Original Investigation

Sun Protection and Skin Examination Practices in a Setting of High Ambient Solar Radiation
A Population-Based Cohort Study

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IMPORTANCE Primary prevention and early detection are integral strategies to reduce the burden of skin cancer.

OBJECTIVES To describe the prevalence of sun protection and skin examination practices in a population exposed to high levels of ambient solar radiation and to identify associated factors.

DESIGN, SETTING, AND PARTICIPANTS Cross-sectional analyses of baseline data from a prospective cohort of 40 172 adults aged 40 through 69 years from Queensland, Australia, recruited in 2011. We obtained data on all melanoma diagnoses through 2009 via record linkage with the Queensland Cancer Registry (notifications have been mandatory since 1982).

MAIN OUTCOMES AND MEASURES We calculated prevalence proportion ratios to compare prevalence of sun protection and skin examination practices in 3 separate groups: those with a history of melanoma (group 1), those with a self-reported history of treated actinic lesions (group 2), and those without either (group 3). We used multivariate generalized linear models to identify factors associated with each practice.

RESULTS Participants with a previously confirmed melanoma (group 1; n = 1433) and/or treated actinic lesions (group 2; n = 24 006) were more likely than those without (group 3; n = 14 733) to report sun protection practices, including regular use of sunscreen (53.3%, 45.1%, and 38.1%, respectively) and wearing hats (74.7%, 68.2%, and 58.2%, respectively). They were also more likely to have had a whole-body skin examination by a physician in the past 3 years (93.7%, 83.4%, and 52.1%, respectively). Within all 3 groups, the strongest association with sun protection practices was with sun-sensitive skin type. Within group 3 (no history of treated skin lesions), the strongest factor associated with clinical skin examinations was self-reported nevus density at 21 years of age, whereas a family history of melanoma was a significant factor in groups 2 and 3.

CONCLUSIONS AND RELEVANCE In this large sample exposed to high levels of ambient solar radiation, sun protection and skin examination practices were most frequent among those with a history of treated skin lesions or sun-sensitive skin types.

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Primary prevention remains the cornerstone for reducing the incidence of skin cancer. Skin cancer prevention programs have been prominent in Australia since the early 1980s.[1] Introduced in 1981, the successful "Slip! Slop! Slap!" public health campaign was designed to increase the use of sun protective measures in an effort to prevent skin cancer.[2] Despite these campaigns and the resultant increased knowledge of the link between sun exposure and skin cancer among Australians,[3] adherence to sun protection practices remains suboptimal. For example, a national survey conducted in 2003-2004 reported that less than 40% of Australians used sunscreen when outdoors on the weekend and less than 50% wore a hat.[4]

Early detection (secondary prevention) to diagnose lesions at an early stage is encouraged, but relatively little is known about the extent of whole-body skin examination in Australia, and the data available suggest that the prevalence varies across subgroups of the population. Understanding the distribution and factors associated with early detection practices is necessary to tailoring secondary prevention campaigns, particularly with a view to targeting those in the population who are most likely to benefit.[5]

The objective of this study was to describe the prevalence and predictive factors for sun protection and skin examination practices of adults in Queensland, Australia, the jurisdiction with the highest rates of skin cancer in the world.[6-8] Of particular interest was whether sun protection and skin examination practices differed between those with and without a previously confirmed melanoma and/or treatment for actinic skin lesions.

Methods

QSkin Sun and Health Study

The QSkin Sun and Health Study is a prospective cohort study of men and women 40 through 69 years of age at recruitment in 2011 who were sampled randomly from the Queensland population (n = 43 794). A description of the study design and methods has been published previously.[9] At baseline, in addition to demographic items and general medical history, information about standard pigmentary characteristics, sun protection, whole-body skin examination practices, and history of skin cancer was collected by questionnaire.[10,11]

We restricted our analyses to participants with white European ancestry (which excluded 3154) and those with complete information on self-reported history of skin lesion treatment (which excluded 454). We also excluded 14 participants who withdrew consent, leaving 40 172 participants in these analyses.

