ORIGINAL RESEARCH

SUN PROTECTIVE BEHAVIOURS AMONGST RECREATIONAL BOAT USERS IN NORTHERN AUSTRALIA: ASSOCIATIONS WITH PERSONAL EXPERIENCE OF SKIN CANCER

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ABSTRACT

Objective: To identify whether personal experience of skin cancer in people who regularly participate in recreational boating is associated with their level of midday sun exposure, current sun protective behaviours and sun-induced skin damage. Methods: Cross-sectional survey with 24-hour follow-up of recreational boat users who regularly go boating between 9am and 3pm. The study was conducted in Townsville, North Queensland (latitude 19°S), during the summer of 2003. Of the 134 boat users approached, 124 consented to participate, with 5 later excluded from analysis (n=119, response rate=92%). Results: In comparison to people reporting no personal experience of skin cancer, people with personal experience of skin cancer were more likely to: (1) report spending fewer hours on the boat between 9am to 3pm (p=0.010), (2) report using a canopy during the boat trip (p=0.038), (3) report wearing sunglasses (p=0.013), and (4) spend more than one hour in the sun on a typical workday (p=0.059). People who reported having previous skin cancer were no more likely to use personal sun protection or have a lighter tan, and no less likely to experience sunburn from the boat trip, than people not having skin cancer. Conclusions: During recreational boating, people who reported previous skin cancer were more likely to use a shade structure and spend less time in the sun during peak UVR hours (particularly those who typically worked indoors), but not to use more individual sun protection practices excepting sunglasses, than people not having skin cancer.

KEY WORDS: Skin cancer; Behaviour; Sun; Protection; Exposure; Recreational; Australia.

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INTRODUCTION

Exposure to ultra-violet radiation (UVR) from the sun is regarded as the major environmental risk factor for squamous cell carcinoma (SCC), basal cell carcinoma (BCC) and cutaneous melanoma (IARC, 1992; Rosso et al., 1996; Gilchrest et al., 1999; Armstrong and Kricker, 2001). Specifically, intense, intermittent sun exposure (peeling sunburn) in childhood and adulthood appear to significantly contribute to the development of melanoma (Gilchrest et al., 1999; Armstrong and Kricker, 2001; Autier et al., 1997), while cumulative sun exposure (long-term outdoor working and sun-tanning) appears responsible for the development of SCC (Rosso et al., 1996; Kricker et al., 1994; Gallagher et al., 1995b; Lavkar et al., 1995), while mixed effects of cumulative and intermittent sun exposure seem to account for the development of BCC (Rosso et al., 1996; Gallagher et al., 1995a; van Dam et al., 1999; Lavkar et al., 1995). Cumulative and intermittent sun damage is thought to significantly decrease the ability of the skin's immune system to repair chromosomal damage and detect and destroy potential cancerous cells (Grossman and Leffell, 1997; Garssen et al., 1998; Vermeer and Hurks, 1994).

The Cancer Council of Queensland currently endorses six strategies to reduce cumulative and intermittent sun damage including: minimising time spent in the sun between 10am and 3pm; seeking shade; wearing suitable clothing that provides good sun protection; choosing a broad brim, legionnaire-style or bucket-style hat that protects the face, neck and ears; wearing sunglasses; and applying SPF 30+ broad spectrum, water-resistant sunscreen 20 minutes before going out into the sun (Cancer Council Queensland, 2009).

This North Queensland (NQ) study sought to identify whether personal experience of skin cancer is associated with the sun protective behaviours and cumulative and intermittent skin damage (suntan level and sunburn) of people who regularly participate in a high exposure recreation activity such as boating.

METHODS

Participants

The study had a cross-sectional design with a 24-hour follow up. Data were collected first by a researcher-administered questionnaire, then by telephone 24 hours later. The survey was

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conducted in Townsville (latitude 19ºS, population 127,000), North Queensland, Australia, on three separate warm (above 30ºC) and sunny Sundays between February and March 2003. The study population was adults (aged 18 years or older) who regularly participated in recreational boating activities (went boating at least once every two months).

