with no history of skin cancer (no policy $M=3.21$; policy $M=3.44$) but may have reduced it in those with a skin cancer history (no policy $M=3.81$; policy $M=3.52$; $p=0.034$).

Mediation of SSW Effects by Policy Implementation

As expected, SSW's effect on employee sun protection practices was mediated by the number of actions at the workplace to implement elements of sun safety policy. Specifically, observation of sun protection messages and equipment in the workplace (indirect estimate=0.028, $p=0.041$) and employee training in sun safety (indirect estimate=0.050, $p=0.035$) was higher in the intervention than the control condition and, in turn, more observed messages/equipment and training predicted improved composite sun protection score (proportion mediated: 26.4% observed messages/equipment, 37.6% training). Likewise, observed sun protection messages/equipment (indirect estimate=0.075, $p=0.048$), sun safety training (indirect estimate=0.146, $p=0.020$), and reported communication about sun safety by the employer (indirect estimate=0.147, $p=0.006$) increased in the intervention group compared to controls and increased frequency of employees having sunscreen, sunglasses, and at hat on the job (proportion mediated: 48.3% observed messages/equipment, 63.2% training, 66.8% communication). The effect of the intervention on frequency of using sunscreen on the body also was positively mediated by reported communication about sun safety from the employer (indirect estimate=0.108, $p=0.039$, proportion mediated: 44.7%).

Moderation of SSW Effects by Job Classification

A moderation analysis was conducted to assess if the impact of the intervention or adoption of a policy differed between employees based on job type (public works, parks and recreation, and public safety). Positive trends in the direction of increased sun protection were observed in all employee groups associated with the intervention and policy but the stratification resulted in a reduction in sample size thus statistical power, decreasing the number of statistically-significant differences as seen in the overall analysis. There was no evidence that job type altered this general improvement in sun protection.

Discussion

The SSW intervention that promoted adoption of sun protection policies by employers and delivered training on skin cancer prevention to employees at posttest⁵⁶ improved reported sun protection of employees on the job. A composite of all sun protection practices improved, although sunscreen and wide-brimmed hat usage increased the most. Sunscreen is a popular sun protection practice in North America, which undoubtedly led many employees to opt for it. However, the improved use of wide-brimmed hats is notable, especially since hats with any brim did not increase, suggesting the effect of the intervention was to increase use of highly-protective headwear. Wide-brimmed hats protect the ears and neck, while baseball hats with only a front brim protect only the middle of the face. We reported previously that senior managers at the intervention employers reported providing wide-brimmed hats more than controls⁵⁶ and the reports by employees appear to corroborate that the intervention increased this protective practice.

In this organizational context, the mediation analyses provided evidence that sun safety communication was instrumental in producing the positive effects of the SSW intervention. The implementation of actions including communicating (e.g., interpersonal, digital, posters) and training about sun protection by the employer impacted the sun safety practices of employees. These results indicate that policy adoption alone is unlikely to improve sun protection on the job. Instead, a comprehensive approach is needed that not only advocates for a new and improved occupational sun protection policy but also delivers training to employees, assists managers and supervisors in communicating with employees about sun safety, provides equipment that can support sun safety (e.g., sunscreen and wide-brimmed hats) to achieve real improvements in sun protection in the workplace.

The SSW intervention also appeared to reduce sunburns among the employee population. Sunburns are a marker of both poor protection practices and excess sun exposure and have been linked to development of melanoma skin cancers.^{70,71} The reduction in sunburns is likely to be a result of the improved sun protection practices by employees. Most importantly, it suggests that the SSW program resulted in reductions in two risk factors for skin cancer – sun exposure and sunburns among employees.

The fact that the existence of an occupational sun protection policy was associated with some of the same improvements in sun protection practices as the SSW intervention⁵⁶ in general provides evidence that policy adoption on its own can motivate some employees to take precautions. However, sunburns were unaffected by policy adoption. It may be that policy creates an environment supportive of sun protection and motivates some sun safety by employees but training on sun safety may be needed for employees to practice sun protection in ways that help them avoid sunburns. Thus, an effective occupational intervention should promote policy adoption and deliver employee education to achieve meaningful improvements in sun safety on the job.

