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Charles Darwin University

## Lifetime prevalence of non-melanoma and melanoma skin cancer in Australian recreational and competitive surfers

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1 **Lifetime prevalence of non-melanoma and melanoma skin cancer in Australian**  
2 **recreational and competitive surfers**

3

#### 4 **Abstract**

#### 5 **Background/purpose**

6 Surfing is one of the most popular outdoor aquatic activities in Australia with an estimated  
7 2.7 million recreational surfers however, Australia has long been recognized as having the  
8 highest incidence of melanoma in the world, and it is the most common type of cancer in  
9 young Australians. The aim of this study was to investigate the lifetime prevalence of non-  
10 melanoma (basal cell carcinoma (BCC), squamous cell carcinoma (SCC)), and melanoma  
11 skin cancers in Australian recreational and competitive surfers.

#### 12 **Methods**

13 Australian surfers were invited to complete an online surveillance survey to determine the  
14 lifetime prevalence of non-melanoma and melanoma skin cancers.

#### 15 **Results**

16 A total 1,348 surfers (56.9% recreational) participated in this study, of which 184 surfers  
17 reported a skin cancer (competitive n=96, recreational n=87). Of non-melanoma and  
18 melanoma cancers reported, BCC was the most common (6.8%), followed by melanoma  
19 (1.4%) and SCC (0.6%). The relative risk was higher ( $p<0.001$ ) in competitive versus  
20 recreational surfers (OR 1.74 (CI 1.28-2.31)). There was a higher ( $p<0.05$ ) number of skin  
21 cancers reported on the face (23.5%), back (16.4%) and arms (12.4%). There were  
22 significant trends ( $p<0.001$ ) in reported skin cancers between competitive and recreational  
23 surfers, as well as significantly ( $p<0.001$ ) more skin cancers reported in males (14.6%) than  
24 females (9.4%).

#### 25 **Conclusion**

26 Based upon these findings, individuals who surf are advised to regularly utilize sun protection  
27 strategies (avoid peak ultra violet radiation (10am-3pm), rashvest, hat and sunscreen) and  
28 primary care physicians are recommended to regularly screen their patients who surf.

29

30 **Keywords:** physical activity; public health; questionnaire survey; sun exposure; skin  
31 neoplasms; ultraviolet radiation

32

33

## 34 **Introduction**

35 Surfing is one of the most popular outdoor aquatic activities in Australia with an estimated 2.7  
36 million recreational surfers (1). As a result the expected risk of skin cancer in surfers due to  
37 long periods of exposure to ultraviolet radiation (UVR) (2), wearing less clothing and reflection  
38 from water is of great concern. According to the Cancer Council, nearly one third of all  
39 Australians had a skin cancer, making it the most common type of cancer in Australians (3).  
40 Non-melanoma skin cancers (NMSC) were the most prevalent with over 750,000 treated each  
41 year. Australia has also been recognized as having the highest incidence of melanoma skin  
42 cancer (MSC) in the world (4-6), and it is the most common cancer in Australians aged 15 to  
43 29 years (7), although this has recently been challenged (8). Melanoma is also the third most  
44 common form of skin cancer, the mechanism of which is attributed to sunlight exposure,  
45 particularly UVR within the 250 to 400 nm wavelength (9, 10). It is estimated in 2015 there  
46 will be an estimated 938,000 treatments related to skin cancer in Australia, reportedly costing  
47 the medical benefits scheme \$703 million for diagnosis, treatment and pathology (11). A recent  
48 report on the epidemiological incidence of keratinocyte skin cancer revealed basal cell  
49 carcinoma (BCC) was the most common type of skin cancer in the Australian population  
50 followed by squamous cell carcinoma (SCC) (12), the report emphasized UVR exposure is of  
51 critical importance in Australian as a mechanism for the development of skin cancer. Despite  
52 the popularity of surfing there is very limited research (13) available on the prevalence of skin  
53 cancers in surfers. Dozier and Wagner (12) reported the results of a free skin cancer screening  
54 conducted by dermatologists in Texas (USA) surfers (n=49). The majority (73.4%) of the  
55 surfers screened were identified as having atypical moles (36.7%), actinic keratosis (40.8%)  
56 and BCCs (16.3%). Significance ( $p < 0.47$ ) was only identified with regard to BCCs in the  
57 surfers as opposed to a self-selected general population (16.3% versus 3.2%, respectively).  
58 There were no lesions identified that were suggestive of SCCs or melanomas. The purpose

59 of this study was to investigate the lifetime prevalence of non-melanoma and melanoma skin  
60 cancers in recreational and competitive surfers in Australia.