Participants were approached after docking their boat at either the Townsville Sailing Club, or boat ramps at the Townsville Breakwater, South Townsville National Park, Bohle or Giru. Recruitment occurred between the hours 11am to 5pm, so participants could potentially have spent at least one hour in the sun between 9am to 3pm – the extreme period for UVR during a North Queensland summer (Bernhard et al., 1997). On a typical Townsville summer day, UV-B peaks around midday, but levels are at least 1 Standard Erythemal Dose (SED) between the hours of 9am to 3pm (Bernhard et al., 1997). The SED is the proposed measure for erythemally-effective UVR exposure (equivalent to 100 J m^{-2} of erythemally-weighted irradiance), and is a standard measure that can be used for all individuals, regardless of skin type (Diffey et al., 1997). For example, an exposure of approximately 1.5 SED will just redden the skin of a sun-sensitive person who never tans (Fitzpatrick skin type I).

Of 134 boat users approached, 124 consented to participate. While all adults in a boat were invited to participate, in most instances (83%) it was only possible to obtain data from one member of the boating party, as the others were involved in attending to the docking of the boat. The data from 5 participants were excluded from the analyses because they either did not fulfill the study criteria of boating at least once every two months (1 participant) or spending any time boating between the hours 9am to 3pm (4 participants). The final sample population was 119 participants (response rate 92%). Approval for the study was obtained from the James Cook University Ethics Committee, number H1334.

Questionnaire

Demographic questions included age, gender, and total number of years spent in North Queensland. Participants self-assessed their skin type according to Fitzpatrick's classification: an index of sun-sensitivity representing the propensity to sunburn, scale I to IV from most sun sensitive to least sun sensitive Caucasian skin (Fitzpatrick, 1988). Respondents assigned the current suntan level on their face to one of five categories: very light, light, moderate, dark or very dark.

Each participant was asked about their personal history of skin cancer; this data was then dichotomised into the dependent variable: "have/have not experienced a skin cancer". Participants were also asked if they were currently employed and, if so, how many hours they work in the sun on a typical workday. Specific questions asked whether or not participants used a canopy or covered area on the boat; and whether or not they used the following sun protective measures on the boat trip: sunscreen; wide-brimmed hat; narrow-brimmed hat; cap; long-sleeved shirt; sunglasses; long pants or "other" (open-ended so respondents can report use of less common measures such as legionnaire-style hats or sun-gloves). At analysis, those people who reported having one or more personal barriers and those people who reported having no personal barriers were dichotomised into a 'yes' or 'no' category for the variable "I had reasons why I did not use sun protection".

A time scale was used to obtain data on sun exposure during the boat trip, which allowed the investigation of both the total time in the sun, and time during peak UVR hours between 9am and 3pm. Recent sun exposure was assessed by asking frequency of boat trips and hours of sun exposure on a typical workday in the previous week. Participant's beliefs about sun exposure and sun damage were assessed by 'yes' or 'no' answers to the following questions: enjoyment of exposing their skin to the sun; if an occasional sunburn was an acceptable risk; if a boat canopy provided adequate sun protection; and if sun reflection off the water was a "big problem".

Sunburn arising directly from the boat trip (defined as "at least skin redness or tenderness after 24 hours") was determined by self-report after 24 to 48 hours via telephone follow-up, as all participants were asked to provide a first name and contact telephone number. All 119 eligible participants were able to be followed up by telephone to provide the required sunburn information.

While the questionnaire was not validated for the present study, a very similar questionnaire was piloted with 81 recreational boat users as part of a small undergraduate student project investigating sunburn incidence in 2002. Further, many of the measures relating to sun protection, sun exposure, sun damage and demographics used in the present questionnaire were adapted from a previous skin cancer survey administered by the authors to North Queensland men with a histologically-confirmed epithelial skin cancer (Woolley et al., 2003). Validation of that survey included interviewing five men from the target population to ensure the phrasing and terminology of each question was well understood and questions were answered as intended, with analysis of the pilot study involving 30 participants showing at least moderate agreement for most items.