For these analyses, the primary outcomes were sun protection practices (use of sunscreen and frequency of wearing a hat) and whole-body skin examination. Thus, participants were asked if they routinely (ie, most days) applied sunscreen or cosmetics with a sun protection factor (hereafter combined to sunscreen use), regardless of whether they were going out into the sun. Response options were (1) yes, to my face; (2) yes, to my hands, forearms; (3) yes, to other parts of my body; and (4) no. They were also asked about how often they applied sunscreen or wore a hat when they were outdoors in the past year (never, <50% of the time, ≥50% of the time, or all of the time). Participants were asked about the practice of whole-body skin examination for which the wording of the question was "During the past 3 years how many times has all or nearly all of your skin been deliberately checked by (1) a doctor, (2) someone else (eg, spouse, partner), or (3) yourself"; possible responses were categorical.

We coded responses to the 2 questions about sun protection practices in the past year into dichotomous outcome variables (≥50% of the time vs <50% of the time). For regular use of sunscreen, we derived a composite variable (any regular sunscreen use on face, hands or forearms, or other parts of the body).

Sociodemographic, phenotypic, and skin cancer-related variables were assessed as factors potentially associated with sun protection and skin examination practices. Sociodemographic factors assessed were age at baseline, sex, highest educational level achieved, work status, and ethnicity. Phenotypic variables included skin color, skin type, and nevus density at 21 years of age. Self-reported family history of melanoma in a first- or second-degree relative and self-assessment of future melanoma risk were also assessed.

We obtained data on all melanoma diagnoses up to the end of 2009 via record linkage with the Queensland Cancer Registry (notifications have been mandatory since 1982). We stratified our analyses by 3 groups: previously confirmed melanoma, self-reported history of only actinic skin lesions, and no self-reported history of any skin lesion. Data on nonmelanoma skin cancers and actinic keratoses were obtained by asking "About how many separate skin cancers (but not moles or warts) have you ever had cut off your skin?" and "About how many separate sunspots or skin cancers have you ever had ever frozen or burnt off your skin?" Participants who answered 1 or more to either of these questions were classified as having a history of actinic skin lesion treatment for these analyses. Thus, we had 3 groups for analysis: those with a history of melanoma (group 1), those with a self-reported history of treated actinic lesions (group 2), and those without either (group 3).

The study was approved by the Human Research Ethics Committee of the QIMR Berghofer Medical Research Institute. Each participant provided written informed consent to take part in the study.

Statistical Analysis

We compared the characteristics of study participants in 3 separate groups a priori using χ^2 tests of homogeneity: those with a previously confirmed melanoma, self-reported history of only actinic skin lesions, and no history of either. For the melanoma group, we examined whether the prevalence of these behaviors differed by time since diagnosis (<5 years or ≥5 years).

We calculated the prevalence proportion ratios (PPRs) using PROC GENMOD's log binomial regression in SAS statistical software[12,13] to compare prevalence of protective practices among the 3 groups. We adjusted for age, sex, and educational level a priori because these items have been reported

in past studies to be highly correlated with sun protection behaviors. The PPRs are superior to odds ratios for analyzing cross-sectional data because odds ratios tend to yield inflated effect estimates, especially when the prevalence of outcomes is high.[13,14]

Within each group, we used multivariable regression models to identify factors associated with each practice. Variables significant in univariate analyses and those regarded as important in the literature were retained in the final multivariate models regardless of significance. The PPRs and accompanying 95% CIs are reported. We used SAS statistical software, version 9.2 (SAS Institute Inc), for all analyses.

Results

The characteristics of participants stratified by skin cancer history are provided in **Table 1**. Those with a history of melanoma (group 1; n = 1433) or other treated actinic lesions (group 2; n = 24 006) were older than those without (group 3; n = 14 733) (mean age, 58.7, 57.5, and 53.5 years, respectively; $P < .001$) and were more likely to have fair skin ($P < .001$). Of the 1433 patients diagnosed as having melanoma, 442 had in situ lesions and 991 were invasive. Overall, the distribution of melanoma thicknesses was as follows: in situ, 30.8%; 1.00 mm or smaller, 41.9%; 1.01 through 2.00 mm, 6.8%; 2.01 through 4.00 mm, 1.6%; 4.00 mm or larger, 0.8%; and unknown thickness, 18.1%.

