Rye, S. and Janda, M. and Stoneham, M. and Crane, P. and Sendall, M. and Youl, P. and Tenkate, T. et al. 2014. Changes in Outdoor Workers' Sun-Related Attitudes, Beliefs, and Behaviors: A Pre–Post Workplace Intervention. Journal of Occupational and Environmental Medicine. 56 (9): pp. e62-e72.

Running Title: Changes in outdoor worker sun protection behaviour

Abstract

Objective: To evaluate changes in outdoor workers' sun-related attitudes, beliefs, and behaviours in response to a health promotion intervention using a participatory-action research process.

Methods: Fourteen workplaces across four outdoor industry types worked collaboratively with the project team to develop tailored sun protection action plans. Workers were assessed before and after the 18-month intervention.

Results: Outdoor workers reported increases in workplace support for sun protection ($p < 0.01$) and personal use of sun protection ($p < 0.01$). More workers reported seeking natural shade (+20%), and wearing more PPE including broad-brimmed hats (+25%), long-sleeved collared shirts (+19%), and long trousers (+16%). The proportion of workers reporting sunburn over the past 12 months was lower at post-intervention (-14%) ($p = .03$); however, the intensity of reported sunburn increased.

Conclusions: This intervention was successful in increasing workers' sun protective attitudes, beliefs, and behaviours.

The incidence of melanoma and non-melanoma skin cancers (NMSC) has been increasing worldwide, constituting a major public health issue. The World Health Organisation has estimated between two to three million squamous cell carcinomas, ten million basal cell carcinomas and 200,000 melanomas are diagnosed globally each year.(1) Ultraviolet (UV) radiation is the most important skin cancer risk factor, and excessive UV exposure can lead to other negative health consequences such as eye diseases, actinic keratoses and premature skin ageing.(2) Skin cancer places an enormous financial burden on the Australian health care system with over 700,000 NMSCs treated in 2010, costing at least $511 million.(3) Outdoor workers are at increased risk for the development of NMSCs due to the nature of their occupation and high levels of chronic or intermittent UV exposure, while there are inconsistent findings with regards to whether their melanoma risk is increased.(4-9) Around 34 per cent of workers in Australia are regularly exposed to excessive UV radiation during working hours.(10)

Over the past few decades, a combination of public education, social marketing, and more recently, social media campaigns have been used to promote sun protection and skin cancer prevention. However, despite ongoing public health campaigns, there are still some difficult-to-reach adult target groups including outdoor workers.(11-13) Occupational exposure to UV radiation is a modifiable risk factor and the potential for change in workplace settings is large. Targeted interventions that are multi-component and use a combination of healthy public policy and health promotion approaches may be most useful at increasing sun safe behaviours in the workplace.(14)

Multi-component interventions have included diverse strategies such as the provision of wide-brimmed hats and sunscreen, education sessions and sun safety reminders, policy development and role modelling to prompt sun safe behaviour change among workers(14-16). A number of studies have found multi-component interventions including several of these strategies improved the sun safe behaviours of outdoor workers. For example, the *Pool Cool* study (2001) integrated environmental changes such as shade provision as well as sun safety education, sunscreen provision and incentives for sun safe workers. The study found swimming pools assigned to the intervention had significantly more sun protection policies and lifeguards at these pools reported significantly fewer sunburns at follow-up.(17) A very large study with workers employed by the outdoor recreation industry and/or resorts also reported significant improvements in sun safety outcomes including reductions in sunburn following a multi-component intervention.(18)

In Australia, a study conducted amongst outdoor workers from the construction/road works industries in a tropical area found workers under a mandatory sun protection policy experienced less sun damage compared to workers under a voluntary policy.(19) Perceived workplace support and personal factors, such as a higher perception of risk to developing skin cancer have been found to be strongly associated with more positive sun protection behaviours among workers.(20) Social and organisational factors (e.g., role modelling(21), training of safety officers(22), and peer leader modelling(23)) have also been associated with better personal protective equipment (PPE) use and compliance.(18, 24, 25) A variety of educational strategies including employee training, and the use of different types of resources (e.g., posters, videos, brochures, and reminder systems) have prompted positive change in workers' knowledge and sun protection habits (i.e., wearing a shirt, sunglasses, seeking shade, using sunscreen, and wearing a hat).(23, 25, 26)

Based on recent evidence, The Community Preventive Services Task Force(27) changed its' recommendation from insufficient evidence to strong evidence for the effectiveness of interventions in increasing outdoor workers sun protective behaviours and reducing sunburn. Interventions which include a component of education, activities to influence knowledge, attitudes or behaviours, environment changes or policy are most likely to be effective. Recent reviews(15, 16) have also concluded there is now sufficient evidence demonstrating the effectiveness of educational and multi-component interventions in promoting positive sun protection habits among outdoor workers. However, it is unclear whether such interventions will be equally useful for workers from all outdoor industries, and more evidence is needed among different occupation types, especially non-recreational settings.(27)

Based on the efficacy of multi-component interventions in previous research, the objective of this project was to apply a comprehensive, health promotion intervention using a participatory action approach to influence the sun behaviour practices of outdoor workers in non-recreational workplace settings in Queensland, Australia and to assess the intervention's effect on outdoor workers' sun-related attitudes, beliefs and behaviours in a pre-post intervention design.

METHODS

Ethical approval for this project was obtained from Queensland University of Technology's Human Research Ethics Committee (approval number QUT 1000000968). This pre-post project used

qualitative and quantitative data collected at baseline and at the end of the 18-month intervention period.

Participants and recruitment

Recruitment and baseline characteristics have been described in detail previously.(28) In brief, workplaces from four industries with a high proportion of outdoor workers (building/construction, rural/farming, local government, or public sector) in Queensland were recruited based on their size (small, less than 30 employees versus large, greater than 100 employees), and geographic location (regional and rural). Out of 125 workplaces screened, 38 were eligible and sent an invitation letter, and fifteen (39%) agreed to participate. One of the initial workplaces withdrew prior to the intervention commencing. Subsequently 14 of the 38 eligible workplaces participated in the intervention phase and are included in this analysis. In addition, two workplaces participated in some of the post-intervention data collection, but were unable to provide any workers for the telephone interviews.

