Manuscript Title: Uptake of skin self-examination and clinical examination behaviour by outdoor workers

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The authors declare that they have no conflict of interest.

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Abstract

This study investigated the association between outdoor work and response to a behavioural skin cancer early detection intervention among men 50 years or older. Overall, 495 men currently working in outdoor, mixed or indoor occupations were randomised to a video-based intervention or control group. At 7 months post intervention, indoor workers reported the lowest proportion of whole-body skin self-examination (wbSSE; 20%). However, at 13 months mixed workers engaged more commonly in wbSSE (36%) compared to indoor (31%) and outdoor (32%) workers. In adjusted analysis, the uptake of early detection behaviours during the trial did not differ between men working in different settings. Outdoor workers compared to men in indoor or mixed work settings were similar in their response to an intervention encouraging uptake of secondary skin cancer prevention behaviours during this intervention trial.

Introduction

Skin cancer is the most common cancer worldwide [1]. In Australia, incidence rates are very high, and two out of three adults will develop skin cancer during their lifetime [2]. Melanoma, a skin cancer arising from melanocytes, can be difficult to treat if detected late [3]. In countries with a high incidence of melanoma, such as the USA or Australia, men aged 50 years or older are at twice the risk of developing the disease as women of the same age [1, 4], and the incidence of melanoma in older men continues to rise [5, 6]. Clinical skin examinations by a doctor (CSE) are a low-cost way of detecting melanoma early in people over 50 years [2, 7].

Exposure to ultraviolet radiation (UVR) from the sun is the most important environmental risk factor for the development of melanoma [8-12]. Within the Australian workforce, people employed in outdoor occupations are exposed to five to ten times more UVR than indoor workers [13]. Men are more likely to engage in physical labour-intensive occupations, [14] and this type of work aligns closely with excessive sun exposure [15]. A recent Australian study found that the risk of being exposed to direct sunlight in the workplace was 2.9 times higher in men than in women [16].

Most prior research suggests that outdoor workers are at increased risk of skin cancer, including melanoma [17-23]. This may be due to the high levels of sun exposure received in outdoor occupations, inadequate use of sun protective measures during outdoor work [11, 24], or greater recreational UVR exposure than other workers [25]. Epidemiological literature specifies that occupational UVR exposure is a significant risk factor for the development of cutaneous squamous cell carcinoma (SCC) and basal cell carcinoma (BCC)[26].

Despite strong support for an association between outdoor work and increased melanoma incidence, some studies have not found an increased risk [27-29] possibly because of a tendency for people with less sun sensitive skin to self-select for outdoor work, particularly in high-solar UVR environments such as Queensland [15, 27]. However, a Queensland study did not confirm this hypothesis [15], as the majority of outdoor working participants reported having sun-sensitive skin (Fitzpatrick Classification Scale categories I-III)[30].

Given the high UVR exposure in both occupational and recreational settings of outdoor workers [25], and uncertainty about whether their skin type would predispose them to skin cancer or not, secondary skin cancer prevention that fosters the early detection and removal of skin cancers has the potential to improve survival from melanoma [3, 31, 32]. Skin self-examination (SSE) is one such method that may be an effective tool in either finding skin cancers early or raising awareness of the need for CSE [33-36]. This inexpensive and non-invasive technique can be conducted by workers themselves, with or without the help of another person, to detect preliminary signs of melanoma, such as suspicious moles or changing skin lesions [37]. However at present, prevalence of SSE in the Australian population is low, especially in older men [38], and men are less likely than women to engage in regular SSE [39].

Given their greater exposure, it is currently unknown whether men who work outdoors are more likely to engage in secondary skin cancer prevention behaviours than men who work in occupations that are not predominantly outdoors. We therefore sought to explore this issue by conducting a secondary analysis of data collected during the Skin Awareness Study, a randomised trial of a video-delivered intervention which aimed to increase SSE in men 50 years or older [40].

Methods

Ethical Approval

Ethical clearance was granted by the Human Research Ethics Committee from the Queensland University of Technology (QUT), and the trial was registered with the Australian New Zealand Clinical Trials Registry (ANZCTR N12608000384358).