SSW increased sun protection in groups that may be at highest risk for unprotected sun exposure. More educated employees who spent more time working outdoors and thus in high-UV environments on the job reported more gains in sun protection than less educated

employees in the intervention condition. SSW improved sun protection among higher educated employees and reduced sunburning among younger employees. Past research has shown that more educated individuals experience more skin cancer while younger individuals practice less protection.^{36,72,73} Likewise, men generally are less sun protective than women but in the workplaces with best-practices sun protection policies, male employees improved their sun protection to be on par with female employees. These results support the idea that a large benefit of workplace health policies is overcoming disparities among employee groups by motivating preventive practices among employee groups who are not normally predisposed to take precautions. The one unexpected pattern was that employees with a history of skin cancer reduced their use of sunscreen on the face, possibly because they learned and were given other effective sun protection practices such as wide-brimmed hats.

It is notable that the improvements in sun protection among employees was witnessed two-years after the conclusion of the SSW intervention. We have previously seen that employees' sun protection declines even within the first year after a skin cancer prevention education program in workplaces.^{48,74} It was expected that policy would help to sustain initial changes and overcome barriers to continued prevention such as turnover in managers and supervisors.⁶⁸ The continued use of all sun protection practices by employees in this two-year follow-up implies that policy had some lasting effect on occupational sun protection. Still, it would be useful to follow-up with these employers after a few more years to see if policy routinizes skin cancer prevention in the employee safety efforts at these workplaces, the final step in the diffusion of innovations process according to DIT.

These conclusions are strengthened by several advantages in this trial. The sample of local government organizations was large and represented a diversity in terms of size and organizational structure. Also, policy scores were evaluated by the coding of written documents, not self-reports. However, the sample was limited to public employers, who may be more amenable to employee safety due to their lack of profit motive (although our success on sun protection with a large private outdoor recreation industry suggests otherwise^{50,53–55} and willing to be evaluated, and to a single state with high UV levels due to a dry climate, abundant sunshine, and high elevation that may have increased the importance of sun protection. These weaknesses reduced generalizability of the results. The two-year follow-up assessment was strengthened by the use of validated measures, but some were self-report measures that can be affected by demand effects. The small number of differences in organizations associated with follow-up and between experimental condition suggested that the sample in the follow-up assessment represented the entire trial sample and continued to be balanced by randomization. The sample of employees was a convenience sample accessed through the cooperation of the senior managers. Senior managers could have selected work groups who were more sun protective (e.g., workers with sun sensitive skin or older workers), increasing the apparent effectiveness of the intervention.

The U.S. Surgeon General and other health authorities^{75,76} have concluded that occupational sun protection is essential for reducing the high rates of skin cancer worldwide.⁷⁷ Outdoor workers are a high-risk population for large, chronic UV exposure, a known causes of skin cancer. Comprehensive interventions that address the workplace environment through policy

and educate employees in personal sun protection may go a long way toward preventing skin cancer in this relatively large population and reduce the substantial costs associated with treatment.⁷⁸ The identification of effective strategies to facilitate the successful implementation of evidence-based programs can maximize scarce resources and help sustain programs over the long term.⁵⁹ To achieve this benefit will require scaling up these interventions programs beyond a single state by possibly working with professional associations that serve industries with outdoor workers by identifying new workplace safety risks such as UV exposure and solutions for mitigating these risks such as SSW.