Workplace champions (mostly the Workplace Health and Safety Officer or a manager) were recruited to serve as a contact person during the project. They were primarily responsible for communication with the project team and were the drivers of the intervention implementation at their workplace. Following recruitment of the workplaces, individual workers were recruited separately for the on-site, semi-structured discussion groups at baseline and post-intervention. Workers consent and contact information for telephone interviews were obtained at the discussion groups at both time-points.

Health promotion intervention

The workplaces and the project team worked collaboratively utilising a participatory action research approach(29)[1] to develop a tailored sun protection action plan for each workplace. For this project, sun safe strategies appropriate for each workplace were established in the following six areas: 1) *Policy* (e.g., develop a workplace sun protection policy if required or check for comprehensiveness of an existing policy; adopt sun safety practices at all company social events; include a sun-safe clause in all contracts and work task sheets); 2) *structural and environmental* (e.g., provide portable shade at worksites; eliminate or minimise reflective surfaces); 3) *personal protective equipment (PPE) (*e.g., supply broad-brimmed hats, long-sleeved collared shirts, sunscreen,

[1] Involves a focused, 'heads together' way of thinking, values people's inputs, takes advantage of existing skills and resources and stimulates innovation.

sunglasses); 4) *education and awareness* (e.g., include sun safety awareness and correct use of PPE in inductions; display sun awareness posters in prominent spaces); 5) *role modelling* (e.g., site supervisors to be sun safe role models); and 6) *skin examinations* (e.g., provide annual skin examinations; encourage workers to check their own skin regularly and visit their doctor). Feedback from workers and management at baseline was incorporated into the action plan.

The project team maintained weekly contact (via telephone or email) with the workplaces over the 18-month intervention period to monitor action plan implementation and to provide assistance, information, and support. There was a project website with relevant information and materials for workplaces to access and they were provided with education resources, samples of PPE, examples of policy documents and strategies for effective engagement of managers or workers, relevant to each individual workplace.

Procedures

Workers were individually assessed for pre- and post-intervention sun protection behaviours, knowledge, and attitudes.

Site visits and discussion groups

Three workplace site visits were carried out by the project team to discuss the current status of workplace sun protection (visit 1, pre-intervention), provide baseline feedback (visit 2, start of intervention), and to discuss sun protection approximately 18 months later (visit 3, post-intervention). Semi-structured discussion groups with the workers were conducted pre- and post-intervention (data not described here).

Worker survey

Computer Assisted Telephone Interviews (CATIs) were conducted with the workers pre- and post-intervention. Survey items were adapted from previous research(30, 31), and included additional questions developed for this project. The interviews collected workers' socio-demographic characteristics, skin cancer risk factors, history of skin cancer, sun protection attitudes, beliefs, and behaviours at work. Questions about knowledge of their workplaces sun protection policy and perception of their workplaces level of support for sun protection and workers' perception of changes to workplace sun safety protocols after the intervention were also asked (question details are listed in the tables). Due to the transient nature of the workforce, the pre- and post-implementation worker surveys were cross-sectional.

Measures

Perceived workplace support

The perceived workplace support score was an average of the responses to four attitudinal statements about sun protection in the workplace ('*sun protection is valued at my workplace*', '*sun protection is enforced at my workplace*', '*my supervisors protect themselves from the sun*', and '*my colleagues protect themselves from the sun*') measured on a 5-point Likert scale (1 = strongly agree to 5 = strongly disagree). The items were reverse coded before averaging the total score, with a higher score indicating a higher level of perceived workplace support.

Sun protection

The sun protection score was computed as an average of the responses for six sun protective behaviours based on the sun protection index by Glanz et.al(31) (using natural/artificial shade, limiting time in the sun between 10 am and 3 pm, wearing a hat, collared shirt with sleeves, sunglasses, or sunscreen) measured on a 5-point ordinal scale ranging from 1 = rarely to 5 = always. Higher scores indicated a higher level of sun protection.

Sunburn

The sunburn score took into account the frequency and severity of sunburn while at work in the past 12 months. Sunburn was defined as any amount of reddening of the skin after being in the sun and severe sunburn was defined as causing pain for 2 to 5 days with blistering or peeling of the skin. The score ranged from 1 = sunburnt once or less to 5 = sunburnt severely 6 or more times. Higher scores indicated a greater amount of sunburn in the past 12 months. Additional questions assessed the proportion of workers using sun protection in the physical environment, as well as PPE and sun safety education received in the workplace.

Data Analysis

Analysis was completed using the Statistical Package for the Social Sciences (SPSS) (version 21). Survey questions measured using a 5-point Likert scale (strongly agree, agree, neither agree nor disagree, disagree, strongly disagree) were collapsed into three (3) categories for analysis (agree, neither agree nor disagree, disagree). For questions with yes/no/unsure response options, the unsure responses were combined with the 'no' responses if representing less than 5% of the responses.

Descriptive statistics were presented either as means and standard deviations or as frequencies. Worker characteristics at baseline and post-intervention and the proportion of workers reporting relevant sun safety attitudes, beliefs and behaviours were compared using Chi square analysis or Fisher's Exact test. All available data from workers who participated in pre- or post-intervention were included in restricted maximum likelihood linear mixed models analyses to determine changes in the perceived workplace support score, the sun protection score and the sunburn score from baseline and factors associated with such change. Only the variables which performed better than the base model (smaller Akaike information criterion [AIC] value) in univariable analyses were included in the multivariable analyses. For each outcome variable, the best fitting model was found by removing each least significant variable and comparing AIC values. To account for the effect of workplace characteristics, each model was run three times to determine the best model fit; 1) individual workplaces, 2) workplace type (construction, rural, local government or public sector), 3) workplace size (small/large).

RESULTS

Workplace characteristics

Information about the selection and recruitment of workplaces has been published previously.(28) Consistent with stratification, approximate equal numbers from local government, building/construction, public sector and farming/rural industries were recruited (Table 1). Around half the workplaces (53.3%) already had some form of sun protection policy in existence at baseline.