61

## 62 **Methods**

### 63 *Study design*

64 This research utilized a commercially available, customizable cloud-based survey in a cross-  
65 sectional observational study design.

66

### 67 *Sample*

68 Given the wide geographic distribution of surfing in Australia, an on-line survey was  
69 developed to allow for national data collection on surfing injuries (14) and determine the  
70 lifetime prevalence of non-melanoma and melanoma skin cancers in recreational and  
71 competitive surfers. We defined lifetime prevalence as the proportion of the population who,  
72 at some point in their lifetime up to the time of this survey, has ever had a melanoma (MSC)  
73 or non-melanoma skin cancer (NMSC). Media (broadcast, print and radio) promotion and  
74 direct contact with national surfing organizations and surfing clubs (n=103) was utilized to  
75 promote the study to all individuals who were currently surfing either recreationally or  
76 competitively in Australia. Ethics approval for this study was granted by Bond University  
77 Human Research Ethics committee (RO1540).

78

### 79 *Survey*

80 The survey consisted of two primary sections. Section 1 contained questions that pertained to  
81 participants physiological demographics (such as age, height, mass) and their surfing specific

82 demographics (board type) and surfing exposure (average hours per week and weeks per  
83 year for the previous year). Additionally, we inquired if the participants surfed during peak  
84 UVR which is recognized as 10am to 3pm, inclusive (15, 16). We also queried the  
85 participants surf status (recreational or competitive) and if the latter whether it was for their  
86 local club, international or the World Championship Tour. Section 2 pertained to surfing  
87 injuries (14) (acute and chronic) and included questions pertaining to the lifetime prevalence  
88 of non-melanoma and melanoma skin cancers. Participants were instructed to report only  
89 NMSCs and MSCs by type and location that have only been diagnosed and/or treated by  
90 either a general practitioner (GP) or dermatologist. This question specified that diagnosis  
91 needed to be confirmed by tissue biopsy, however participants were not required to upload  
92 either medical reports of diagnosed skin cancers or associated pathology reports. As most of  
93 the participants would be unaware of their Fitzpatrick skin phototype (17) we simplified skin  
94 types to the following; fair, medium, olive, brown and black (18).

95

96 Survey questions consisted of array, single choice, multiple choice, list dropdown, numerical  
97 input and short answer free text. Filters (where appropriate) were utilized to ensure  
98 participants provided electronic informed consent (individuals under the age of 18 years were  
99 required to have parental or guardian supervision whilst completing the survey), met entry  
100 criteria, expedite completion of the survey and help ensure responses were within logical  
101 limits. Additionally, participants were informed they could only complete one survey per  
102 participant and the online survey mechanism allowed each participant to only complete the  
103 survey once. All participants were required to provide informed consent electronically to  
104 enable access to the survey which was active for six months.

105 *Statistical analysis*



106 Data normality was assessed by investigating kurtosis, skewness, Q-Q plots, as well as the  
107 Kolmogorov-Smirnov (KS) test with Lilliefors significance correction. Heteroscedasticity  
108 was assessed using Levene's test. Statistical analyses were completed using the IBM  
109 Statistical Package for the Social Sciences (SPSS, version 22) and included demographics  
110 (mean  $\pm$  SD), correlations, t-tests and chi-square tests to determine significance of differences  
111 between groups, alpha was set at  $p < 0.05$  *a priori*.