Statistical analysis

Data were coded numerically and entered into SPSS, release 14 for Windows (SPSS Inc., Chicago, Illinois). The Table shows a complete list of the variables as they were considered for statistical analysis. Numerical variables were described as mean values and standard deviations (SD). The bivariate associations between variables describing demographics, sun exposure, and sun protective beliefs and behaviours, and the respondent's personal history of skin cancer, were assessed with Chi-squared tests and T-tests, as appropriate. A statistical test was considered significant when the p-value was below 0.05.

RESULTS

A total of 119 (response rate 92%) North Queensland adults involved in regular recreational boating participated in the study. The mean age of the participants was 36.0 years (SD $\pm$ 11.1), most (79%) were male, almost half (49%) experienced sunburn as a result of the boat trip, and almost twenty percent (18%) of participants reported having a dark or very dark tan. Overall, 84% reported that they used sunscreen while boating, 51% wore a wide-brimmed hat, 33% wore a long-sleeved shirt, 85% wore sunglasses, 12% wore long pants, and 56% reported they spent more than one hour in the sun on a typical workday.

Of the 39 participants who reported a barrier to why they did not use personal sun protection on the day, 41% stated that "it was too

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hot", 21% commented that they "forgot", 21% said they did not own a long-sleeved shirt or wide-brimmed hat, and 15% stated that a wide-brimmed hat "blows off too easily".

Twenty-four percent of participants reported a personal experience of skin cancer. In comparison to people with no experience of skin cancer, people with experience of skin cancer were more likely to: (1) report spending fewer hours on the boat between 9 am and 3pm (p=0.010); (2) report using a canopy during the boat trip (p=0.038); (3) report wearing sunglasses (p=0.013); and (4) spend more than one hour in the sun on a typical workday (p=0.059). People reporting previous skin cancer were no more likely to use personal sun protection or have a lighter tan, and no less likely to experience sunburn from the boat trip, than people without previous skin cancer (Table).

Statistical analysis found no significant age-related differences in sun exposure or sun protective behaviours. However, stratification of the data found indoor workers with previous skin cancer, compared to outdoor workers with previous skin cancer, were more likely to use a canopy (88% versus 50%) and report personal barriers to using sun protection (85% versus 63%), respectively.

Table: Bivariate relationships between self-reported previous experience of skin cancer and sun exposure, sunburn and current sun protective behaviours during a recreational boat trip. Results are based on 119 regular recreational boat users resident in North Queensland.

	No history of skin cancer (n = 91)	History of skin cancer (n = 28)	p-value
Demographics			
My age in years (mean ± SD*)	35.3 ± 10.7	39.9 ± 12.6	0.064
My gender is male	78%	86%	0.775
I have skin type I or II (Fitzpatrick classification)	32%	34%	0.851
I have a "dark" or "very dark" suntan level	18%	29%	0.205
I work more than 1 hour in the sun on a typical workday	51%	71%	0.059
Years spent living in tropics (mean ± SD*)	18.7 (13.7)	20.3 (17.4)	0.611
Sun exposure			
Hours spent in the sun on this boat trip between 9am to 3pm (mean ± SD*)	4.4 ± 1.5	3.5 ± 1.4	0.010
I experienced sunburn as a result of the boat trip	52%	48%	0.718
Sun protective beliefs			
"Sun reflection off the water is a big problem"	97%	100%	0.330
"A canopy alone is not adequate sun protection"	72%	79%	0.519
"I do not enjoy exposing my skin to the sun"	65%	68%	0.769
"An occasional sunburn is not an acceptable risk"	52%	64%	0.240
Sun protective behaviours on the boat trip			
I wore a wide brimmed hat today	47%	57%	0.360
I wore a long sleeved shirt today	34%	39%	0.613
I applied sunscreen today	85%	79%	0.465
I wore sunglasses today	81%	100%	0.013
I wore long pants today	11%	18%	0.338
The boat I was on used a canopy today	39%	61%	0.038
I had reasons why I did not use sun protection	35%	21%	0.173