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References

1. Ultraviolet radiation and intersun programme. Skin cancers. World Health Organization. Available at: <http://www.who.int/uv/faq/skincancer/en/index1.html>. Published 2016. Accessed May 11, 2018.
2. Armstrong BK, English DR. Cutaneous malignant melanoma In: Schottenfeld D, Franmeni JF, eds. Cancer Epidemiology and Prevention. Vol 2nd New York, NY: Oxford University Press; 1996:1282–1312.
3. Koh HK, Kligler BE, Lew RA. Sunlight and cutaneous malignant melanoma: evidence for and against causation. Photochem Photobiol. 1990;51(6):765–779. [PubMed: 2195564]
4. Krickler A, Armstrong BK, English DR, Heenan PJ. Does intermittent sun exposure cause basal cell carcinoma? A case-control study in Western Australia. Int J Cancer. 1995;60(4):489–494. [PubMed: 7829262]
5. Marks R Nonmelanotic skin cancer and solar keratoses: the quiet 20th century epidemic. Int J Dermatol. 1987;26(4):201–205. [PubMed: 3298089]
6. Marks R, Jolley D, Lestsas S, Foley P. The role of childhood exposure to sunlight in the development of solar keratoses and non-melanocytic skin cancer. Med J Aust. 1990;152(2):62–66. [PubMed: 2296232]
7. Weinstock MA, Colditz GA, Willett WC, et al. Nonfamilial cutaneous melanoma incidence in women associated with sun exposure before 20 years of age. Pediatrics. 1989;84(2):199–204. [PubMed: 2748244]
8. MacKie RM, Aitchison T. Severe sunburn and subsequent risk of primary cutaneous malignant melanoma in Scotland. Br J Cancer. 1982;46(6):955–960. [PubMed: 7150488]
9. Marlenga B The health beliefs and skin cancer prevention practices of Wisconsin dairy farmers. Oncol Nurs Forum. 1995;22(4):681–686. [PubMed: 7675670]
10. Vishvakarman D, Wong JC. Description of the use of a risk estimation model to assess the increased risk of non-melanoma skin cancer among outdoor workers in Central Queensland, Australia. Photodermatol Photoimmunol Photomed. 2003;19(2):81–88. [PubMed: 12945807]
11. Goodman KJ, Bible ML, London S, Mack TM. Proportional melanoma incidence and occupation among white males in Los Angeles County (California, United States). Cancer Causes Control. 1995;6(5):451–459. [PubMed: 8547544]
12. Walter SD, King WD, Marrett LD. Association of cutaneous malignant melanoma with intermittent exposure to ultraviolet radiation: results of a case-control study in Ontario, Canada. Int J Epidemiol. 1999;28(3):418–427. [PubMed: 10405843]
13. Weiss J, Bertz J, Jung EG. Malignant melanoma in southern Germany: different predictive value of risk factors for melanoma subtypes. Dermatologica. 1991;183(2):109–113. [PubMed: 1743370]
14. Beral V, Robinson N. The relationship of malignant melanoma, basal and squamous skin cancers to indoor and outdoor work. Br J Cancer. 1981;44(6):886–891. [PubMed: 7326198]

