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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).

Variable	Cohort (n=1,348)	Recreational (n=767)	Competitive (n=581)	P value
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 ²)	24.73 (3.75)	24.5 (3.3)	24.9 (3.5)	NS
Surfing demographics				
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)

Type	Cohort (n=1,348)	Recreational (n=767)	Competitive (n=581)	P value
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

365

366