Outdoor worker characteristics and sun-related knowledge, attitudes, and beliefs

Within the 14 workplaces, 150 outdoor workers participated in the baseline interview. Of these, 50 participated in the

post-intervention interview (58% of the 86 workers interviewed post-intervention) (Table 1). The workers participating in the post-intervention survey were significantly older compared to the pre-intervention respondents. Workers from the Local Government sector were on average older (48-49 years) at both pre- and post-intervention compared to workers from the Building and construction industry (36-37 years). Workers from the Local Government sector were more likely to have private health insurance (p=0.04). There were no other differences in the distributions of socio-demographic

characteristics (gender, marital status, education, country of birth, or level of insurance) between pre- and post-intervention (Table 2). At both time-points, the majority of workers were male, married/living with their partner, and born in Australia. There were no differences in the distribution of skin cancer risk factors (e.g., blue/green eye colour, blonde/red hair colour, and fair skin type). More workers at post-intervention reported they would have a 'deep tan' following several days of sun exposure (X^2 (4) = 13.7, p = 0.01) (Table 2).

The proportion of workers who agreed it was 'very likely' they would get skin cancer at some point in the future was 11% higher at post-intervention (28% pre- to 39% post-intervention p = 0.17). The proportion of workers who checked their own skin for early signs of skin cancer was higher following the intervention (45% pre- to 52% post-intervention p = 0.34), with 80% of these workers having conducted a skin check in the last 12 months. A larger proportion of workers also reported having a skin check by a doctor during the past 12 months (40%) compared to baseline (30%) (p = 0.21) (Table 2).

Table 2 also presents the workers' sun-protective attitudes, beliefs and behaviours. The proportion of workers who agreed their workplace enforced sun protection and agreed their supervisors protected themselves from the sun increased by 10% from baseline to post-intervention (59% to 68%, and 66% to 76%, respectively). Workers beliefs shifted toward a higher proportion in agreement with the statement 'being in the sun at work is one of my biggest concerns' at post-intervention (45% to 51%) (p = 0.02). At baseline, nearly all workers (92%) agreed they had a responsibility under Workplace Health and Safety legislation to protect themselves from the sun, increasing to 97% post-intervention. The proportion of workers who agreed with the statement "my employer has a responsibility under Workplace Health and Safety legislation to protect worker from the sun" was slightly higher post-intervention (72% to 77%) (Table 2).

Perceived workplace support

Unadjusted, the intervention had a significant effect on the perceived workplace support score which increased from 3.7 (95% CI: 3.6, 3.8) to 3.9 (95% CI: 3.7, 4.0) following the intervention (p < 0.01) (Table 3). The greatest improvement in perceived support was reported by workers from small workplaces and the Public Sector. While the perceived support score improved overall, once adjusted for "received education on skin cancer prevention", "received education on use of PPE", "skin colour after several days of exposure" and the "sun protection score", the intervention effect was no-longer

significant, showing the increase in workplace support score was mediated by the factors listed above (Table 4). Workers who protected themselves more from the sun (higher sun protection score) were more likely to perceive a higher level of support from their workplace ($\beta = 0.23$, $p < 0.01$). In addition, the workers who reported receiving education and training on sun safety or skin cancer prevention as part of the intervention were significantly more likely to report a higher workplace support score (greater perceived level of support from the workplace) ($\beta = 0.21$, $p = 0.01$) (Table 4).

Sun protection score

Unadjusted, the intervention had a significant effect on the sun protection score which increased from 3.4 (95% CI: 3.3, 3.5) to 3.6 (95% CI: 3.5, 3.7, $p < 0.01$) (Table 3). Workers from the construction industry had the highest level of sun protection at baseline; while workers from small workplaces and the Public Sector increased their sun protection score the most from pre- to post-intervention.

Agreeing with the statements "being in the sun at work was a big concern" and "being in the sun was just part of normal working life" were significantly related to a higher sun protection score ($\beta = 0.21$, $p = .01$; $\beta = 0.66$, $p = .01$, respectively). Compared to workers who tanned without burning, workers who reported burning without tanning when in the sun for 30 minutes at the beginning of summer without a tan or protection, had a significantly higher sun protection score ($\beta = 0.25$, $p = .04$). A higher perceived workplace policy score (sun protection is valued and enforced by the workplace; role modelling occurs by supervisors and by colleagues) was also significantly related to a higher sun protection score ($\beta = 0.15$, $p = .02$) (Table 4).

Sunburn frequency and severity

Overall, the proportion of workers who reported they had been sunburnt in the past 12 months was significantly reduced post-intervention (69% pre- and 55% post-intervention; $\chi^2(1) = 4.97$, $p = .03$). However, the proportion of workers reporting being sunburnt six or more times (19% to 31%; $\chi^2(1) = 4.04$, $p = .05$) and reporting severe sunburn (10% to 13%; $\chi^2(1) = 0.52$, $p = .52$) increased pre- and post-intervention, respectively (Table 2).

Unadjusted, the sunburn score (composite of number of sunburns and severity) did not change significantly over the intervention period; although the sunburn score for workers from small workplaces and the farming sector decreased from pre- to post- intervention (Table 3). Workers born in Australia were significantly more likely to report being sunburnt at work more frequently and more

severely compared to workers born overseas (higher sunburn score) (β = 0.63, p = .01) (Table 4). Workers with a higher sunburn score were also significantly more likely to report being concerned about a spot or mole (β = 0.51, p < 0.01). There was an inverse relationship between the age of outdoor workers and the sunburn score; with increasing age, the sunburn score decreased (less frequently and less severely burned) (β = -0.03, p < 0.01).

Sun safe behaviours and practices

Following the intervention, significantly more workers reported 'usually or always' seeking natural shade (+20%), and wearing PPE including broad-brimmed hats (+25%), long-sleeved collared shirts (+19%), and long-trousers (+16%). There was no change in sunscreen use pre- to post-intervention (Table 5). Outdoor workers from smaller workplaces were much more likely to increase their use of PPE including long-sleeved collared shirts (+36%), and long trousers (+32%), compared to workers from larger workplaces (+11% and +9% for shirts and trousers, respectively).