15. Green A, Battistutta D, Hart V, Leslie D, Weedon D. Skin cancer in a subtropical Australian population: incidence and lack of association with occupation. The Nambour Study Group. *Am J Epidemiol.* 1996;144(11):1034–1040. [PubMed: 8942434]
16. Stepanski BM, Mayer JA. Solar protection behaviors among outdoor workers. *J Occup Environ Med.* 1998;40(1):43–48. [PubMed: 9467119]
17. Rosenman KD, Gardiner J, Swanson GM, Mullan P, Zhu Z. Use of skin-cancer prevention strategies among farmers and their spouses. *Am J Prev Med.* 1995;11(5):342–347. [PubMed: 8573366]
18. Lewis KG, Weinstock MA, Weaver AL, Otley CC. Adjuvant local irradiation for Merkel cell carcinoma. *Arch Dermatol.* 2006;142(6):693–700. [PubMed: 16785371]
19. Pichon LC, Mayer JA, Slymen DJ, Elder JP, Lewis EC, Galindo GR. Ethnoracial differences among outdoor workers in key sun-safety behaviors. *Am J Prev Med.* 2005;28(4):374–378. [PubMed: 15831344]
20. Salas R, Mayer JA, Hoerster KD. Sun-protective behaviors of California farmworkers. *J Occup Environ Med.* 2005;47(12):1244–1249. [PubMed: 16340705]
21. Duffy SA, Choi SH, Hollern R, Ronis DL. Factors associated with risky sun exposure behaviors among operating engineers. *Am J Ind Med.* 2012;55(9):786–792. [PubMed: 22692974]
22. Position Statement: Sun Protection in the Workplace. Canberra, ACT, Australia: The Cancer Council of Australia; December 2005.
23. Canadian Centre for Occupational Health and Safety. Skin cancer and sunlight. 2008. http://www.ccohs.ca/oshanswers/diseases/skin_cancer.html. Accessed May 11, 2018.
24. California Department of Public Health. Outdoor-Based Business: Sun Protection Policy Guidelines. California Department of Public Health, Skin Cancer Prevention Program; 2008.
25. California Department of Public Health. Sun Safety: What Outdoor-Based Employees Should Know. California Department of Public Health, Skin Cancer Prevention Program; 2008.
26. Occupational Safety & Health Administration. Protecting Yourself in the Sun. Washington, D.C.: Occupational Safety and Health Administration; 2003 OSHA 3166–06R.
27. Goetzel RZ, Roemer EC, Liss-Levinson RC, Samoly DK; Partnership for Prevention, Emory University. Workplace health promotion: policy recommendations that encourage employers to support health improvement programs for their workers. Partnership for Prevention; 12 2008.
28. Hymel PA, Loeppke RR, Baase CM, et al. Workplace health protection and promotion: a new pathway for a healthier- and safer- workforce. *J Occup Environ Med.* 2011;53(6):695–702. [PubMed: 21654443]
29. Bauer JE, Hyland A, Quiang L, Steger C, Cummings KM. A longitudinal assessment of the impact of smoke-free worksite policies on tobacco use. *Am J Public Health.* 2005;95(6):1024–1029. [PubMed: 15914828]
30. Boehmer TK, Luke DA, Haire-Joshu DL, Bates HS, Brownson RC. Preventing childhood obesity through state policy. Predictors of bill enactment. *Am J Prev Med.* 2008;34(4):333–340. [PubMed: 18374247]
31. Fitch K, Pyenson B. Taking stock of wellness. *Benefits Quarterly.* 2008;24(2):34–40. [PubMed: 18590182]
32. Jamrozik K Population strategies to prevent smoking. *Br Med J.* 2004;328(7442):759–762. [PubMed: 15044295]
33. Floyd MF, Crespo CJ, Sallis JF. Active living research in diverse and disadvantaged communities stimulating dialogue and policy solutions. *Am J Prev Med.* 2008;34(4):271–274.
34. Kone RG, Zurick E, Patterson S, Peeples A. Injury and violence prevention policy: celebrating our successes, protecting our future. *J Safety Res.* 2012;43(4):265–270. [PubMed: 23127675]
35. Sallis J, Owen N. Ecological models of health behavior In: Glanz K, Lewis FM, Rimer BK, eds. *Health Behavior and Health Education: Theory, Research and Practice*: Jossey-Bass; 1997:406–424.
36. Coups EJ, Manne SL, Heckman CJ. Multiple skin cancer risk behaviors in the U.S. population. *Am J Prev Med.* 2008;34(2):87–93. [PubMed: 18201637]