Overall Prevalence of Sun Protection and Skin Examination

In total, 42.6% of participants regularly used sunscreen or cosmetics with a skin protection factor. When outdoors and in the sun, 64.7% of participants reported wearing a hat more than half the time, and 37.2% used sunscreen more than half the time. Almost three-quarters of participants (72.3%) reported having had all their skin examined by a physician in the past 3 years, 29.8% by someone else, and 55.1% by themselves (**Table 2**). Among those with a past diagnosis of melanoma, the prevalence of protection practices did not differ by time since diagnosis, although clinical skin examinations were more prevalent for those with a more recent diagnosis (98.4% for those diagnosed <5 years ago and 92.5% for those diagnosed ≥5 years ago, $P < .001$).

Comparison of Those With and Without a History of Melanoma or Treatment for Actinic Lesions

Compared with those with no treated actinic lesions (group 3), participants who had melanoma and those with prior treatments for actinic lesions were significantly more likely to report regularly using sunscreen and wearing hats. They were also substantially more likely to engage in skin examination practices; the greatest difference between the groups was in having their skin checked by a physician in the past 3 years (Table 2).

Multivariable Analysis of Sun Protection Practices

Within each group, the most consistent predictor of sunscreen and hat use was having skin that burns easily (**Table 3** and eTable 1 and eTable 2 in the Supplement). Educational level was strongly associated with sunscreen use in all groups and was significantly associated with hat use, although the magnitude of the association was lower than for sunscreen. Nevus density and a family history of melanoma were not significantly associated with sun protection practices; however, a perceived high risk of developing melanoma in the future was a significantly associated factor among those with and without histories of treated actinic lesions. Women were significantly more likely than men to use sunscreen regularly and when outdoors but were less likely than men to wear a hat more than half the time when outdoors.

Multivariable Analysis of Skin Examination Practices

Factors associated with whole-body skin examinations conducted by a physician differed depending on history of melanoma or treatment for a skin lesion (Table 3 and eTable 3 and eTable 4 in the Supplement). Among all participants, skin examinations by a physicians were more common among those with many moles at 21 years of age, a family history of melanoma, and a perceived high risk of melanoma. Of note, we found no factors significantly associated with clinical skin examinations in the melanoma group (group 1).

In multivariable analyses, factors associated with skin self-examination were similar among all 3 groups, being most likely among women, younger adults, those with post-high school qualifications (eg, college diplomas, trade certificates, or university degrees), and those with a perceived high risk of melanoma. Skin examinations conducted by other people were much less likely for women than men and among older than younger people; these observations held regardless of prior history, whereas skin examinations by others were more prevalent among those with many moles at 21 years of age. Among those with a prior treatment history (group 2), skin examination by others was also more prevalent among those with a family history of melanoma and a perceived high risk of melanoma.

Discussion

Effective skin cancer control requires 2 strategies: regular sun protection to prevent new cancers from occurring and early detection facilitated by periodic skin examinations. We found that the prevalence of sun protection and skin examination practices is high in this sample from a largely fair-skinned population exposed to high ambient solar radiation. We found that people with a history of melanoma or actinic lesions and those with a skin type prone to burning or a large number of moles (hereafter high-risk phenotypes) were more likely to engage in sun protection and skin examination practices than those without these factors.

The prevalence of sun protection measures in Australia appears to have increased in recent decades. Whereas only 12% of Australians observed at the beach wore a wide brimmed hat in 1993,[15] an Australia-wide survey conducted in 2003 found that 48% of adults reported wearing a hat on weekend days.[4] In comparison, a study of US adults published in 2000 reported that 14% of beach-goers wore a wide-brimmed hat.[16]

Table 1. Characteristics of the QSkin Sun and Health Study Participants Stratified by History of Melanoma or Self-reported History of Excision or Destruction of an Actinic Skin Lesion