The Skin Awareness Study

The Skin Awareness Study was conducted in Queensland, Australia. In brief, 2899 potential male participants aged 50 years or older were mailed an invitation letter and a brochure detailing the background and purpose of the study. Of these, 1032 did not wish to participate and 288 were ineligible due to cognitive or hearing impairment, non-English speaking background, no access to either a video or DVD player, or a previous melanoma diagnosis. Of the total 2276 (78%) men who responded to the initial mail-out, 929 (37%) provided informed consent to participate in the study. Study materials have been previously described in detail[40]. Briefly, we randomised men to receive either a DVD/video or a brief pamphlet only[41]. The 12-minute DVD featured a nationally recognised sports personality who presented information about what skin cancer is, risk factors for skin cancer and explained that men 50 years or older are at increased risk to develop skin cancer. Men were also informed on how to detect skin cancer early. A 65 year old male actor then guided viewers through a step-by-step SSE, explaining what to look for and how to overcome common obstacles such as limited spare time and not having a partner to help with difficult to see body areas. The actor then visited a doctor to highlight what happens during a clinical skin examination, and to allow the doctor to reinforce the message that skin self-examination is

important. Both groups received the pamphlet showing the common features of benign and malignant skin lesions as well as highlighting the importance of SSE.

Data Collection

We used Computer Assisted Telephone Interviews (CATIs) to collect information at baseline, and at 7 and 13 months following enrolment. Information collected included: socio-demographic and phenotypic characteristics; skin cancer history; attitudes and beliefs about skin examinations; sun protection; SSE and CSE history; social support and self-efficacy. A series of previously validated questions [42] provided the foundation for the main variables of the study. To distinguish men according to their location of work, at baseline we asked the question *'Is your main job or activity now…?'* with the following answer categories, *'mainly indoors'*; *'mainly outdoors'*; and *'about equal amounts indoors and outdoors'*.

We also asked men whether they had ever examined their own skin (any SSE) and if so, the frequency and the extent of any examinations. The completeness of SSE amongst the participants was measured by asking men to specify the body area(s) they had examined during their last SSE, whether they used a full-size and/or hand-held mirror when independently conducting SSE and if they sought assistance from another person to examine hard-to-see areas. Either mirrors or the assistance of another person were necessary to qualify for a whole body (wb) SSE. We asked participants whether they had received a CSE by a doctor within the past 12 months.

Statistical Analysis

Descriptive statistics for all baseline variables comparing intervention and control group participants have been published elsewhere. From the original sample of 929 men with baseline data [40], those who did not provide information about the nature of their employment were excluded (n=10). We also excluded men who were retired at the time of the baseline interview (n=494), leaving 495 participants for analysis. We used chi-squared tests to assess differences in socio-demographic, phenotypic, attitudinal and behavioural factors between outdoor, indoor and mixed worker groups. Chi-square tests were also used to test for differences in the proportion of participants in the three work groups separately by their assignment into the treatment arms (intervention or control) who performed any SSE or a wbSSE within the past six months, or who attended a doctor for a CSE in the past six or twelve months. Logistic regression models were used to compare the odds of conducting SSE or CSE of men working indoors (reference group) with that of those working in either mixed occupations or outdoors, adjusted for the socio-demographic characteristics found to differ between the three groups (age, education, income, area of Queensland) as well as treatment arm. A generalised estimating equation (GEE) model using the logit link function was conducted to assess the uptake of SSE in participants across the three occupational groups over the course of the study, adjusted for age, education, income, area of residence and treatment arm. Statistical analyses were conducted using the SPSS statistical package version 18 and SAS version 9. Statistical significance was specified at the level $p \leq 0.05$.