Fifty-nine percent of workers reported they had noticed more sun safety education in their workplace and over two-thirds (69%) reported seeing posters and brochures relating to sun safety in their workplaces. After the intervention, there was a 12% increase in the proportion of workers reporting to have received formal education on sun safety and skin cancer as part of the intervention (Table 5) (+7% for larger versus, +23% for small workplaces, respectively). A greater proportion of workers from larger workplaces had already received such education at baseline (60% large versus 38% small) leaving less opportunity for improvement in this outcome.

DISCUSSION

Overview of findings

This project extends previous research by assessing sun safety before and after an 18 month multi-component intervention for outdoor workers from four types of small and large outdoor industries. Following the intervention, a significant increase in workers' perceived workplace support for sun protection and workers' use of sun protection was observed. Workers were more likely to report seeking natural shade, and wearing PPE including broad-brimmed hats, long-sleeved collared shirts, and long trousers. Improvements in sun protection practices were greater for outdoor workers from smaller workplaces, most likely due to their lower baseline level compared to workers from larger workplaces where sun protection practices were often already in place. These findings confirm those

of Hammond and colleagues(20) who first reported the importance of perceived workplace support and found it to be strongly associated with sun protection practices in the workplace. The findings from this project highlight the importance of consistent sunsafe workplace culture and focused management support in the delivery of sun protection strategies in the workplace. As has been reported by others, workplace management plays a vital role in creating a healthy work environment and motivating workers to participate in sun protection practices.(32, 33) Other studies have reported increased sunscreen use in association with a supportive workplace culture(34-36); however, this project was unable to achieve any change to sunscreen use.

Although the sunburn score did not change significantly over time in the current project, the proportion of workers who reported being sunburnt over the past 12 months was significantly lower post-intervention. However, for those workers who did report sunburn, the intensity and number of times they were sunburnt was higher post-intervention. This finding is surprising given the increase in sun-protection behaviours and positive attitudes and beliefs reported by the workers. One of the strategies selected by four workplaces for their sun protection action plan was to encourage workers to report sunburn using standard injury reporting procedures. It is possible this intervention component increased workers awareness of sunburn, or enhanced their perceptions of what sunburn is and the different levels of severity. This may have led to more frequent or more accurate reporting of sunburn by workers after the intervention. Given the lower proportion of workers reporting sunburn overall post-intervention and stability of the sunburn score, this seems the most likely interpretation.

More broadly, workers' attitudes shifted significantly post-intervention towards a greater level of concern for 'being in the sun at work'. The proportion of workers who felt it was 'very likely' they would get skin cancer at some point in the future increased by 10 per cent from pre- to post-intervention (28% to 39%, respectively). An increase of 7 per cent in the number of workers who had checked their skin for early signs of skin cancer was reported post-intervention, with 80 per cent reporting they had checked in the last 12 months. Our findings are consistent with previous literature by Hammond and colleagues (2008) who found workers who perceived they were at higher risk of developing skin cancer were more likely to display sun protective behaviours.(20)

In the current project, receiving workplace sun safety education and training was associated with a higher level of perceived workplace support which, in turn, assisted workers to engage in more frequent use of sun protection. Following the intervention, significantly more workers reported they

had received education specifically on sun safety and skin cancer prevention. Previous studies(23, 25, 26) found a range of educational strategies using a variety of resources (e.g., posters, videos, brochures, and reminder systems) prompted positive change in workers' knowledge and sun protection behaviours.

Workers' perceptions of enforcement of sun protection in the workplace and positive role modelling of sun protective behaviours by supervisors and peers increased following the intervention. Post-intervention, nearly all workers believed they had a responsibility to protect themselves from the sun while at work, however as this belief was already common at baseline (92%), the overall increase was small (5%). The proportion of workers agreeing the workplace should play an important role in sun safety also increased. Other studies found comparable results(18, 23-25, 37), including the value that peer leader modelling increases workers' willingness to protect from the sun.

Limitations

There are several limitations which must be considered when interpreting the results of this project. Firstly, as a convenience sample of outdoor workers (i.e., those individuals who were available at the discussion groups) was utilised, these workers may have been more likely to be interested in sun protection and may have been more likely to report protective behaviours. Outdoor workers with low literacy levels or who spoke little English may have been reluctant to participate, leading to potentially overestimated sun protection and perceived workplace support. Future interventions should incorporate multi-lingual, user-friendly materials and cater for workers with low literacy levels. The self-reported nature of the data may have resulted in socially desirable responses which is a common bias associated with this method of data collection. In addition, due to the pre-post design we cannot exclude the possibility that improvements in sun safety were a result of the Hawthorne effect (improved behaviours due to the effect of being observed). Several challenges were also encountered by workplaces during implementation (e.g., floods, cyclones) and around the post-intervention site visits (e.g., lower worker participation in the discussion groups, replacement of workplace champions, government changes) which impacted data collection.

CONCLUSION

This project involved the successful development and implementation of a comprehensive health promotion intervention grounded in a participatory action research process. With the support of

the project team, and led by their workplace champion, the majority of workplaces successfully implemented sun protection strategies. A multi-component approach to sun safety interventions appears to be promising in reaching workplaces across a variety of industries, particularly for small workplaces or those with lower levels of sun protection strategies in place. Significant intervention effects were observed increasing the proportion of workers who: (i) Received education or training in sun safety; (ii) improved their overall sun protection and workplace support score (unadjusted); and (iii) used PPE (broad-brimmed hat, natural shade, long-sleeved shirt, long trousers). Furthermore, workers who perceived their workplace provided more support and showed a higher degree of concern towards being in the sun were significantly more likely to protect themselves from the sun. Future research could assess the sustainability of the project by re-visiting the 14 participating workplaces in two to three years' time. As the evidence for the positive effects of sun protection in the workplace grows, there is also now a need to focus on how to more effectively and widely disseminate the interventions. It is unknown whether a web-based or automated delivery would be just as effective or whether change agents are needed to facilitate uptake of the sun protection intervention package. The results show there is a continued need to support outdoor workplaces to ensure skin cancer prevention is identified and addressed as a priority, especially at smaller workplaces and in those with fewer resources.