Characteristic	No. (%) of Participants[a]			*P* Value[b]
	Melanoma (n = 1433)	Excision or Destruction of Skin Lesion (n = 24 006)	No Past Lesions (n = 14 733)[c]	
Sex				
Male	710 (49.5)	11 381 (47.4)	6376 (43.3)	<.001
Female	723 (50.5)	12 625 (52.6)	8357 (56.7)	
Age group, y				
40-44	82 (5.7)	1770 (7.4)	2778 (18.9)	<.001
45-49	157 (11.0)	2862 (11.9)	2881 (19.6)	
50-54	191 (13.3)	4224 (17.6)	2888 (19.6)	
55-59	310 (21.6)	5080 (21.2)	2501 (17.0)	
60-64	326 (22.7)	5073 (21.1)	1992 (13.5)	
65-69	367 (25.6)	4997 (20.8)	1693 (11.5)	
Highest level of education				
No school certificate	102 (7.1)	1822 (7.6)	1118 (7.6)	<.001
School certificate	272 (19.0)	4046 (16.9)	1941 (13.2)	
Higher school certificate	250 (17.4)	4372 (18.2)	2693 (18.3)	
Trade, certificate, or diploma	379 (26.4)	6527 (27.2)	4325 (29.4)	
University degree	323 (22.5)	5406 (22.5)	3732 (25.3)	
Missing	107 (7.5)	1833 (7.6)	924 (6.3)	
Work status				
Full-time worker	529 (36.9)	9929 (41.4)	7211 (48.9)	<.001
Part-time worker	246 (17.2)	4003 (16.7)	2670 (18.1)	
Home duties	102 (7.1)	1547 (6.4)	1074 (7.3)	
Retired	429 (29.9)	6205 (25.8)	2222 (15.1)	
Other[d]	127 (8.9)	2322 (9.7)	1556 (10.6)	
Skin color				
Fair	1068 (74.5)	17 138 (71.4)	7469 (50.7)	<.001
Medium	321 (22.4)	6730 (28.0)	5676 (38.5)	
Olive or dark	38 (2.7)	1045 (4.4)	1489 (10.1)	
Missing	6 (0.4)	93 (0.4)	99 (0.7)	
Skin reaction to 30 minutes of midday sun				
Not burn	57 (4.0)	1567 (6.5)	1785 (12.1)	<.001
Burn a little	482 (33.6)	9595 (40.0)	7073 (48.0)	
Burn moderately	596 (41.6)	8653 (36.0)	4402 (29.9)	
Burn badly	291 (20.3)	4063 (16.9)	1401 (9.5)	
Missing	7 (0.5)	128 (0.5)	72 (0.5)	
Skin reaction to several weeks in sun				
Not tan	174 (12.1)	1977 (8.2)	526 (3.6)	<.001
Tan lightly	424 (29.6)	5767 (24.0)	2343 (15.9)	
Tan moderately	648 (45.2)	11 676 (48.6)	7582 (51.5)	
Tan deeply	182 (12.7)	4406 (18.4)	4196 (28.5)	
Missing	5 (0.3)	180 (0.7)	86 (0.6)	
Moles at 21 years of age (whole body)				
None	226 (15.8)	6702 (27.9)	4001 (27.2)	<.001
A few	673 (47.0)	12 331 (51.4)	7825 (53.1)	
Some	342 (23.9)	3613 (15.1)	2108 (14.3)	
Many	162 (11.3)	741 (3.1)	428 (2.9)	
Missing	30 (2.1)	619 (2.6)	371 (2.5)	

(continued)

Table 1. Characteristics of the QSkin Sun and Health Study Participants Stratified by History of Melanoma or Self-reported History of Excision or Destruction of an Actinic Skin Lesion (continued)