37. Fichtenberg CM, Glantz SA. Effect of smoke-free workplaces on smoking behaviour: systematic review. *Br Med J*. 2002;325(7357):188. [PubMed: 12142305]
38. Moskowitz JM, Lin Z, Hudes ES. The impact of workplace smoking ordinances in California on smoking cessation. *Am J Public Health*. 2000;90(5):757–761. [PubMed: 10800425]
39. Shelley D, Yerneni R, Hung D, Das D, Fahs M. The relative effect of household and workplace smoking restriction on health status among Chinese Americans living in New York City. *J Urban Health*. 2007;84(3):360–371. [PubMed: 17410472]
40. Green LW, Orleans CT, Ottoson JM, Cameron R, Pierce J, Bettinghaus EP. Inferring strategies for disseminating physical activity policies, programs, and practices from the successes of tobacco control. *Am J Prev Med*. 2004;31(4):66–81.
41. Engbers LH, van Poppel MN, Chin A Paw MJ, van Mechelen W. Worksite health promotion programs with environmental changes: a systematic review. *Am J Prev Med*. 2005;29(1):61–70. [PubMed: 15958254]
42. Kahn EB, Ramsey LT, Brownson RC, et al. The effectiveness of interventions to increase physical activity. A systematic review. *Am J Prev Med*. 2002;22(4 Suppl):73–107. [PubMed: 11985936]
43. Zaza S, Briss PA, Harris KW, et al. *The Guide to Community Preventive Services: What Works to Promote Health?* New York, NY: Oxford University Press; 2005.
44. Heany CA, Goldenhar LM. Worksite health programs: working together to advance employee health. *Health Educ Q*. 1996;23(2):133–136. [PubMed: 8744868]
45. Stokols D, Pelletier KR, Fielding JE. The ecology of work and health: research and policy directions for the promotion of employee health. *Health Educ Q*. 1996;23(2):137–158.
46. Authors. Reducing ultraviolet radiation exposure among outdoor workers: state of the evidence and recommendations. *Environ Health*. 2007;6(1):22. [PubMed: 17686155]
47. Horsham C, Auster J, Sendall MC, et al. Interventions to decrease skin cancer in outdoor workers: update to 2007 systematic review. *BMC Res Notes*. 2014;7:10. [PubMed: 24397996]
48. Authors. The sustainability of an occupational skin cancer prevention program. *J Occup Environ Med*. 2015;57(11):1207–1213. [PubMed: 26539769]
49. Rye S, Janda M, Stoneham M, et al. Changes in outdoor workers' sun-related attitudes, beliefs, and behaviors: a pre-post workplace intervention. *J Occup Environ Med*. 2014;56(9):e62–e72. [PubMed: 25153299]
50. Authors. Randomized trial testing a worksite sun protection program in an outdoor recreation industry. *Health Educ Behav*. 2005;32(4):514–535. [PubMed: 16009748]
51. Hall DM, McCarty F, Elliott T, Glanz K. Lifeguards' sun protection habits and sunburns: association with sun-safe environments and skin cancer prevention program participation. *Arch Dermatol*. 2009;145(2):139–144. [PubMed: 19221258]
52. Reinau D, Weiss M, Meier CR, Diepgen TL, Surber C. Outdoor workers' sun-related knowledge, attitudes and protective behaviours: a systematic review of cross-sectional and interventional studies. *Br J Dermatol*. 2013;168(5):928–940. [PubMed: 23252833]
53. Authors. Testing the long term effects of the Go Sun Smart worksite sun protection program: a group-randomized experimental study. *J Commun* 2008;58(3):447–471.
54. Authors. Sustained use of an occupational sun safety program in a recreation industry: follow-up to a randomized trial on dissemination strategies. *Transl Behav Med* 2015 12;5(4):361–371. [PubMed: 26622909]
55. Authors. Enhancing industry-based dissemination of an occupational sun protection program with theory-based strategies employing personal contact. *Am J Health Promot*. 2012;26(6):356–365. [PubMed: 22747318]
56. Authors. Results of a randomized trial on an intervention promoting adoption of occupational sun protection policies. *Am J Health Promot* 2018;32(4):1042–1053. [PubMed: 28447466]
57. Woolley T, Lowe J, Raasch B, Glasby M, Buettner PG. Workplace sun protection policies and employees' sun-related skin damage. *Am J Health Behav*. 2008;32(2):201–208. [PubMed: 18052860]
58. Hammond V, Reeder AI, Gray AR, Bell ML. Are workers or their workplaces the key to occupational sun protection? *Health Promot J Aust*. 2008;19(2):97–101.