112

## 113 **Results**

### 114 *Sample characteristics*

115 Table 1 depicts the physiological and surfing demographics of all participants. A total of 1,348  
116 surfers completed the survey, the majority of which were male (91.3%) and surfing  
117 recreationally (56.9%). The overall mean age of participants was 35.8 years (range 11-70) with  
118 competitive surfers (n=581, 43.1%) significantly ( $p < 0.05$ ) older (+3.9%) and slightly shorter  
119 (-.05%) than recreational surfers. With regard to surfing demographics competitive surfers  
120 reported surfing significantly ( $p < 0.001$ ) more hours per week (+37.2%), weeks per year  
121 (+13.4%) and total hours per year (+43.8%). There was no difference ( $p > 0.05$ ) with regard to  
122 surfing exposure between genders. The majority of surfers rode short boards (82%), followed  
123 by longboards (10.9%) and mini-mals (7.1%)

124

125 Insert Table 1 approximately here

126

### 127 *Lifetime prevalence of skin cancer*

128 A total of 184 of the survey participants (13.6%) reported being diagnosed and/or treated for a  
129 NMSC and/or MSC (Figure 1), there were a greater number of skin cancers reported in  
130 competitive (Table 2) than recreational surfers ( $p<0.05$ ). Competitive surfers had reported  
131 proportionally more skin cancers than recreational surfers (16.5% and 11.4%, respectively).  
132 The relative risk of developing a skin cancer was significantly ( $p<0.001$ ) higher in competitive  
133 versus recreational surfers (odds ratio 1.74 (CI 1.28-2.31)). An additional 37 participants (2.7%)  
134 reported having a skin cancer however, were unable to recall the specific type. There was a  
135 trend ( $p=0.06$ ) for competitive surfers to surf more often during peak UVR as opposed to  
136 recreational surfers (50.9% versus 39.0%, respectively).

137

138 Insert Figure 1 approximately here

139

140

141 Regarding location, NSW participants reported the highest incidence of skin cancers (38.3%)  
142 followed closely by Queensland (37.8%). Other states included Victoria (8.5%), followed  
143 closely by Western Australia (8.0%), then South Australia (4.8%) and Tasmania (0.5%).

144 With regard to the total cohort, BCC's were the most frequently (6.8%) reported NMSC  
145 followed by MSCs (1.4%) and NMSC SCC's (0.6%). Of note is the number of participants  
146 who reported multiple types of skin cancers; BCC and SCC (1.7%), BCC and SCC and  
147 melanoma (0.3%) and BCC and melanoma (0.2%). Competitive surfers reported more BCC's  
148 (+19.6%) however, surprisingly there were more MSC reported by recreational surfers (Table  
149 2). There were no significant differences between the type of skin cancer and surfing status  
150 (recreational versus competitive). The NMSC BCC was primarily reported in NSW ( $n=51$ )  
151 followed closely by Queensland ( $n=47$ ), this was similar to SCCs (NSW,  $n=17$ ; Queensland,

152 n=12). Melanoma skin cancers were most prevalent in Queensland (n=11), followed closely  
153 by NSW (n=9).

154

155 Insert Table 2 approximately here

156

### 157 *Skin cancer by site*

158 With respect to the site of the skin cancers (Figure 2), there was a significantly higher incidence  
159 of skin cancers on the face ( $p<0.001$ ), back ( $p<0.001$ ) and arms ( $p<0.05$ ) whereas the feet, thigh  
160 and neck had the lowest number of reported skin cancers. Although our cohort of female surf  
161 participants is the largest dataset of lifetime prevalence of skin cancer to date, for comparative  
162 purposes this study was limited due to the relatively small number (n=117) of female  
163 participants in comparison to male participants (n=1231). The location of MSC was most  
164 commonly reported on the back (27.8%) followed by the face (16.3%) and shoulder and arms  
165 (11.4%).

166

167 Insert Figure 2 approximately here

### 168 *Key demographical and physiological risk factors*

169 There was a negative correlation between age and time spent surfing with older surfers surfing  
170 less hours per week ( $p<0.0001$ ) and less weeks per year ( $p<0.005$ ). As would be expected,  
171 however important to confirm, older surfers had also surfed for more years than their younger  
172 counterparts ( $r=0.73$ ,  $p<0.0001$ ). Those surfers who surfed more hours per week, tended to  
173 also surf more weeks of the year ( $p<0.0001$ ).

174 Surfers reporting a skin cancer had higher body mass index (BMI) ( $p<0.0001$ ), older in age  
175 ( $p<0.0001$ ), and mass ( $p<0.0001$ ), though years surfing was identified as the most significant  
176 factor ( $p<0.0001$ ).