REFERENCES

1. Lucas R, McMichael T, Smith W, Armstrong B. Solar ultraviolet radiation: Global burden of disease from solar ultraviolet radiation. *Environmental Burden of Disease Series, No 13*. Geneva, CH: World Health Organisation; 2006:1-258.
2. World Health Organisation. Environmental health criteria 160: Ultraviolet radiation. Geneva, CH: World Health Organisation; 1994.
3. Fransen M, Karahalios A, Sharma N, English D, Giles G, Sinclair R. Non-melanoma skin cancer in Australia. *The Medical Journal of Australia*. 2012;197:565-568.
4. Antoine M, Pierre-Edouard S, Jean-Luc B, David V. Effective exposure to solar UV in building workers: influence of local and individual factors. *Journal of Exposure Science and Environmental Epidemiology*. 2006;17:58-68.
5. Gies P, Wright J. Measured solar ultraviolet radiation exposures of outdoor workers in Queensland in the building and construction industry. *Photochemistry and Photobiology*. 2003;78:342-348.
6. Hammond V, Reeder AI, Gray A. Patterns of real-time occupational ultraviolet radiation exposure among a sample of outdoor workers in New Zealand. *Public Health*. 2009;123:182-187.
7. Armstrong B. How sun exposure causes skin cancer: An epidemiological perspective. In: Hill D, Elwood M, English D, eds. *Prevention of skin cancer*. Dordrecht, NL: Kluwer Academic Publishers; 2004:89-116.
8. Bauer A, Diepgen T, Schmitt J. Is occupational solar ultraviolet irradiation a relevant risk factor for basal cell carcinoma? A systematic review and meta analysis of the epidemiological literature. *British Journal of Dermatology*. 2011;165:612-625.
9. Schmitt J, Diepgen T, Bauer A. Occupational exposure to non artificial UV light and

non melanocytic skin cancer–a systematic review concerning a new occupational disease. *JDDG: Journal der Deutschen Dermatologischen Gesellschaft*. 2010;8:250-263.

10. Safe Work Australia. National hazard exposure worker surveillance: Exposure to direct sunlight and the provision of sun exposure controls in Australian workplaces. Barton, ACT: Commonwealth of Australia; 2009.
11. Andersen P, Buller D, Walkosz B, et al. Expanding occupational sun safety to an outdoor recreation industry: A translational study of the Go Sun Smart program. *Translational Behavioural Medicine* 2012;2:10-18.
12. Burke M, Sarpy S, Smith-Crowe K, Chan-Serafin S, Salvador R, Islam G. Relative effectiveness of worker safety and health training methods. *Research and Practice* 2006;96:315-324.
13. Smith B, Ferguson C, McKenzie J, Bauman A, Vita P. Impacts from repeated mass media campaigns to promote sun protection in Australia. *Health Promotion International*. 2002;17:51-60.
14. Glanz K, Buller D, Saraiya M. Reducing ultraviolet radiation exposure among outdoor workers: State of the evidence and recommendations. *Environmental Health*. 2007;6:22-32.
15. Horsham C, Auster J, Sendall M, et al. Interventions to decrease skin cancer risk in outdoor workers: update to a 2007 systematic review. *BMC Research Notes*. 2014 (in press).
16. Reinau D, Weiss M, Meier C, Diepgen T, Surber C. Outdoor workers' sun-related

knowledge, attitudes, and protective behaviours: A systematic review of cross-sectional and interventional studies. *British Journal of Dermatology*. 2013;168:928-940.

17. Geller A, Glanz K, Shigaki D, Isnec M, Sun T, Maddock J. Impact of skin cancer prevention on outdoor aquatics staff: The pool cool program in Hawaii and Massachusetts. *Preventive Medicine*. 2001;33:155-161.

18. Buller D, Andersen P, Walkosz B, et al. Randomised trial testing a worksite sun protection program in an outdoor recreation industry. *Health Education & Behaviour*. 2005;32:514-535.

19. Woolley T, Lowe J, Raasch B, Glasby M, Buettner P. Workplace sun protection policies and employees' sun-related skin damage. *American Journal of Health Behaviour*. 2008;32:201-208.

20. Hammond V, Reeder A, Gray A, Bell M. Are workers or their workplaces the key to occupational sun protection? *Health Promotion Journal of Australia*. 2008;19:97-101.

21. Winett R, Cleaveland B, Tate D, et al. The effects of the safe-sun program on patrons' and lifeguards' skin cancer risk-reduction behaviors at swimming pools. *Journal of Health Psychology*. 1997;2:85-95.

22. Azizi E, Flint P, Sadetzki S, et al. A graded work site intervention program to improve sun protection and skin cancer awareness in outdoor workers in Israel. *Cancer Causes and Control*. 2000;11:513-521.

23. Lombard D, Neubauer T, Canfield D, Winett R. Behavioural community intervention to reduce the risk of skin cancer. *Journal of Applied Behaviour Analysis*. 1991;24:677-686.

24. Andersen P, Buller D, Voeks J, et al. Testing the long-term effects of the Go Sun Smart

worksite health communication campaign: A group-randomised experimental study. *Journal of Communication*. 2008;58:447-471.

25. Torp S, Grøgaard J, Moen B, Bråtveit M. The impact of social and organisational factors on workers' use of personal protective equipment: A multilevel approach. *Journal of Occupational and Environmental Medicine*. 2005;47:829-837.

26. Mayer J, Elder J, Slymen D, et al. Promoting sun safety among US postal service letter carriers: Impact of a 2-year intervention. *American Journal of Public Health*. 2007;97:559-565.

27. Community Preventive Services Task Force. Preventing Skin Cancer: Interventions in Outdoor Occupational Settings, Task Force Finding and Rationale Statement. *http://wwwthecommunityguideorg/cancer/skin/education-policy/RRoutdooroccupationshtml*. Atlanta, GA: Community Guide Branch, Division of Epidemiology, Analysis and Library Services, Center for Surveillance, Epidemiology and Laboratory Services, Office of Public Health Scientific Services, Centers for Disease Control and Prevention (CDC); 2013.