Characteristic	No. (%) of Participants[a]			P Value[b]
	Melanoma (n = 1433)	Excision or Destruction of Skin Lesion (n = 24 006)	No Past Lesions (n = 14 733)[c]	
Family history of melanoma				
Yes	586 (40.9)	6114 (25.5)	2846 (19.3)	<.001
No	618 (43.1)	14 343 (59.7)	9771 (66.3)	
Do not know or missing	229 (16.0)	3549 (14.8)	2116 (14.4)	
Likelihood of getting melanoma in the future				
Highly unlikely	52 (3.6)	2064 (8.6)	2334 (15.8)	<.001
Somewhat unlikely	100 (7.0)	5601 (23.3)	4685 (31.8)	
About the same as others	298 (20.8)	11 412 (47.5)	6133 (41.6)	
Somewhat more likely	463 (32.3)	3295 (13.7)	915 (6.2)	
Highly likely	469 (32.7)	1070 (4.5)	286 (1.9)	
No. of skin cancers excised[e]				
None	108 (7.5)	8765 (36.5)	14 733 (100)	<.001[f]
1	323 (22.5)	5433 (22.6)		
2-10	750 (52.3)	8203 (34.2)		
11-20	141 (9.8)	968 (4.0)		
>20	111 (7.7)	637 (2.7)		
No. of sunspots or skin cancers destroyed				
None	246 (17.2)	2631 (11.0)	14 733 (100)	<.001[e]
1-5	352 (24.6)	10 445 (43.5)		
6-10	191 (13.3)	3690 (15.4)		
11-20	205 (14.3)	2992 (12.5)		
21-50	225 (15.7)	2312 (9.6)		
>50	214 (14.9)	1936 (8.1)		

[a] Numbers may not total because of missing data.

[b] The χ^2 test for heterogeneity.

[c] Defined as self-reported history of surgery or other treatment for a skin cancer or sunspot.

[d] Includes students, unemployed, and other work status (eg, caregivers).

[e] Includes both melanoma and keratinocyte skin cancer excisions.

[f] For melanoma and past actinic lesions group only.

Increases in the prevalence of sun protection behaviors since the 1980s are likely to be attributed to primary prevention campaigns, such as the SunSmart campaign.[1,17] Research indicates that knowledge of sun protection practices is an important predictor of these behaviors.[18]

Previous studies have suggested that sun protection behavior is higher among females[4,19,20] and those with a sun-sensitive skin type,[4,16,19,21-25] increases with age,[4] and is greater among those with a perceived high risk of skin cancer.[19] The most consistent predictor of regular sun protection in our study was a sun-sensitive skin type. We also found that those with a history of treated actinic lesions were significantly more likely to apply sunscreen regularly and wear hats when outdoors than those without prior actinic lesions. Data exploring the association between personal history of skin cancer and sun protection behaviors are scant. Although several studies[23,24,26] have reported that a history of actinic lesions increases sun protection practices, much of the existing literature is based on adolescents among whom skin cancer incidence is very low.[27]

We measured 3 types of skin examination: by a physician, by oneself, and by others. Skin examinations conducted by a physician were common in this cohort, with almost 75% reporting they had had their skin examined by a physician within the past 3 years. Participants with a history of treated skin lesions had an almost 2-fold higher adjusted prevalence of skin examinations conducted by a physician than those with no prior history, which accords with other research.[28] Reverse causality is one plausible explanation for this finding, whereby a diagnosis of skin cancer would precipitate subsequent skin checks by a physician, although it is also possible that those undergoing regular skin checks by a physician were more likely to have actinic lesions detected. Indeed, it is likely that both forces operate within this population, given the high awareness of skin cancer in the community and the ready availability of skin cancer clinics that provide skin examination services.[29] Our ongoing follow-up of this cohort may help to untangle these complex associations.

The prevalence of skin self-examination was higher in our cohort (55.1%) than previously reported for Queensland residents (33.9% in a 1998 telephone survey[30]), and compares with 10.6% for a 2010 US study.[31] Although these differences may be partly attributable to period effects, it is also notable that our cohort included a high proportion of people with a history of treated actinic lesions.

A strength of our analysis was our calculation of PPRs, which provide a better estimate of the ratio of prevalences among subgroups in a sample. In addition, the large sample size, comprehensive data collection and use of validated instruments,[9,32] and universal capture of prior melanoma diagnoses through the population-based cancer registry were further strengths.