177 There was a significant difference between genders as males reported a higher number of skin  
178 cancers versus females (0.36 vs. 0.12,  $p<0.0001$ ). This was however, unsurprising as males  
179 also had surfed for more years than females ( $p<0.0001$ ) and this was shown to also be related  
180 to the number of skin cancers reported.

181

182 **Insert Figure 1 here**

183

184 Competitive surfers were found to have a significantly ( $p<0.001$ ) higher proportion of skin  
185 cancers than recreational surfers however, competitive surfers had surfed longer ( $p<0.0001$ )  
186 and were older (36.6 vs. 35.2yrs).

187

### 188 *Skin cancer and skin color*

189 With regard to skin colour, there was a significant ( $p<0.005$ ) relationship between the number  
190 of skin cancers and lighter skin as fair and medium skin participants reported the highest  
191 frequency (43.4% and 46.7%, respectively) of NMSCs (86.4%) and MSCs (13.6%). However,  
192 it should be noted that the limited number of brown ( $n=1$ ) and black ( $n=0$ ) skinned participants  
193 is not a representative sample.

194

### 195 **Discussion**

196 This study represents the largest survey that has investigated NMSCs and MSC in both  
197 recreational and competitive surfers. Our findings are in agreement with the only previously  
198 published study (13) which reported a similar (16.3%) cohort prevalence of skin cancer.  
199 Although that study did not report SCC per se, the authors did report a high prevalence (40.8%)  
200 of actinic keratosis which has been shown to give rise to SCCs in 44 to 82% of cases (19). The  
201 prevalence of BCC in our study is less than previously reported (13) (16.3%) despite our study  
202 investigating lifetime prevalence versus incidence.

203

204 The risk of skin cancer development has also been investigated in other outdoor recreational  
205 and sporting groups and shown to be an independent risk factor for BCC (2). Lichte and  
206 colleagues (20) investigated the incidence of skin cancer in mountain guides and reported a  
207 similar incidence of BCCs (7.1%) and a slightly higher incidence of SCCs (1.4%). The cohort  
208 (n=283) of adult males only identified 1 MSC. Skin cancer has also been investigated in  
209 outdoor farm workers (21), the proportionate MSC incidence (0.18) was found to be higher  
210 than urinary bladder cancer (0.59) however, lower than kidney cancer (1.60), liver cancer  
211 (4.24) , prostate cancer (1.13) and uterine cancer (2.08).

212

213 Our data analysis demonstrated that the total number of years surfing was a more significant  
214 factor with regard to skin cancer than current surfing activity (hours per week). However, this  
215 may be mitigated by the fact that surfers who were older surfed less than their younger  
216 counterparts. A consideration is that if older surfers have always surfed less than younger  
217 counterparts (an assumption that may not be valid), the extent of skin cancers reported in future  
218 may be far higher once the currently younger cohort of surfers have spent an equivalent number  
219 of years exposed to UVR whilst surfing.

220

221 With regard to the tendency ( $p>0.05$ ) for less skin cancers on the top of head, face, ears and  
222 neck in females, this was possibly attributed to the protective factor of longer hair however,  
223 this was not evaluated in the survey and is only speculative.

224

225 These findings are in agreement with previous research which have reported a lower incidence  
226 of skin cancers in races and ethnicities with darker skin (22, 23), as these races and ethnicities  
227 have been shown to have a higher melanin content (22). Bradford (24) previously reported in  
228 the United States Caucasians had the highest incidence of skin cancers (35-40%) followed by  
229 Hispanics (4-5%) Asians (2-4%) and Afro-Americans (1-2%).

230

231 This study also found a lifetime prevalence for melanoma to be 1.4% within a surfing  
232 population whereas a 27 year prevalence of melanoma in Australia was found to be 0.6% in  
233 2007 (25), comparatively the rate in the USA (26) was reported to be considerably higher (3.8%)  
234 and is expected to rise significantly in the near future (27). This comparison needs to be viewed  
235 cautiously as timeframes differ; however as this is the only comparable Australian dataset it  
236 highlights the potential threat of melanoma in patients who surf.