*SD = Standard deviation

DISCUSSION

This study showed that participants with a history of skin cancer were more likely to use a boat canopy and sunglasses and they decreased the length of time they spent out on the water during peak UVR hours. However, they were no more likely to use other sun protective behaviours, to limit their tan nor did they experience fewer sunburn as a result of the boat trip. Almost 50% of people with previous skin cancer experienced sunburn from the boat trip, with almost one-third reporting a dark or very dark suntan level (a higher percentage than people without previous skin cancer). Furthermore, almost three-quarter of participants were in an occupation involving significant time working in the sun. These factors have all previously been associated with a higher risk of developing BCC and SCC (Rosso et al., 1996; Armstrong & Kricker, 2001; Lavkar et al., 1995; Radespiel-TrÖger et al., 2009; Beral and Robinson, 1981).

Previous studies showed that people with a history of epithelial skin cancers have increased susceptibility to developing further skin cancer (Levi et al., 1998; Levi et al., 1997; Hemminki and Dong, 2000; Marghoob et al., 1993). Raasch and Buettner (2002) found a similar scenario in North Queensland; of 6708 patients with epithelial skin cancer, 39% developed another skin cancer within a 3-year follow up period. These findings suggest that the high rate of multiple skin cancers in the North Queensland population might be at least partly the result of chronic and intermittent UVR-induced skin damage experienced during recreational and occupational

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activities by people who had already developed skin cancer previously. Although "incidence" refers to new cases; most studies on epithelial skin cancer have a restricted time frame and limited resources to assess whether a case is genuinely new.

In this study, people with personal experience of skin cancer were more likely to rely on shade structures (a boat canopy) and reducing time spent in the sun during peak hours for UVR, than using recommended personal protective measures of long-sleeved shirts, wide-brimmed hats and sunscreen. However, a boat canopy is unlikely to provide adequate protection from reflected UVR off seawater early or late in the day, when up to 60% of UVR is reflected (Xenopolous et al., 2001). UVR studies in a tropical setting showed that shade structures alone do not provide sufficient protection against solar radiation even on dry land (Moise and Ainsley, 1999).

Relying predominantly on shade during high-UVR exposure activities may partly explain the high proportion of people with previous skin cancer who continue to experience episodes of sunburn. Reliance on shade rather than personal protection may be related to factors associated with boating and the tropical environment: brimmed hats tend to be blown away more easily in a breeze than caps, and there is a common perception in the North Queensland population that long-sleeved shirts are too hot and uncomfortable to wear during the warmer months of the year (Woolley et al., 2004).

Indoor workers with previous skin cancer, compared to outdoor workers with previous skin cancer, were more likely to use a canopy and reported personal barriers to using sun protection. This suggests that at least in this tropical population, those who typically spend less time in the sun tend to use shade as their primary sun protection strategy and have more personal barriers to using recommended sun protection practices. These personal barriers and preference for shade in indoor workers may help explain the less than adequate use of personal sun protection strategies (long-sleeved shirt, brimmed hat and long pants) in the overall groupe of people with a history of skin cancer. Further investigation is needed to explore the barriers that indoor workers perceive against using personal sun protection.

It must be noted that the present study has several limitations. The prior experience of skin cancer, suntan level, skin type and working status of the individuals who participated in the study were self-reported, and as a consequence, misclassification bias is possible with respect to these variables. However, recall bias would likely be minimal, as sun protection and sun behaviour information was obtained as participants returned from the boat trip. As almost half the respondents reported using less than optimal sun protection and about half reported experiencing sunburn as a result of the boat trip, misinformation bias from participants providing more "acceptable" responses about their sun protection practices and sun damage is likely to be minimal. In addition, selection bias for both sailing-boat and motor-boat users was unlikely; only one sailing club operates in Townsville and most members participated, and data were collected from all four major motor-boat ramps within 50 kilometres of Townsville city.

In conclusion, people with a history of skin cancer who participated in recreational boating were as likely to become sunburnt during the activity as people without a previous skin cancer. Many people with previous skin cancer who participated in recreational boating, particularly those who worked indoors, relied on shade or reducing time spent in the sun during peak UVR hours to prevent sunburn, rather than using recommended sun protective practices.

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