59. MacDonald M, Pauly B, Wong G, et al. Supporting successful implementation of public health interventions: protocol for a realist synthesis. *Syst Rev*. 2016;5:54. doi: 10.1186/s13643-016-0229-1. [PubMed: 27055820]
60. Rogers EM. *Diffusion of Innovations*. 5th ed New York, NY: Free Press; 2003.
61. Authors. Moderators of implementation of occupational sun protection policy by public-sector employers in a randomized trial. Annual Meeting of the Society of Behavioral Medicine; April; New Orleans, LA.
62. Taylor DA, Altman I. Communication in interpersonal relationships: social penetration processes In: Roloff ME, Miller GR, eds. *Interpersonal Processes: New Directions in Communication Research*. Vol 14 Thousand Oaks, CA: Sage Publications, Inc; 1987:257–277.
63. Scott MD, Powers WG. *Interpersonal Communication: A Question of Needs*. Boston, MA: Houghton Mifflin; 1978.
64. Authors. Factors associated with occupational sun-protection policies in local government organizations in Colorado. *J Am Med Assoc Dermatol*. 2015;151(9):991–997.
65. Authors. School sun protection policies: measure development and assessments in two regions of the United States. *J School Health*. 2012;82(11):499–507. [PubMed: 23061553]
66. Centers for Disease Control and Prevention. Skin cancer. Available at: <https://www.cdc.gov/cancer/skin>. Published 2016. Updated September 28, 2016. Accessed May 16, 2018.
67. National Institute for Occupational Safety and Health. Sun exposure. Available at: <https://www.cdc.gov/niosh/topics/sunexposure/>. Published 2016. Updated July 26, 2016. Accessed May 16, 2018.
68. Authors. Sustained use of an occupational sun safety program in a recreation industry: follow-up to a randomized trial on dissemination strategies. *Transl Behav Med*. 2015;5(4):361–371. [PubMed: 26622909]
69. Glanz K, Yaroch AL, Dancel M, et al. Measures of sun exposure and sun protection practices for behavioral and epidemiologic research. *Arch Dermatol*. 2008;144(2):217–222. [PubMed: 18283179]
70. Dennis LK, Vanbeek MJ, Beane Freeman LE, Smith BJ, Dawson DV, Coughlin JA. Sunburns and risk of cutaneous melanoma: does age matter? a comprehensive meta-analysis. *Ann Epidemiol*. 2008;18(8):614–627. [PubMed: 18652979]
71. Wu S, Han J, Laden F, Qureshi AA. Long-term ultraviolet flux, other potential risk factors, and skin cancer risk: a cohort study. *Cancer Epidemiol Biomarkers Prev*. 2014;23(6):1080–1089. [PubMed: 24876226]
72. Authors. Prevalence of sunburn, sun protection, and indoor tanning behaviors among Americans: systematic review from national surveys. *J Am Acad Dermatol*. 2011;65(5 Suppl 1):114–123.
73. Hu S, Parmet Y, Allen G, et al. Disparity in melanoma: a trend analysis of melanoma incidence and stage at diagnosis among whites, Hispanics, and blacks in Florida. *Arch Dermatol*. 2009;145(12):1369–1374. [PubMed: 20026844]
74. Authors. Sustainability of the dissemination of an occupational sun protection program in a randomized trial. *Health Educ Behav*. 2012;39(4):498–502. [PubMed: 22102323]
75. U.S. Department of Health and Human Services. The Surgeon General's Call to Action to Prevent Skin Cancer. Washington, D.C.: U.S. Department of Health and Human Services, Office of the Surgeon General;2014.
76. Cancer prevention in the workplace. Division of Cancer Prevention and Control, Centers for Disease Control and Prevention. Available at: <https://www.cdc.gov/cancer/dccp/resources/features/cancerpreventioninworkplace/index.htm>. Updated March 8, 2017. Accessed April 30, 2018
77. Office of the Surgeon General; U.S. Department of Health and Human Services. The Surgeon General's call to action to prevent skin cancer. Available at: <http://www.surgeongeneral.gov/library/calls/prevent-skin-cancer/call-to-action-prevent-skin-cancer.pdf>. 2014. Accessed April 30, 2018
78. Mofidi A, Tompa E, Spencer J, et al. The economic burden of occupational non-melanoma skin cancer due to solar radiation. *J Occup Environ Hyg*. 2018:1–11.