Limitations of the analysis include the cross-sectional nature of the study design, which prevented us from assessing the

Table 2. Percentages and Adjusted PPRs of the QSkin Sun and Health Study Participants Practicing Sun Protection or Skin Examination Behaviors by History of Melanoma, History of Excision or Destruction of an Actinic Skin Lesion, or Neither

Practice	No. (%) of Participants[a]				PPR (95% CI)[b]	
	All Participants (n = 40 172)	Melanoma (n = 1433)	Excision or Destruction of Skin Lesion (n = 24 006)	No Past Actinic Lesions (n = 14 733)[c]	Melanoma vs No History	Actinic Lesions vs No History
Sun Protection and Regular Use of Sunscreen (Most Days)						
On the face						
No	24 193 (60.2)	808 (56.4)	13 906 (57.9)	9479 (64.3)	1.78 (1.60-2.00)	1.17 (1.15-1.19)
Yes	15 979 (39.8)	625 (43.6)	10 100 (42.1)	5254 (35.7)		
On the arms or forearms						
No	34 199 (85.1)	1162 (81.1)	19 995 (83.3)	13 042 (88.5)	1.66 (1.47-1.87)	1.13 (1.11-1.15)
Yes	5973 (14.9)	271 (18.9)	4011 (16.7)	1691 (11.5)		
On other parts of the body						
No	37 225 (92.7)	1300 (90.7)	22 147 (92.3)	13 820 (93.8)	1.48 (1.25-1.74)	1.07 (1.05-1.10)
Yes	2947 (7.3)	133 (9.3)	1859 (7.7)	955 (6.5)		
Any regular use of sunscreen						
No	23 053 (57.4)	669 (46.7)	13 176 (54.9)	9113 (61.9)	1.77 (1.59-1.97)	1.17 (1.15-1.19)
Yes	17 119 (42.6)	764 (53.3)	10 830 (45.1)	5620 (38.1)		
Sunscreen use in past year when outside in the sun						
Never or <50% of the time	25 033 (62.3)	793 (55.3)	14 383 (59.9)	9857 (66.9)	2.07 (1.88-2.29)	1.19 (1.18-1.21)
All the time or ≥50% of the time	14 939 (37.2)	632 (44.1)	9504 (39.6)	4803 (32.6)		
Hat use in past year when outside in the sun						
Never or <50% of the time	12 979 (32.3)	321 (22.4)	6895 (28.7)	5775 (39.2)	2.05 (1.81-2.31)	1.18 (1.16-1.20)
All the time or ≥50% of the time	25 976 (64.7)	1071 (74.7)	16 363 (68.2)	8569 (58.2)		
Whole-body Skin Examinations in Past 3 Years						
By a physician						
No	10 282 (25.6)	72 (5.0)	3592 (15.0)	6618 (44.9)	14.04 (11.11-17.75)	1.99 (1.93-2.04)
Yes	29 038 (72.3)	1343 (93.7)	20015 (83.4)	7680 (52.1)		
By someone else						
No	27 320 (68.0)	885 (61.8)	16 256 (67.7)	10 179 (69.1)	1.50 (1.36-1.66)	1.06 (1.04-1.07)
Yes	11 973 (29.8)	528 (36.8)	7301 (30.4)	4144 (28.1)		
By yourself						
No	17 091 (42.5)	583 (40.7)	10 051 (41.9)	6457 (43.8)	1.25 (1.14-1.39)	1.06 (1.04-1.08)
Yes	22 120 (55.1)	822 (57.4)	13 412 (55.9)	7886 (53.5)		

Abbreviation: PPR, prevalence proportion ratio.

[a] Numbers may not total because of missing data.

[b] Adjusted for age (5-years age groups), sex, and educational level.

[c] Defined as self-reported history of surgery or other treatment for a skin cancer or sunspot; numbers may not sum to total because of missing data.