237

238 Non-melanoma skin cancers are the most common cancer in Australia and the highest in the  
239 world (11). These cancers also place a high financial burden on the Australian health care  
240 system with an estimated yearly cost of \$700 million. Given the large proportion of  
241 Australians who surf and numbers of reported NMSC and MSC within this cohort, surfers may  
242 account for a notable proportion of all skin cancers within Australia. The authors acknowledge  
243 that the generalizability of our results is limited to Australian surfers.

244

245 With regard to limitations to this study, selection bias may have existed as individuals without  
246 internet access would not have had the opportunity to have participated, we attempted to  
247 minimize information bias by requiring melanoma and non-melanoma data to only be entered  
248 when diagnosed and/or treated by the participants GP or specialist. We believe there was no  
249 confounding bias as we did not investigate casual relationships. A further limitation to this  
250 study was the exclusion of investigating sun protection strategies which have been shown to  
251 be effective in reducing the risk of skin cancer in other outdoor athletes (28).

252

### 253 **Conclusions**

254 Surfers have previously been surveyed successfully (29-31) and we believe this study adds  
255 insight into the lifetime prevalence of non-melanoma and melanoma skin cancers in the  
256 Australian surfing cohort. Although the data obtained was self-report which has recently come  
257 under question (32), participants were required to only report skin cancers diagnosed and/or  
258 treated by their GP or medical specialist. Given this study's findings with respect to the lifetime  
259 prevalence of skin cancer in Australian surfers, GP's are recommended to rigorously screen  
260 their patients who surf as based upon our findings they appear to be at increased risk of  
261 developing either a non-melanoma and/or melanoma skin cancer. Screenings are important  
262 preventative measures as GP screening examinations has previously been shown to be effective  
263 in reducing premature death from skin cancers (5). Furthermore, GP's should also advise  
264 patients to utilize multiple sun protection strategies specific to surfing (avoid peak UVR,  
265 rashvest, hat and sunscreen (9, 33, 34)). Previous investigators (35) have shown that sun safety  
266 education programs are effective in changing sun protective behaviours, particularly for non-  
267 melanoma and melanoma skin cancers.

268 Additionally, lighter skinned surfers with an extensive surfing history appear to a key subgroup  
269 at greatest risk for skin cancer. The key high incidence areas of exposure need recognition and  
270 strategies to reduce the incidence of skin cancers in these areas would be worthy of  
271 consideration (i.e. the face, back and arms).

272

273



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279

280 All authors contributed to the design of the research study, Dr. Furness performed the  
281 research, all authors contributed to the statistical analyses and writing of this paper.

282

283 **Disclosure and competing interests**

284 None declared

285

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355

356

357

358 **Table 1.** Descriptive statistics for participants (values are mean ( $\pm$ SD)). 95% Confidence  
 359 intervals (95% CI).

<b>Variable</b>	<b>Cohort (n=1,348)</b>	<b>Recreational (n=767)</b>	<b>Competitive (n=581)</b>	<b>P value</b>
Age (yrs)	35.84 (13.08)	35.2 (12.2)	36.7 (14.1)	.04
Weight (kg)	78.59 (12.79)	78.3 (11.9)	78.9 (13.7)	NS
Height (cm)	178.16 (9.03)	178.6 (9.1)	177.7 (8.6)	NS
BMI (kg/m <sup>2</sup> )	24.73 (3.75)	24.5 (3.3)	24.9 (3.5)	NS
<b>Surfing demographics</b>				
Surfing:				
• Hours/week	6.7 (5.6)	5.4 (4.4)	8.6 (6.6)	.001
• Weeks/year	40.5 (13.6)	38.0 (14.6)	43.8 (11.4)	.001
• Hours/year	305.5 (291.2)	228.7 (214.3)	406.9 (343.7)	.001

360

361

362

363 **Table 2.** Lifetime incidence of non-melanoma and melanoma skin cancers in participants  
 364 (number, percentage)

<b>Type</b>	<b>Cohort (n=1,348)</b>	<b>Recreational (n=767)</b>	<b>Competitive (n=581)</b>	<b>P value</b>
BCC (n)	123	56 (45.5%)	67 (54.5%)	NS
Melanoma (n)	25	15 (60.0%)	10 (40.0%)	NS
SCC (n)	36	17 (47.2%)	19 (52.8%)	NS
Total (n)	184	88 (47.8%)	96 (52.2%)	NS

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