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Golf participants in Australia have a higher lifetime prevalence of skin cancer compared with the general population

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ABSTRACT

Objective To estimate the age-specific lifetime prevalence of skin cancer in a sample of Australian golf participants and estimate skin cancer risk in golf participants compared with a general population-based sample.

Methods Golf participants in Australia (n=336) completed the Australian Golf Health Survey which collected data on skin cancer diagnosis (self-reported history), physical activity levels and participant demographics. Data were compared with a sample of the Australian general population (n=15780, Australian Health Survey). Age-specific lifetime prevalence of skin cancer in golf and general population-based samples was determined, and modified Poisson regression (adjusted for age, sex, education and smoking status) was used to estimate the association between playing golf and the risk of a current or past skin cancer diagnosis.

Results One in four golf participants (n=91; 27%) had received a skin cancer diagnosis compared with 7% (n=1173) of the general population. Golf participants were 2.42 (2.01 to 2.91) (relative risk (95% CI)) times more likely to report a skin cancer diagnosis than the general population after adjusting for age, sex, education and smoking status.

Conclusion Playing golf in Australia is associated with a higher age-specific lifetime prevalence of skin cancer compared with the general population. Golf organisations, clubs and facilities should inform golf participants about the risk of skin cancer and promote preventive strategies including use of high-Sun Protection Factor (SPF) sunscreen, appropriate hats and clothing.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Golf is a popular sport worldwide and is associated with physical, mental and cognitive health benefits.
⇒ Golf participants are exposed to high levels of ultraviolet radiation.
⇒ The risk of skin cancer has not previously been studied in golf participants compared with a general population-based sample.

WHAT THIS STUDY ADDS

⇒ One in four golf participants had been diagnosed with skin cancer at some point in their life compared with just 7% of the general population.
⇒ The risk of skin cancer was 3.4 times higher among golf participants than the general population and 2.4 times higher after adjusting for confounders.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Our findings suggest that golf participants need to focus on skin health and take measures to protect themselves from excessive ultraviolet (UV) exposure.
⇒ The golf industry more broadly should increase promotion of the risks and strategies to reduce excessive UV exposure.

INTRODUCTION

The increased risk of skin cancer as a result of exposure to ultraviolet radiation (UVR) is well known.[1] People who experience prolonged exposure to the sun are known to have a higher risk of developing skin cancer in later life and skin cancer related to ultraviolet (UV) exposure has been steadily increasing over time.[2] One in every three cancers diagnosed are skin related, with over 1.2 million new cases of non-melanoma and 325 000 melanomas of the skin diagnosed globally each year.[1] Over 100 000 people worldwide are estimated to have died prematurely in 2020 as a result of skin cancer from excessive exposure to UVR.[1] On the other hand, UVR in small amounts contributes to the production of vitamin D, which in turn strengthens the musculoskeletal system, can improve mood and reduce the risk of cardiovascular disease and asthma.[3 4]

Outdoor sport participants may have an elevated risk of skin cancer due to prolonged sun exposure, sweating, poor sunscreen application and a lack of adequate clothing protection.[5] Sports associated with excessive UVR exposure include athletics/running, cycling, tennis, sailing, cricket, fishing and outdoor swimming.[5 6] Golf is an outdoor

sport and one of the motivating factors for playing golf is spending time in the natural, green outdoor environment.[7 8] As such, participants are likely to spend significant amounts of time in direct exposure to UVR, with some geographic locations such as Australia and USA, and those close to the equator throughout South America, Asia and Middle East, potentially exposed to higher levels of UVR during seasonal conditions. Unlike some outdoor sports (eg, football codes), golf participants can self-select wearing attire, are permitted to wear hats and have opportunities to reapply sunscreen while participating. However, data from Spain, USA and Australia suggest commonly worn golf attire provides limited protection, and that skin protective behaviours such as frequent application of sunscreen and hat wearing varied greatly.[9–11]

Regular golf participation is associated with a range of health benefits, including benefits to cardiovascular health, lung and muscular function and strength.[12] Playing golf is also associated with improved quality of life and higher levels of mental well-being.[13] Compared with other sports, golf can be played into later life and these benefits may be maintained across the lifespan. Despite golf having a relatively low risk of injury compared with other sports,[14] the outdoor environment in which golf is played may contribute to an increased risk of skin cancer. A narrative review explored UVR exposure in golf participants and found that limited data exist on the history of skin cancer diagnosis among golf participants.[15] Instead, UVR dosimetry had been used in very small samples (eg, n=2) to estimate UVR exposure[6 16] and potential skin cancer risk.[10] There are no known epidemiological studies investigating the risk of skin cancer in golf participants. The aim of this study was to evaluate the age-specific lifetime prevalence of skin cancer in Australian golf participants and compare skin cancer risk between golf participants and a general population-based sample.