Results

Tables 1-3 show the main characteristics of the 495 men separated into the three work categories. Overall, 236 (48%) men reported working mainly indoors, 118 (24%) worked equally indoors and outdoors and 140 (28%) worked mainly outdoors. Most socio-demographic characteristics were similar across all three occupational groups. However, 63% of outdoor workers resided in non-metropolitan areas compared to 46% of indoor and 54% of mixed workers ($p<0.01$). More outdoor workers had completed junior-high school only (39%), compared to 31% of mixed and 16% of indoor workers ($p<0.01$). Thirty-eight per cent of indoor workers were in high income households (>$100,001), compared with 21% of outdoor and 15% of mixed workers ($p<0.01$). Regardless of work type, most men were either married or living with a partner (86%) and born in Australia (80%). The majority of participants had a British, Scottish or Welsh/Irish ethnic background (80%; Table 1).

Phenotypic Characteristics/Primary Sun Protection

Consistent with their predominantly northern European heritage, most men reported sun-sensitive phenotypic characteristics and there was no difference according to work type (Table 2). A smaller proportion of indoor workers (6%) compared to mixed (13%) or outdoor (12%) workers reported being sunburned six or more times over the past twelve months ($p<0.01$). Sun protective behaviours also varied between the groups as detailed in Table 2. Overall, sunscreen use was low with 30% of indoor, 41% of mixed and 46% of outdoor workers reporting infrequent (never/rarely) use ($p=0.01$).

Attitudes/beliefs towards SSE

At baseline, almost half of all indoor workers had made no future plans to perform SSE (48%) compared to 40% of mixed and 36% of outdoor workers (Table 3). Despite this, approximately half of all workers agreed with the statement that it was *"important to examine*

their skin for skin cancer even in the absence of symptoms". Compared to 41% of mixed workers, 48% of indoor workers and 54% of outdoor workers agreed that they would seek medical attention if they found a suspicious skin lesion. While 18% of men employed in mixed occupations reported 'high' confidence (9-10) in their ability to correctly perform SSE, only 11% of outdoor and 10% of indoor workers were equally as confident (p=0.047).

SSE and CSE behaviours at baseline, and 7 and 13 month time points

Across all occupational groups, SSE and CSE behaviours recorded at baseline were similar (Table 4). Including men from intervention and control groups, 66% of mixed workers had conducted some form of SSE within the past six months, compared to 56% of outdoor and 53% of indoor workers. The proportion of indoor workers who had conducted a wbSSE was somewhat lower (9%), than in outdoors workers (12%) or those in mixed environments (13%). The majority of indoor workers recalled a CSE in the previous twelve months (53%), similar to 59% of mixed workers and 56% of outdoor workers.

At seven months, SSE and CSE behaviours of all men increased, irrespective of whether they were in the intervention or the control group (Table 4). Men in the intervention group were more likely to report any SSE within the past six months ($p<0.01$), but no other significant differences were observed between men in different work types or treatment groups (Table 4).

After combining data from men across control and intervention groups and adjusting for age, education, income and treatment arm, mixed workers were somewhat more likely to report SSE and CSE at all three time points than indoor workers (Odds ratios ranging from 1.03-1.48) (Table 5). Outdoor workers reported greater odds of whole body SSE at seven months (OR= 1.37), but not at thirteen months (OR= 0.96) compared to indoor workers. In contrast, outdoor workers reported significantly lower odds of a CSE at the seven month time point, than indoor workers (p=0.04). However, considering all work groups and changes over the

twelve month observation period, simultaneously in the GEE (adjusted for age, income and education, location of residence and treatment group), we detected no significant work type by time interaction effects (Table 5).

Comment

Secondary skin cancer prevention behaviours have been shown to reduce the risk of being diagnosed with a thick melanoma which carries increased mortality, and could therefore greatly improve melanoma outcomes in high risk outdoor workers [33, 43]. While outdoor working men have high UVR exposure, and often do not use adequate personal sun protection, there is currently limited information about their willingness to engage in secondary skin cancer prevention behaviours. This analysis shows that over a period of twelve months intervention trial, outdoor working men 50 years or older were largely similar in their uptake of SSE behaviours as men working indoors or in mixed occupations. This is encouraging as men working outdoors in Australia accumulate a large dose of UVR over time, thus increasing their risk of skin cancer development. However, for men working across all work groups there is still room for improvement; a wbSSE was conducted by only 20-30% of men at the seven and thirteen months time points.