28. Janda M, Stoneham M, Youl P, et al. What encourages sun protection among outdoor workers from four industries? *Journal of Occupational Health*. 2014.

29. Crane P, O'Regan M. On PAR: Using participatory action research to improve early intervention. Department of Families, Housing, Community Services, and Indigenous Affairs. Canberra, ACT: Australian Government; 2010.

30. Janda M, Baade P, Youl P, et al. The skin awareness study: Promoting thorough skin self-examination for skin cancer among men 50 years or older. *Contemporary Clinical Trials*. 2009;31:119-130.

31. Glanz K, Schoenfeld E, Steffen A. A randomised trial of tailored skin cancer

prevention messages for adults: Project SCAPE. *American Journal of Public Health*. 2010;100:735-741.

32. Parker S, Axtell C, Turner N. Designing a safer workplace: Importance of job autonomy, communication quality, and supportive supervisors. *Journal of Occupational Health Psychology*. 2002;6:211-228.

33. Buller D, Andersen P, Walkosz B, et al. Enhancing industry-based dissemination of an occupational sun protection program with theory-based strategies employing personal contact. *American Journal of Health Promotion*. 2012;26:356-365.

34. Hall D, McCarty F, Elliott T, Glanz K. Lifeguards' sun protection habits and sunburns: Association with sun-safe environments and skin cancer prevention program participation. *Archives of Dermatology*. 2009;145:139-144.

35. Kütting B, Drexler H. UV-induced skin cancer at workplace and evidence-based prevention. *International Archives of Occupational and Environmental Health*. 2010;83:843-854.

36. McCool J, Reeder A, Robinson E, Petrie K, Gorman D. Outdoor workers' perceptions of the risks of excess sun-exposure. *Journal of Occupational Health*. 2009;51:404-411.

37. Dobbinson S, Borland R, Anderson M. Sponsorship and sun protection practices in lifesavers. *Health Promotion International*. 1999;14:167-176.

TABLE 1. Number of participating workplaces and outdoor workers from four industry types at pre- and post-intervention

	Workplaces		Workers
	n=14 (%)	Pre n=150 (%)	Post n=86 (%)
Industry Type			
Building and Construction	4 (28.6)	36 (24.0)	13 (15.1)
Local Government	2 (14.2)	27 (18.0)	32 (37.2)
Rural and Farming	4 (28.6)	49 (32.7)	27 (31.4)
Public Sector	4 (28.6)	38 (25.3)	14 (16.3)
Workplace Size			
Large (>100 employees)	7 (50.0)	102 (68.0)	58 (67.4)
Small (<30 employees)	7 (50.0)	48 (32.0)	28 (32.6)

TABLE 2. Outdoor workers characteristics and sun-related attitudes, beliefs, and behaviours at pre- and post-intervention

	Pre n=150		Post n=86		
Characteristic	**n**	**(%)**	**n**	**(%)**	**p-value**
Sociodemographic characteristics					
Age (years) mean (sd)	41.7	(14.3)	46.4	(12.8)	0.01
Gender					1.00
Male	140	(93.3)	80	(93.0)	
Female	10	(6.7)	6	(7.0)	
Marital status[a]					0.99
Married/living together	84	(56.4)	49	(57.0)	
Divorced/separated	11	(7.4)	6	(7.0)	
Single	54	(36.2)	31	(36.0)	
Highest level of education completed					0.29
Primary school/junior high (year 7 or 8)	6	(4.0)	7	(8.1)	
Some high school (year 9-12)	70	(46.7)	45	(52.3)	
Trade/technical certificate or diploma	61	(40.7)	30	(34.9)	
University or college degree	13	(8.7)	4	(4.7)	
Country of birth[b]					0.82
Australia	134	(90.5)	79	(91.9)	
Other[c]	14	(9.5)	7	(8.1)	
Private insurance[b]					0.89
Yes	64	(42.7)	37	(44.0)	
No/ don't know	86	(57.3)	47	(56.0)	
Household income[b]					0.01
Less than $40,000	25	(16.7)	6	(7.1)	
$40,000 to $79,999	52	(34.7)	25	(29.8)	
$80, 000 or more	41	(27.3)	19	(22.6)	
Don't know	14	(9.3)	9	(10.7)	
Refused	18	(12.0)	25	(29.8)	
Skin cancer risk factors					
Eye colour[b]					0.94
Brown or Black	46	(30.7)	27	(32.1)	
Blue or Grey	46	(30.7)	24	(28.6)	
Green or Hazel	58	(38.7)	33	(39.3)	
Natural hair colour[b]					0.99
Dark brown or black	51	(34.2)	28	(33.3)	
Light brown	51	(34.2)	28	(33.3)	
Sandy/Blonde	38	(25.5)	23	(27.4)	
Red	9	(6.0)	5	(6.0)	
Skin colour before tanning[b]					0.68
Fair	91	(60.7)	46	(54.8)	
Medium	29	(19.3)	19	(22.6)	
Olive/brown/black	30	(20.0)	19	(22.6)	
Skin after strong sun exposure for 30 minutes without protection[b]					0.54
Burn without tanning afterwards	26	(17.8)	17	(20.7)	
Burn then tan	68	(46.6)	32	(39.0)	
Tan without burning	52	(35.6)	33	(40.2)	