METHOD

To obtain specific data from a sample of the golfing population within Australia a purpose-built online survey was developed in REDCap hosted by the University of South Australia, allowing for safe and secure collection and storage of data.

Study information and a link to the consent form and survey was distributed to potential participants by Golf Australia via social media and an electronic newsletter. There are approximately 450 000 registered golf participants within the Golf Australia database. However, due to the nature of recruitment the exact number of golf participants who viewed and responded to the study invitation on social media or electronic newsletter is unknown.

Equity, diversity and inclusion statement

Inclusive eligibility criteria were employed to attract a diverse representative sample of Australian golf participants. Participants were required to be current golf participants (ie, playing golf at least once per month); however, there were no limitations on the duration of involvement in golf, nor were there restrictions on age, gender, playing ability, health issues, ethnicity, race, geographic location within Australia or socioeconomic status. The potential influence of these factors is provided within the discussion.

During the first stage, the Australian Golf and Health Survey (AGHS) was developed and used to collect new data related to golf participation and measures of health and well-being. Recruitment occurred during November 2018 to May 2019. The AGHS collected demographic data, golf participation such as years played, frequency of playing and level of ability, self-reported measures of medical diagnosis, health-related quality of life and physical activity levels (International Physical Activity Questionnaire[17 18]).

The second stage of data collection involved accessing a subset of the 2017–2018 Australian Health Survey (AHS) to use as a general population comparator group. The AHS is a large population-based data set containing data related to demographics, nutrition, diet, medical conditions, physical activity and socioeconomic indicators, and is conducted every 4 years by the Australian Bureau of Statistics (ABS). Data are accessed via the secure DataLab facility provided by the ABS, following training and clearance of approved researchers (BS and TB). The two data sets (AGHS and AHS) were screened for consistency between variables of interest, and where necessary, variables were recoded to ensure consistency between the two data sets.

Within the AHS, a history of skin cancer was assessed by asking participants 'have you ever been told by a doctor or nurse that you have skin cancer?', while in the AGHS, a history of skin cancer was determined by asking participants 'have you ever been told you have any of the following by a doctor: skin cancer (yes or no)?'. Physical activity data within the AHS and AGHS were recorded as weekly time spent completing moderate to vigorous physical activity (MVPA). Once recoded, the two data sets were merged, so that the final data set consisted of a sample of golf participants and the general Australian population (refer to figure 1).

Data analysis

Descriptive statistics were used to describe the participants in the AGHS and the AHS, as well as those who had and had not been diagnosed with skin cancer. Modified Poisson regression was used to estimate the association between playing golf and the risk of having ever been diagnosed with skin cancer. As the outcome was not rare, modified Poisson regression was used instead of logistic regression to avoid misinterpretation of ORs.[19] Age, sex, education and smoking status were included as confounders as all were thought to be associated with the likelihood of playing golf and the likelihood of a skin cancer diagnosis.

All analyses were performed in Stata (V.16, StataCorp, College Station, Texas).