In contrast to their similar SSE uptake, compared to indoor workers, outdoor workers had lower odds of reporting a CSE at the seven month time point. We have previously described facilitators and barriers for attendance at skin cancer screening clinics offering free CSEs within a community-based randomised intervention for melanoma screening [44]. Clinics were offered at different community venues, but also delivered directly to people's workplaces, and this was one of the most attractive features for men [44]. A workplace screening program has been implemented in California, and has reported a significant reduction in the incidence of thick melanomas and mortality from melanoma [45]. Given the success of these workplace programs, in addition to education and behaviour change interventions such as that tested in

the present trial, offering CSEs or training in SSE directly at workplaces should be considered, especially by workplaces with a high proportion of outdoor workers.

It has been reported that outdoor workers may be self-selected to be less sun sensitive [25, 27]. We found no differences in measures of sun sensitivity between the three worker groups, with the exception of freckling which was less frequent in outdoor workers. This similarity in phenotype may have contributed to the relatively similar uptake of SSE and CSE regardless of work type. Compared to indoor and mixed workers, men employed in outdoor occupations were more likely to wear hats and seek shade, findings that parallel other research [27, 46]. However, although outdoor workers were more likely to seek shade when outdoors, they were less likely than other men to avoid the sun during peak hours or to use sunscreen, and 12% of men in mixed or outdoor occupations reported six or more sunburns over the past twelve months. This highlights the challenges inherent in practicing sun safety in outdoor occupations that require work to be performed during much of the 9am-3pm peak UVR hour period.

In relation to sunscreen use, despite public health efforts to promote the benefits of sunscreen application [47, 48], and recent evidence for its utility in preventing melanoma [49],the observation that outdoor workers in this study rarely wore sunscreen is consistent with previous findings [46, 50]. It has been summarised previously that men, smokers, younger people and those without a previous history of skin excisions are less likely to use sunscreen [51]. Inconvenience, impracticality, greasiness and forgetfulness are major contributors to inadequate sunscreen use [52]. Better education of outdoor workers to increase awareness of the value of UVR protection and the value of sunscreen use in particular still seems needed [53], as well as innovations to make sunscreens more appealing. Stringent workplace sun protection policies

(e.g., enforcing protective clothing and provision of hats), alongside incentives for tax deductions on sun protection products should be encouraged as they may improve uptake of sun safe product use [54, 55].

Our study strengths included the use of longitudinal data, and the high retention of participants (Table 4). However, there are some limitations that need to be considered when interpreting the results. While we adjusted for age, education, income and area of residence, it is possible that there may have been other unmeasured confounding factors. Questions about current work location were only asked at baseline and were not repeated in the seven and thirteen month questionnaires. Thus, any change in location of work during the study was not captured, which may have influenced the final outcomes. Also, the baseline questionnaire only required participants to specify their current location of work or main activity and did not take into consideration their lifetime working environments. It is possible that some men may have worked the majority of their life outdoors and at the point of survey, had only recently acquired indoor employment. This may have reduced the differences in attitudes, beliefs and sun protection behaviours observed between occupational groups. A limitation common to behavioural studies was the reliance on self-reported data. However, previous studies examining outdoor workers have found that self-reported information on skin protection measures are in good to excellent agreement with actual observed behaviour [56].

In summary, it is encouraging to note that outdoor workers in this study were largely similar to other men 50 years or older in their willingness to engage in SSE, and responded positively to a video intervention. In addition to encouraging SSE, workplace programs may assist outdoor workers further to take up CSEs (e.g. workplace clinics offering free CSE); to increase use of sun protective measures such as sunscreen; and finally develop innovative

ideas to reduce amount of time spent in the sun between 10 am and 3 pm. Offering such targeted interventions to workers could increase the prevalence of wbSSE, which remains unused by many men at risk of melanoma.

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