temporality of the exposure-outcome association. We stratified our analyses based on participants' history of clinical sequelae of solar exposure. Melanoma diagnoses were confirmed histologically, whereas history of excisions or destruction of actinic skin lesions was based on self-reported information. Such recall might be prone to misclassification, although we observed very high levels of repeatability for these measures.[32] Moreover, they correlated well with physician counts of actinic keratoses,[32] suggesting that these self-reported items are highly valid markers of chronically sun damaged skin. Except for melanomas, we did not ascertain the histologic diagnosis of treated lesions because such diagnoses are not recorded by the Queensland Cancer Registry and many such lesions are treated destructively. Moreover, the multiplicity of lesions for most affected participants limits the utility of further categorization. Of note, we found that the predictors of sun protection and skin examination behaviors were essentially the same for people with and without a history of treatment for actinic skin lesions, suggesting that knowledge of precise histologic diagnoses would be unlikely to influence personal behavior. It is likely that we have missed some melanoma diagnosis for the year 2010 (cancer registry data were only complete to the end of 2009);

Table 3. Strongest Predictors of Skin Cancer Protection Behaviors and Whole-body Skin Examination Among QSkin Sun and Health Study Participants With a Diagnosis of Melanoma, With a Self-reported History of Excision/Destruction of an Actinic Lesion, and Those Without Either

Characteristic	PPR (95% CI)		
	Melanoma	Past Actinic Lesions	No Past Actinic Lesions
Regular Sunscreen Use (Most Days)[a]			
Skin type—burning			
Not burn	1 [Reference]	1 [Reference]	1 [Reference]
Burn a little	1.19 (0.86-1.65)	1.28 (1.18-1.38)[b]	1.19 (1.10-1.29)[b]
Burn moderately	1.32 (0.95-1.84)	1.40 (1.30-1.52)[b]	1.26 (1.16-1.37)[b]
Burn badly	1.30 (0.93-1.83)	1.44 (1.33-1.56)[c]	1.33 (1.21-1.46)[b]
Skin type—tanning			
Not tan	1 [Reference]	1 [Reference]	1 [Reference]
Tan lightly	0.93 (0.77-1.12)	1.10 (1.05-1.17)[c]	1.06 (0.96-1.16)
Tan moderately	0.93 (0.79-1.10)	1.09 (1.04-1.14)[c]	1.10 (1.03-1.17)
Tan deeply	0.90 (0.77-1.05)	1.04 (1.00-1.08)	1.06 (1.01-1.11)
Sunscreen Use Past Year When in Sun[a]			
Skin type—burning			
Not burn	1 [Reference]	1 [Reference]	1 [Reference]
Burn a little	1.43 (0.98-2.08)	1.66 (1.49-1.86)[a]	1.56 (1.39-1.75)[b]
Burn moderately	1.52 (1.04-2.23)[c]	2.06 (1.84-2.31)[b]	1.91 (1.70-2.15)[b]
Burn badly	1.78 (1.20-2.64)[c]	2.28 (2.04-2.56)[b]	2.26 (1.99-2.56)[b]
Skin type—tanning			
Not tan	1 [Reference]	1 [Reference]	1 [Reference]
Tan lightly	1.05 (0.85-1.29)	1.12 (1.05-1.19)[b]	1.06 (0.95-1.18)
Tan moderately	0.99 (0.82-1.18)	1.10 (1.04-1.16)[b]	1.00 (0.93-1.08)
Tan deeply	1.01 (0.86-1.20)	1.04 (0.99-1.09)	1.03 (0.97-1.09)
Hat Use Past Year When in Sun[a]			
Skin type—burning			
Not burn	1 [Reference]	1 [Reference]	1 [Reference]
Burn a little	1.55 (0.97-2.47)	1.09 (1.04-1.13)[b]	1.14 (1.08-1.20)[b]
Burn moderately	1.44 (0.89-2.33)	1.15 (1.10-1.20)[b]	1.20 (1.13-1.26)[b]
Burn badly	1.85 (1.13-3.03)	1.20 (1.15-1.26)[b]	1.26 (1.19-1.35)[b]
Skin type—tanning			
Not tan	1 [Reference]	1 [Reference]	1 [Reference]
Tan lightly	0.84 (0.63-1.13)	1.08 (1.04-1.11)[b]	1.10 (1.03-1.18)
Tan moderately	1.02 (0.81-1.28)	1.07 (1.04-1.10)[b]	1.00 (0.95-1.04)
Tan deeply	0.98 (0.80-1.20)	1.03 (1.00-1.05)[c]	1.02 (0.99-1.05)
Skin Check in Last 3 Years—Doctor[d]			
Moles at age 21			
None	1 [Reference]	1 [Reference]	1 [Reference]
A few	1.01 (0.94-1.09)	1.00 (0.99-1.01)	1.09 (1.05-1.13)[b]
Some	0.99 (0.91-1.08)	1.01 (1.00-1.03)	1.15 (1.09-1.21)[b]
Many	1.02 (0.90-1.14)	1.06 (1.03-1.08)[b]	1.36 (1.27-1.46)[b]
Family history of melanoma			
No	1 [Reference]	1 [Reference]	1 [Reference]
Yes	1.00 (0.94-1.07)	1.02 (1.00-1.03)[c]	1.07 (1.03-1.11)[b]
Skin Check in Last 3 Years—Self[d]			
Moles at age 21			
None	1 [Reference]	1 [Reference]	1 [Reference]
A few	1.02 (0.94-1.12)	1.04 (1.01-1.07)[c]	1.01 (0.98-1.05)
Some	0.99 (0.89-1.09)	1.03 (0.99-1.06)	1.03 (0.98-1.08)
Many	1.05 (0.93-1.17)	1.00 (0.94-1.07)	1.05 (0.97-1.14)