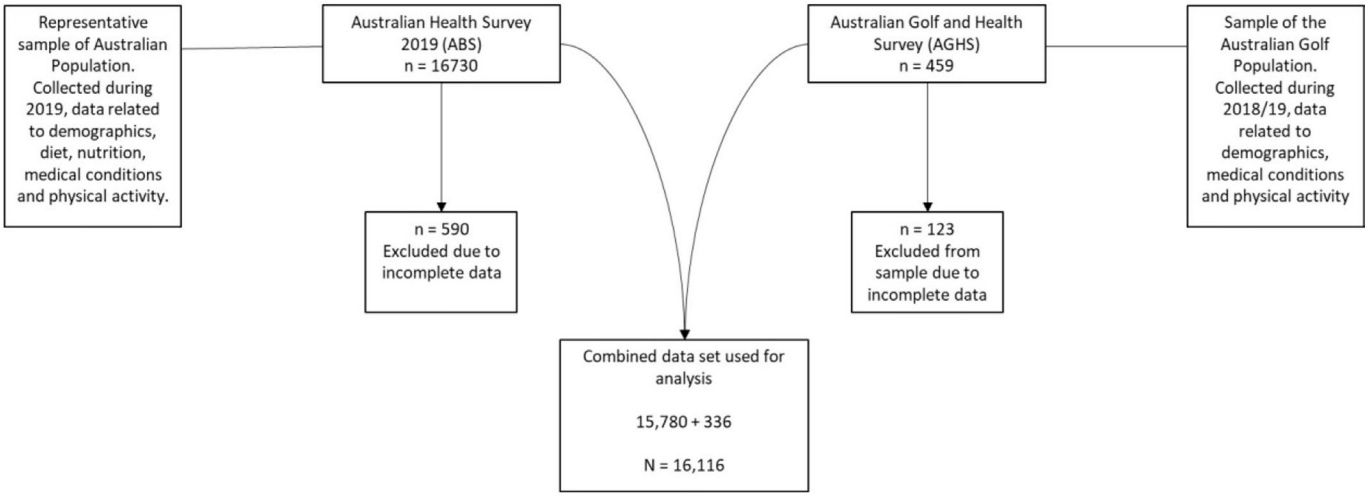

Figure 1 Consolidated Standards of Reporting Trials (CONSORT) diagram of data collection and merging process. ABS, Australian Bureau of Statistics.

RESULTS

Participant characteristics

A total of 336 participants from the AGHS and 15 780 participants from the AHS had data on all the variables included in the final model and were included in the analyses. Compared with the general population-based sample, the sample of golf participants was older on average (mean 62.1 (SD=11.9) years vs 50.6 (18.1) years), and a higher proportion were male (68.2% vs 46.3%) and had a university degree (49.4% vs 28.6%) (table 1). MVPA was higher on average among golf participants compared with the general population (670 (654) min/week vs 285 (652) min/week), while body mass index was lower on average (26.6 vs 28.3 kg/m^2).

Table 1 Demographic data

Variable	Golf participants n=336	Golf participants without skin cancer n=245	Golf participants with skin cancer n=91	General population n=15 780	General population without skin cancer n=14 607	General population with skin cancer n=1173
Age (years)	62.1 (11.9)	60.6 (11.9)	66.1 (9.4)	50.6 (18.1)	49.5 (17.9)	64.7 (14.1)
Sex (n, %)	M=229 (68.2)	M=165 (67.4)	M=64 (70.3)	M=7308 (46.3)	M=6697 (45.8)	M=611 (52.1)
	F=107 (31.8)	F=80 (32.7)	F=27 (29.7)	F=8472 (53.7)	F=7910 (54.2)	F=562 (47.9)
Education status (n, %)						
Did not complete high school	70 (20.8)	56 (22.9)	14 (15.4)	6047 (38.3)	5572 (38.1)	475 (40.5)
High school/ diploma	100 (29.8)	75 (30.6)	25 (27.5)	5222 (33.1)	4802 (32.9)	420 (35.8)
University	166 (49.4)	114 (46.5)	52 (57.1)	4511 (28.6)	4233 (29.0)	278 (23.7)
Smoking (n, %)						
Never smoked	207 (61.6)	154 (62.9)	53 (58.2)	8030 (50.9)	7494 (51.3)	536 (45.7)
Former/current smoker	129 (38.4)	91 (37.1)	38 (41.8)	7750 (49.1)	7113 (48.7)	637 (54.3)
BMI (kg/m^2)	26.6 (4.5)	26.6 (4.0)	26.6 (5.6)	28.3 (6.00)	28.3 (6.00)	29.1 (5.9)
Moderate to vigorous physical activity (min/ week)	670.1 (653.6)	596.9 (548.5)	867.2 (848.7)	285.0 (652.2)	290.4 (657.7)	217.3 (575.1)

Data presented as mean (SD) or n (%) where indicated.
BMI, body mass index.