Table 2 continued

	Pre n=150		Post n=86		
Characteristic	**n**	**(%)**	**n**	**(%)**	**p-value**
Tanning tendency following sun exposure over several days[b]					0.01
Never tan, only burn/freckle	9	(6.3)	9	(10.7)	
Slightly tan	42	(29.6)	22	(26.2)	
Moderately tan	66	(46.5)	25	(29.8)	
Deep tan	25	(17.6)	25	(29.8)	
Don't know/unsure	0	(0.0)	3	(3.6)	
Has previously had skin cancer, mole or other spot removed[b]					0.58
Yes	62	(41.3)	38	(45.2)	
No	88	(58.7)	46	(54.8)	
How likely is it that you will get skin cancer at some time in the future?[b]					0.17
Not at all likely	18	(12.0)	10	(11.9)	
Somewhat likely	65	(43.3)	34	(40.5)	
Very likely	42	(28.0)	33	(39.3)	
Don't know/unsure	25	(16.7)	7	(8.3)	
Currently concerned about a spot/mole[b]					0.87
Yes	35	(23.3)	18	(21.4)	
No/don't know	115	(76.7)	66	(78.6)	
Has ever checked skin for early signs of skin cancer[b]					0.34
Yes	68	(45.3)	44	(52.4)	
No	82	(54.7)	40	(47.6)	
If yes to above, was the check in the last 12 months?[a]					
Yes	-	-	35	(79.5)	
No	-	-	8	(18.2)	
Doctor has checked skin for early signs of skin cancer in past 12 months[b]					0.21
Yes	45	(30.0)	34	(40.5)	
No/don't know	105	(70.0)	50	(59.5)	
Attitudes, beliefs and behaviours					
Sun protection is valued at my workplace [b]					0.86
Strongly disagree/ disagree	9	(6.4)	5	(5.9)	
Neither agree nor disagree	9	(6.4)	4	(4.7)	
Agree/ strongly agree	123	(87.2)	76	(89.4)	
Sun protection is enforced at my workplace [b]					0.32
Strongly disagree/ disagree	44	(31.2)	19	(22.4)	
Neither agree nor disagree	14	(9.9)	8	(9.4)	
Agree/ strongly agree	83	(58.9)	58	(68.2)	
My supervisors or managers protect themselves from the sun well [b]					0.48
Strongly disagree/ disagree	19	(13.5)	10	(11.8)	
Neither agree nor disagree	24	(17.0)	10	(11.8)	
Agree/ strongly agree	98	(65.5)	65	(75.6)	
My colleagues protect themselves from the sun well [b]					0.19
Strongly disagree/ disagree	21	(14.9)	6	(7.1)	
Neither agree nor disagree	15	(10.6)	8	(9.4)	
Agree/ strongly agree	105	(74.5)	71	(83.5)	
Being in the sun during work is one of my biggest concerns [b]					0.02
Strongly disagree/ disagree	65	(46.1)	26	(30.6)	
Neither agree nor disagree	12	(8.5)	16	(18.8)	
Agree/ strongly agree	64	(45.4)	43	(50.6)	
Being in the sun during work is just part of my normal working life [b]					0.63
Strongly disagree/ disagree	4	(2.8)	1	(1.2)	
Neither agree nor disagree	2	(1.4)	2	(2.4)	
Agree/ strongly agree	135	(95.7)	82	(96.5)	

Table 2 continued

	Pre n=150		Post n=86		
Characteristic	**n**	**(%)**	**n**	**(%)**	**p-value**
I have other health concerns that are more important than those caused by too much sun exposure [b]					0.32
Strongly disagree/ disagree	71	(50.4)	34	(40.0)	
Neither agree nor disagree	22	(15.6)	16	(18.8)	
Agree/ strongly agree	48	(34.0)	35	(41.2)	
My employer has a responsibility under Workplace Health and Safety procedures to protect me from the sun [b]					0.24
Strongly disagree/ disagree	19	(13.5)	7	(8.2)	
Neither agree nor disagree	12	(8.5)	12	(14.1)	
Agree/ strongly agree	110	(78.0)	66	(77.6)	
I have a responsibility under Workplace Health and Safety procedures to protect me from the sun [b]					0.37
Strongly disagree/ disagree	6	(4.3)	1	(1.2)	
Neither agree nor disagree	5	(3.5)	2	(2.4)	
Agree/ strongly agree	130	(92.2)	82	(96.5)	
My colleagues generally believe that tanned skin looks healthy [b]					0.37
Strongly disagree/ disagree	68	(48.2)	34	(40.0)	
Neither agree nor disagree	31	(22.0)	25	(29.4)	
Agree/ strongly agree	42	(29.8)	26	(30.5)	
I would not use sunscreen regularly because I like to be tanned [b]					0.30
Strongly disagree/ disagree	125	(88.7)	71	(83.5)	
Neither agree nor disagree	6	(4.3)	8	(9.4)	
Agree/ strongly agree	10	(7.1)	6	(7.1)	
I would not wear long sleeves or long pants in the sun because it would prevent me from getting 'some colour' [b]					0.63
Strongly disagree/ disagree	132	(93.6)	80	(94.1)	
Neither agree nor disagree	3	(2.1)	3	(3.5)	
Agree/ strongly agree	6	(4.3)	2	(2.4)	
In the last 12 months at work did you ever get sunburnt? [b]					0.03
No	46	(30.7)	38	(45.2)	
Yes	104	(69.3)	46	(54.8)	
In the last 12 months how many times did you get sunburnt? [b]					0.05
Less than 6 times	121	(80.7)	58	(69.0)	
More than 6 times	29	(19.3)	26	(31.0)	
In the last 12 months did you ever get severely sunburnt?					0.52
No	135	(90.0)	73	(86.9)	
Yes	15	(10.0)	11	(13.1)	

a. Variable contains 1 missing value
b. Variable contains 2 or more missing values
c. New Zealand, United Kingdom, United States, Europe

Table 3. Unadjusted composite scores at pre- and post-intervention (overall and split by workplace size and type)