Table 1:

Profile of employers in follow-up assessment and comparison by follow-up status and experimental condition

Organization Characteristics	Overall (n=98)	Not Followed-up (n=35)	Followed-up (n=63)	Control (n=30)	Intervention (n=33)
Type of organization					
City	52.0%	54.3%	50.8%	46.7%	54.5%
County	10.2%	11.4%	9.5%	13.3%	6.1%
Special taxing district	37.8%	34.3%	39.7%	40.0%	39.4%
Size of organization (mean (SD))	246.93 (450.09)	284.71 (504.34)	225.94 (419.77)	270.97 (539.37)	185.00 (272.25)
Percentage of female senior managers (mean (SD))	23.3% (19.3%)	25.7% (16.5%)	22.0% (20.6%)	21.7% (20.3%)	22.4% (21.3%)
Political Culture					
Individualistic	61.2%	65.7%	58.7%	60.0%	57.6%
Traditionalistic	16.3%	14.3%	17.5%	20.0%	15.1%
Moralistic	22.5%	20.0%	23.8%	20.0%	27.3%
Colorado Political Culture Regions					
Denver Metro	38.8%	28.6%	44.4%	46.7%	42.4%
Other Front Range	12.2%	14.3%	11.1%	6.7%	15.2%
Eastern Colorado	8.2%	17.1%	3.2%	3.3%	3.0%
Southern and Western Colorado	40.8%	40.0%	41.3%	43.3%	39.4%
Party affiliation (mean (SD) of % voting for Democratic candidate of weighted county population) ¹					
Senatorial election – 2008	52.4% (12.4%)	50.5% (12.7%)	53.5% (12.3%)	52.5% (14.1%)	54.4% (10.5%)
Senatorial election – 2010	47.7% (12.6%)	45.7% (12.6%)	48.8% (12.6%)	47.9% (14.4%)	49.6% (10.8%)
Gubernatorial election – 2010	50.9% (12.8%)	49.1% (13.0%)	51.9% (12.6%)	51.0% (14.4%)	52.8% (10.9%)
Household income of weighted county population (mean (SD))	\$ 77,547.34 (\$18,711.73)	\$ 76,670.45 (\$18,641.43)	\$ 78,034.50 (\$18,882.29)	\$76,688.94 (\$17,445.12)	\$79,257.73 (\$20,291.77)
Percentage of bachelor's degree or higher of weighted county population (mean (SD)) ²	36.4% (12.5%)	34.9% (12.2%)	37.3% (12.7%)	36.0% (13.3%)	38.4% (12.2%)
Distance (in miles) from urban Front Range of Colorado (mean (SD))	82.91 (89.55)	75.26 (73.10)	87.16 (97.79)	84.93 (93.15)	89.18 (103.24)

¹Based on county voting records.
²From 2010 U.S. Census.

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Table 2:

Profile of employees in follow-up assessment and comparison by experimental condition

Characteristics	Overall (n=1784 employees)	Control (n=871 employees)	Intervention (n=913 employees)
Years working at job (mean (SD))	9.45 (9.48)	8.52 (8.97)	10.34 (9.87) **
Work department			
Public Works	35.0%	29.0%	40.8% **
Parks and Recreation	23.4	34.2	13.0
Public Safety	19.9	12.9	26.6
Other	21.7	23.9	19.6
Work outdoors/indoors Mostly indoors or outdoors and indoors equally	51.6%	49.4%	53.8%
Mostly outdoors	48.4	50.6	46.2
Hours of working outside from April to October (mean (SD))	23.36 (20.21)	24.19 (20.84)	22.58 (19.58)
Hours of working outside from November to March (mean (SD))	17.15 (18.20)	16.81 (18.51)	17.47 (17.91)
History of skin cancer			
No	91.7%	91.4%	91.9%
Yes	8.3	8.6	8.1
Skin reaction to exposure to the sun			
Always burns and is unable to tan	5.0%	5.0%	5.1%
Usually burns but can tan if you work at it	22.0	19.4	24.5
Sometimes mildly burns and then tans easily	44.5	45.3	43.6
Rarely burns and tans easily	28.5	30.3	26.8
Age (mean (SD))	42.32 (13.23)	40.99 (14.01)	43.61 (12.30) **
Education			
Less than 4-year college	59.7%	60.9%	58.6%