Table 2 Risk of skin cancer

	Unadjusted Relative risk (95% CI)	Adjusted for age and sex Relative risk (95% CI)	Adjusted for age, sex, education and smoking status Relative risk (95% CI)
General population	1.00 (reference)	1.00 (reference)	1.00 (reference)
Golf participants	3.64 (3.03, 4.38)*	2.54 (2.11, 3.04)*	2.42 (2.01, 2.91)*

*P<0.001.

Mean age was higher among AHS participants who had been diagnosed with skin cancer compared with those who did not report a skin cancer diagnosis (64.7 (14.1) vs 49.5 (17.9) years; table 1). Golf participants who had been diagnosed with skin cancer were also older than golf participants who did not report skin cancer diagnosis (66.1 (9.4) vs 60.6 (11.9) years; table 1).

Age-specific lifetime prevalence and risk of skin cancer

The age-specific lifetime prevalence of skin cancer was 27.1% among golf participants and 7.1% among the general population-based sample (table 1). After adjusting for age, sex, education and smoking status, the lifetime risk of skin cancer as of age at the time of survey completion was 2.42 times higher in golf participants compared with the general population (relative risk 2.42, 95% CI 2.01, 2.91; table 2).

DISCUSSION

The present study aimed to directly address an evidence gap by evaluating the age-specific lifetime prevalence and risk of skin cancer in Australian golf participants compared with a general population-based sample. More golf participants had been diagnosed with skin cancer (27%) compared with the general population (7%). After adjusting for age, sex, education and smoking status, the relative risk of skin cancer was 2.42 times higher among golf participants than the general population.

Previous research has found that playing golf is likely to bring physical and mental health benefits for players.[12 13] Nevertheless, playing golf can also expose players to potentially harmful levels of UVR and thus associated skin problems such as skin cancer. A scoping review found that golf participants are likely at higher risk of skin cancer than non-golf participants,[12] and an international consensus agreed on the statement: 'While moderate sun exposure can offer benefits, golf participants can be exposed to increased risk of skin cancer associated with excess sun exposure if appropriate care and consideration are not taken'.[20] The findings of the current study that golf participants have a higher relative risk of skin cancer than the general population add further evidence to the emerging golf and health literature.

Previous UVR dosimetry studies suggest that golf exposes players to a UVR dose greater than or similar to tennis, sailing[6 16] and gardeners.[21] In addition, a modelling study estimated that men's golf at the Tokyo 2020 Olympics had the second highest UVR exposure of the 144 Olympic sports.[22] Interestingly, a UVR dosimetry study estimated that the relative risk of golf participants developing basal cell carcinoma and squamous cell carcinoma compared with indoor workers was 1.11 on the forearm and 1.16 on the back.[23] This risk is notably lower than the relative risk of skin cancer identified in our study compared with a general population-based sample.[10 22] There are a number of potential explanations for this. First, golf participants could be more likely to develop skin cancer in other locations (such as the legs, face or head); however, we did not collect data on skin cancer location. Second, the risk was calculated on UVR dosimetry, as a proxy for confirmed skin cancer diagnosis, which may have underestimated the prevalence of skin cancer in the previous study.

The only previous study to have collected data on skin cancer diagnosis in golf participants[15] investigated point prevalence of skin cancer and associated risk factors (ie, UVR exposure) for professional and amateur female golf participants in the USA. Professional golf participants in their study were exposed to five times as much sunlight as amateur golf participants mainly due to the requirement to practise and play during the peak UVR exposure times during the day. Approximately 15% of all the golf participants had been diagnosed with skin cancer, lower than the findings of the current study. Although some of the golf participants developed skin cancer much earlier (~25 years old), the average age of those who had been diagnosed with skin cancer was 50.9 years, more in keeping with the findings of our current study. However, the study is limited in its generalisability as a general population comparison group was not used.

Interestingly, a study by Dixon *et al*[24] found that Australian golf participants' sun protection practices declined from 1992 to 2002 in terms of clothing cover and concluded SunSmart campaigns may be failing to reach golf participants. A cross-sectional study of individuals living in Copenhagen[21] found that the median number of episodes of sunburn per year was lower for golf participants than for children, adolescents and indoor workers in a cross-sectional study. However, it is unclear if skin cancer prevention campaigns had any impact on these findings. Further research is needed to investigate the effectiveness of skin cancer prevention programmes on changing skin protection behaviours among golf participants.