	Pre	Post	
Composite Score	**Mean (95% CI)**	**Mean (95% CI)**	**p-value**
Perceived Workplace Support (overall)	**3.67 (3.57, 3.77)**	**3.87 (3.74, 3.99)**	**<0.01**
Workplace Size			
Small	3.59 (3.43, 3.75)	3.90 (3.64, 4.16)	
Large	3.69 (3.55, 3.82)	3.84 (3.68, 4.01)	
Workplace Type			
Local Government	3.85 (3.63, 4.07)	3.90 (3.72, 7.08)	
Construction	3.56 (3.32, 3.80)	3.73 (3.20, 4.26)	
Public Sector	3.62 (3.38, 3.86)	4.07 (3.75, 4.39)	
Farming	3.62 (3.45, 3.78)	3.77 (3.49, 4.05)	
Sun Protection (overall)	**3.39 (3.29, 3.49)**	**3.60 (3.47, 3.73)**	**<0.01**
Workplace Size			
Small	3.25 (3.00, 3.50)	3.79 (3.52, 4.06)	
Large	3.46 (3.34, 3.59)	3.56 (3.41, 3.70)	
Workplace Type			
Local Government	3.54 (3.30, 3.77)	3.46 (3.26, 3.66)	
Construction	3.60 (3.37, 3.84)	3.82 (3.46, 4.18)	
Public Sector	3.34 (3.09, 3.59)	3.92 (3.70, 4.15)	
Farming	3.21 (3.01, 3.42)	3.59 (3.32, 3.86)	
Sunburn (overall)	**1.97 (1.80, 2.13)**	**1.94 (1.74, 2.15)**	**0.84**
Workplace Size			
Small	2.10 (1.81, 2.40)	1.81 (3.64, 4.16)	
Large	1.86 (1.67, 2.06)	1.93 (3.68, 4.01)	
Workplace Type[a]			
Local Government	1.59 (1.32, 1.87)	1.66 (1.24, 2.07)	
Construction	2.33 (1.99, 2.68)	2.33 (1.65, 3.02)	
Public Sector	1.79 (1.48, 2.10)	2.43 (1.69, 3.17)	
Farming	1.96 (1.64, 2.28)	1.69 (1.32, 2.07)	

a Sig difference at pre-intervention.

Table 4. Significant relationships with the three main outcomes (A. Perceived workplace support, B. Sun protection and C. Sunburn)

	Mean	95% CI	p-value
A. Perceived workplace support score[a,b]			
Intervention time period			**0.14**
Pre	3.65	3.49, 3.81	
Post	3.76	3.60, 3.91	
Worker reported they have received formal education and training on sun safety or skin cancer prevention			**0.01**
Yes	3.81	3.64, 3.98	
No/Unsure	3.60	3.44, 3.76	
Sun protection score (β)	0.23	0.11, 0.35	**<0.01**
B. Sun protection score[c,d]			
Intervention time period			**0.27**
Pre	3.00	2.67, 3.34	
Post	3.17	2.83, 3.50	
Being in sun during work is one of biggest concerns			**0.04**
Disagree	2.95	2.61, 3.30	
Neither agree nor disagree	3.14	2.78, 3.50	
Agree	3.16	2.82, 3.50	
Being in sun is part of working life			**0.01**
Disagree	2.75	2.22, 3.27	
Neither agree nor disagree	3.11	2.55, 3.66	
Agree	3.41	3.17, 3.64	
Other health concerns that are more important than those related to sun exposure			**0.02**
Disagree	3.22	2.88, 3.57	
Neither agree nor disagree	2.97	2.61, 3.32	
Agree	3.07	2.74, 3.40	
Worker reported they had a responsibility under Workplace Health and Safety to protect self from sun			**0.01**
Disagree	3.53	3.00, 4.06	
Neither agree nor disagree	2.63	2.15, 3.10	
Agree	3.10	2.82, 3.38	
Worker reported receiving formal education on use of PPE for sun protection			**<0.01**
Yes	3.24	2.90, 3.57	
No/Unsure	2.94	2.60, 3.27	
Workplace support score (β)	0.15	0.02, 0.28	**0.02**
C. Sunburn score[e,f]			
Intervention time period			**0.29**
Pre	1.73	1.26, 2.20	
Post	1.85	1.39, 2.31	
Country of birth			**0.01**
Australia	2.10	1.71, 2.49	
Other	1.48	0.90, 2.09	
Skin colour before tanning			**0.04**
Fair	2.01	1.56, 2.46	
Medium	1.62	1.10, 2.13	
Olive or brown	1.74	1.22, 2.25	
Skin colour after strong sun exposure for 30 minutes			**<0.01**
Tan without burning	1.59	1.12, 2.06	
Burn then tan	2.12	1.63, 2.61	
Burn without tanning	1.65	1.12, 2.18	
Currently concerned about a spot or mole			
Yes	2.04	1.55, 2.54	**<0.01**
No	1.53	1.08, 1.99	
Age (years) (β)	-0.03	-0.04, -0.02	**<0.01**

a. Scale 1-5, higher scores indicate greater perceived value placed on sun protection in workplace
b. Including all variables in table in addition to whether they received formal education on the use of PPE, and skin after exposure for several days
c. Scale 1-5, higher scores indicate more frequent use of natural/artificial shade, staying out of sun 10 am – 3 pm, PPE
d. Including all variables in table in addition to skin after sun exposure for several days, skin after strong exposure for 30 minutes, workplace
e. Scale 1-5, higher scores indicate greater frequency and/or severity of sunburns in the past 12 months
f. Including all variables in table in addition to workers reporting that they would not wear long sleeves or long pants in the sun, skin after exposure for several days, sun protection score

Table 5. Frequency of use of sun protection by workers in a typical work week and education received at pre- and post-intervention

	Pre % Usually/Always	Post % Usually/Always	% change	p-value
Physical Environment				
Natural shade	29.3	48.8	19.5	0.01
Artificial shade	11.3	18.6	7.3	0.30
Restricting amount of time spent in sun between 10am-3pm	10.7	11.9	1.2	0.71
PPE				
Hat (any kind)[a]	86.0	96.5	10.5	0.02
Broad brimmed (min 8cm) hat	52.0	76.7	24.7	<0.01
Long-sleeved, collared shirt	72.0	90.7	18.7	<0.01
Long trousers	58.7	74.4	15.7	0.02
Enclosed boots/shoes	98.0	96.5	-1.5	0.12
Sunglasses	73.3	79.1	5.8	0.59
Sunscreen	40.3	40.7	0.4	0.60
Education	**% Yes**	**% Yes**	**% change**	**p-value**
Received formal education on use of PPE for sun protection	63.3	67.4	4.1	0.53
Received education on sun safety and skin cancer prevention	52.7	64.7	12.0	0.07

a Hats include hard hat, hard hat with brim and or flaps, broad brimmed hat, caps.