Characteristics	Overall (n=1784 employees)	Control (n=871 employees)	Intervention (n=913 employees)
	40.3	39.1	41.4
Gender			
4-year college or more			
Female	19.5%	24.5%	14.8% **
Male	80.5	75.5	85.2
Ethnicity and race			
Other	11.2%	12.7%	9.8%
Non-Hispanic White	88.8	87.3	90.2
Marital status			
Other	31.2%	34.8%	27.8% **
Married/living with a partner	68.8	65.2	72.2
Children in home			
No	60.4%	61.7%	59.3%
Yes	39.6	38.3	40.7

**
p<0.01

Table 3:

Sun protection practices and sunburns (mean; standard deviation) at work reported by employees at two-year follow-up by experimental condition and presence of a best-practice occupational sun protection policy

Sun Protection Practice	Control	Intervention	F	p	No Policy	Policy	F	p
Total composite sun protection when working outdoors. ^{1, 3, 4, 5, 14, 15, 16, 20}	3.34 (0.05)	3.46 (0.05)	7.65	0.009	3.34 (0.05)	3.46 (0.05)	8.34	0.006 *
Have sunscreen, a hat, and eye protection at work. ^{1, 8, 9, 10, 11, 14, 16, 20}	3.95 (0.09)	4.15 (0.10)	4.32	0.043	3.95 (0.09)	4.15 (0.10)	4.44	0.041 *
Apply sunscreen with an SPF 15 or greater on face through the use of aftershave, face lotion or make-up. ^{1, 9, 15, 16, 20}	3.42 (0.09)	3.53 (0.10)	1.37	0.250	3.39 (0.09)	3.58 (0.09)	5.33	0.030 *
Apply sunscreen with an SPF 15 or greater on exposed body parts (not including aftershave, face lotion or make-up). ^{1, 5, 8, 9, 14, 15, 16, 17, 20}	3.39 (0.09)	3.60 (0.10)	7.08	0.012	3.37 (0.09)	3.61 (0.10)	9.56	0.004 *
Apply a lip balm with an SPF 15 or more on lips. ^{10, 13, 16, 17, 20}	3.23 (0.09)	3.39 (0.09)	2.76	0.103	3.24 (0.09)	3.38 (0.09)	1.98	0.165
Wear clothing specifically to protect my skin from the sun, such as long-sleeved shirts and long pants. ^{1, 2, 4, 8, 13, 15, 20}	2.96 (0.07)	3.10 (0.07)	2.71	0.108	3.00 (0.07)	3.06 (0.08)	0.61	0.441
Wear a hat with any brim. ^{1, 3, 9, 10, 14, 20}	3.36 (0.08)	3.44 (0.08)	1.04	0.317	3.36 (0.07)	3.43 (0.08)	0.71	0.406
Wear a hat with a wide-brim. ^{1, 3, 9, 13, 16}	2.58 (0.07)	2.82 (0.08)	10.97	0.002	2.61 (0.08)	2.76 (0.08)	3.57	0.066
Wear sunglasses. ^{9, 17}	4.37 (0.04)	4.33 (0.04)	0.55	0.465	4.32 (0.04)	4.37 (0.04)	0.67	0.419
Limit exposure to the sun during the mid-day hours. ^{4, 5, 9, 11, 15}	2.79 (0.05)	2.86 (0.04)	1.39	0.249	2.81 (0.05)	2.84 (0.05)	0.31	0.579
Stay mostly in the shade when it's available. ^{1, 2, 4, 9, 11, 15}	3.35 (0.05)	3.42 (0.05)	1.37	0.253	3.37 (0.05)	3.40 (0.05)	0.30	0.589
Proportion of employees who received a sunburn in the last 12 months while working on the job. ^{6, 9, 10, 13, 15, 19, 20}	0.460 (0.037)	0.372 (0.035)	3.98	0.046	0.425 (0.036)	0.406 (0.038)	0.16	0.688
Number of sunburns received in the last 12 months while working on the job. ^{9, 10, 13, 15, 16, 17, 20}	1.15 (0.16)	0.82 (0.11)	3.50	0.067	1.05 (0.14)	0.89 (0.13)	0.91	0.345

*
p<0.05