(continued)

Table 3. Strongest Predictors of Skin Cancer Protection Behaviors and Whole-body Skin Examination Among QSkin Sun and Health Study Participants With a Diagnosis of Melanoma, With a Self-reported History of Excision/Destruction of an Actinic Lesion, and Those Without Either (continued)

	PPR (95% CI)		
Characteristic	Melanoma	Past Actinic Lesions	No Past Actinic Lesions
Family history of melanoma			
No	1 [Reference]	1 [Reference]	1 [Reference]
Yes	0.99 (0.93-1.06)	1.01 (0.99-1.04)	1.01 (0.97-1.04)
Skin Check in Last 3 Years—Other[d]			
Moles at age 21			
None	1 [Reference]	1 [Reference]	1 [Reference]
A few	0.97 (0.80-1.18)	1.13 (1.08-1.18)[b]	1.08 (1.01-1.15)[c]
Some	0.88 (0.70-1.10)	1.09 (1.02-1.15)[c]	1.13 (1.04-1.23)[c]
Many	1.04 (0.82-1.33)	1.24 (1.12-1.37)[b]	1.30 (1.13-1.49)[b]
Family history of melanoma			
No	1 [Reference]	1 [Reference]	1 [Reference]
Yes	1.07 (0.93-1.23)	1.08 (1.03-1.13)[c]	1.01 (0.95-1.08)

Abbreviation: PPR, prevalence proportion ratio.

[a] Adjusted for age, sex, education, work status, skin color, moles at age 21, family history of melanoma and perceived risk of melanoma.

[b] $P < .001$.

[c] $P < .05$.

[d] Adjusted for age, sex, education, work status, skin color, skintype (burning, tanning), and perceived risk of melanoma.

however, we estimate that the number of cases missed would be fewer than 50 and unlikely to influence the results. A further limitation was the low participation fraction for the baseline survey (22.7%), which may affect the generalizability of our findings. Although the QSkin cohort is similar to the Queensland population on several key characteristics (educational attainment, employment status, and body mass index),[22] the low response rate of 22.7% means that the sample is prone to some degree of self-selection. Given the subject of the study, it is likely that our sample overrepresents people with an interest in skin cancer or prevention. As such, although our study findings are likely to have high internal validity, they may not be generalizable to other populations. Arguably more important than generalizability is internal validity, that is, the extent to which the associations identified within a given data set are robust and free of information biases or confounding influences of other factors. Given the large sample size, our use of validated data collection instruments, and the statistically significant associations from multivariable analyses assessing PPRs, we contend that these findings have high internal validity.

Conclusions

Our study provides a contemporary assessment of the sun protection and skin examination practices in a large sample from a population exposed to high levels of ambient solar radiation. People with a treatment history for actinic lesions and those with high-risk phenotypes were more likely to engage in both sun protection and skin examination practices than those without these, suggesting that they are receptive to primary and secondary prevention messages.

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