This study represents an advancement in the evidence available on the risk of skin cancer for golf participants. This is only the second study to collect data on history of skin cancer diagnosis in golf participants, and to the best of our knowledge, this is the first study to assess the prevalence of skin cancer in golf participants compared with a general population comparator group. This study's strengths are seen in its relatively large and nationwide Australian setting and the large general population sample size. In addition, the sample of golf participants can be thought of as representative of the Australian golfing population. The data obtained on golf participants are consistent with previously reported data on golf populations where age, gender, playing history and education status have been reported (eg, refs [8 13 25]). Furthermore, the data from our comparator sample were obtained from a large random sample of Australians. The findings of the present study are therefore likely to be generalisable to the wider Australian context.

Despite these strengths, this study possesses limitations that should be acknowledged. The data are cross-sectional and we did not have information about when participants were diagnosed with skin cancer, so we cannot infer causation in terms of the relationship between golf and risk of skin cancer diagnosis. Variables related to ethnicity were not available within the AHS and were unable to be included in the analysis. Ethnicity and exposed skin colour are known risk factors for skin cancer,[26] whereby those with fairer skin have an increased risk of developing skin cancer. Our results may have been influenced by the absence of these variables. In addition, the possibility that surveillance bias may explain some of the higher risk for golf participants should also be considered. Surveillance bias occurs when some individuals may have more diagnostic tests performed than others.[27] In this case, it may be that golf participants are more likely to have regular skin checks than the general population due to public information campaigns on the risks associated with increased sun exposure. Self-report bias has been shown to underestimate the true prevalence of medical conditions.[28] It is possible that the true prevalence of skin cancer was underestimated in both the sample of golf participants and the general population-based sample. Larger prospective studies with more information on potential confounders and objective skin cancer data are needed to confirm the results of this study.

Clinical implications

The findings of this analysis have key implications for golf participants with regard to sun protection practices. Matthews *et al*'s[29] recent narrative review concluded that while definitive evidence exists to indicate that golf participants are exposed to potentially harmful levels of UVR during play, epidemiological studies are required to understand more about the risks to skin health that golf participants face from this exposure. Although causation cannot be established from our study, the findings provide greater insight into morbidity related to sun exposure for golf participants than previous studies in this field have provided to date. Given that we have found a more than twofold increase in lifetime risk of skin cancer golf participants, our findings support the need for golf participants to reduce their UVR exposure during play. Golf industry, golf facilities and the wider public health community have a role in supporting golf participants to reduce their UVR exposure and to engage regularly with health providers for regular skin checks. Specifically, golf participants should use high-Sun Protection Factor (SPF) sunscreen reapplied regularly, wear clothing that protects high-exposure areas such as arms, legs, neck and ears and wear broad brimmed hats rather than peaked caps. Strategies such as these are particularly important for junior golfers, who may be less aware of the risk of skin cancer, and the need to use skin protection from an early age to reduce the risk of developing skin cancer in later life. If applying insect repellent, timing of application should be considered to allow sufficient absorption of sunscreen. Golfers at high risk of skin cancer, such as those with family history, a history of cancer and those needing to avoid UV exposure due to medication and/or treatment, should consider playing at times during the day when UVR exposure is lower. Since Australia is a popular tourist destination for golfing, golfing tourists should also be informed of these risks, especially those from colder climates.[30]

CONCLUSION

Participation in golf as an outdoor sport has been shown to enhance health and well-being and carries a relative low risk of injury. However, our findings suggest Australians who play golf are at higher risk of developing skin cancer than the general population. The higher prevalence and relative risk of being diagnosed with skin cancer highlight the need for golf participants to adopt strategies to reduce excessive exposure to UVR.

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Contributors BS acting as guarantor for the study. BS was responsible for the design, methodology, data collection and preliminary analysis, along with DA and RH. BS and TB performed additional analyses and interpretation of the data was completed by BS, TB and SF. BS was responsible for drafting and redrafting of the manuscript, with contributions from TB, SF, DA, RH and NA. All authors contributed to the critical revision and editing of the manuscript.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by the University of South Australia Human Research Ethics Committee (approval number: 201547) and by the Australian Bureau of Statistics (ABS) DataLab project team. Participants gave informed consent to participate in the study before taking part.

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