







Sun exposure and protection habits in transplant athletes: an international survey

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Abstract

Background: Transplant recipients are particularly prone to the development of skin cancer, and overexposure to UV radiation during outdoor activities increases the risk of carcinogenesis.

Objective: The aim of this study was to analyze sun-related behaviors and knowledge in transplant athletes, examine the frequency of sunburns, and explore associations with a history of skin cancer.

Materials and methods: Cross-sectional descriptive study. Participants (n = 170) in the XXI World Transplant Games from >50 countries completed a questionnaire on sun protection habits and knowledge, type of transplant, immunosuppressive therapy, and personal history of skin cancer.

Results: The most common transplanted organs were the kidney (n = 79), the liver (n = 33), and the heart (n = 31). Overall, 61.3% of athletes had been doing sport for >15 years and 79.5% spent >1–2 h a day outdoors. Fifteen % of athletes had a history of skin cancer. The prevalence of sunburn in the previous year was 28.9%, higher in athletes aged <50 years (37.2%); without a primary school education (58.3%), not taking cyclosporin (32.6%), and athletes who played basketball (75%). The main sun protection measures used were sunscreen (68.9%) and sunglasses (67.3%). Use of a hat or cap was the only measure significantly associated with a reduced prevalence of sunburn.

Conclusions: Despite high awareness that sun exposure increases the risk of skin cancer, sunburn was common in transplant athletes. Efforts should be made to strengthen multidisciplinary sun protection education strategies and ensure periodic dermatologic follow-up to prevent sun-induced skin cancer in this population.

KEYWORDS

photoprotection, skin cancer, sun behavior, transplant athletes, ultraviolet radiation

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1 | INTRODUCTION

Transplant recipients are at an increased risk of developing cancer. Although immunosuppressive therapies are increasingly tailored to individual needs and are less aggressive than they used to be, the risk of melanoma and non-melanoma skin cancer is still much higher in this population than in the general population. In addition, tumors may behave more aggressively.¹

UV radiation from the sun is the main risk factor for skin cancer and exerts its carcinogenic effect at different levels: through the induction of thymine dimers responsible for DNA mutations, the generation of oxidative stress causing damage to cell structures, and the inactivation of tumor suppression genes such as *p53*.²

Transplant recipients on immunosuppressive drugs are highly susceptible to the deleterious effects of UV radiation.³ Specific risk factors that need to be evaluated in this population are time since transplant, duration and intensity of immunosuppressive therapy, history of cancer, history of sun exposure, and number of sunburn episodes since childhood.⁴

On the other hand, it has been shown that athletes who perform sports activities outdoors have higher rates of sunburn and a higher risk of long-term skin cancer, as confirmed in recent studies carried out in international sports competitions.^{5,6} However, there are no publications on a specific population of transplanted athletes.

This study aims to know the knowledge and behaviors in relation to sun exposure of transplanted sports athletes during an international competition covering athletes from 5 continents. So the information of such a sample of a great geographic variability provides a very valuable information from a target population with a double risk factor for the development of skin cancer due to its immunosuppression and sun exposure derived from regular sports practice.

2 | MATERIALS AND METHODS

The XXI World Transplant Games (WTG) were held in Malaga, Spain, in 2017. This event brings together over 1000 international athletes who have received a solid-organ or bone marrow transplant. We took advantage of this unique opportunity to analyze sun exposure and protection behaviors, attitudes, and knowledge in transplant athletes from different parts of the world on immunosuppressive therapy who engage in outdoor sports. We also sought to assess sunburn frequency and explore differences in behaviors between athletes with and without a history of skin cancer.

We conducted an observational descriptive study using a previously validated questionnaire designed to collect data on socio-demographic characteristics (age, sex, country of origin, level of education, profession, marital status, and number of children); the practice of sport; sunburn episodes during the past year; skin type; and sun exposure and protection behaviors, attitudes, and knowledge.⁷ The questionnaire was lengthened by adding questions on type of organ transplant, years since transplant, number of transplants, immunosuppressive therapy, and personal history of skin

cancer (see supplementary file for questionnaire). In total, 1356 solid-organ and bone marrow transplant athletes from >50 countries across five continents participated in the XXI WTG. The games have 17 sports, many of which are only done outdoors. Each athlete can participate in a maximum of five sports. Questionnaires were provided for the team manager of each country, who had direct contact with the athletes and who were responsible for delivering and returning them. The return was highly variable; while some team managers returned a high percentage of completed questionnaires, other did not return any questionnaire, hence the variability in participation according to country of origin.

The study was approved by the WTG Ethics Committee and complied with the principles of the Declaration of Helsinki and the Regulation (EU) 2016/679 of the European Parliament on the protection of personal data.

We performed a descriptive analysis using measures of central tendency for quantitative variables and distribution of frequencies for qualitative variables. This was followed by two bivariate analyses: one stratified by sunburn in the past year and the other by a personal history of skin cancer. Qualitative variables were compared using the chi-square test (or Fisher's test for variables with an expected frequency <5), while quantitative variables were analyzed using the *t* test for normally distributed variables and the Mann-Whitney U test for non-normally distributed variables. Statistical significance was set at $p < .05$.

3 | RESULTS

We collected 170 questionnaires from athletes from five continents; 166 of the athletes answered the question on sunburn in the past year. The sociodemographic data are summarized in Table 1. Twenty-five athletes (15.5%) had undergone retransplantation, the vast majority (84.5%) had received two transplants, but one (0.6%) had received four. All the athletes were on immunosuppressive therapy. Most were taking calcineurin inhibitors, with a clear predominance of tacrolimus, which was mentioned by 95 athletes compared with 27 for cyclosporin. The second most common class of immunosuppressants was cytotoxic immunosuppressants, notably mycophenolate mofetil ($n = 68$) and azathioprine ($n = 18$). Just 46 athletes reported taking corticosteroids. Finally, 22 athletes were taking mTOR (mammalian target of rapamycin) inhibitors: 12 sirolimus and 10 everolimus. The medical conditions behind each transplant varied significantly and were difficult to code, as they were self-reported in an open-ended question. We did not have access to medical reports.

Over 78% of the athletes had been playing sport for 1–5 years, and 68% of them did so on a regular basis (≥ 3 days a week). The most common sports were track and field events, followed by swimming and cycling.

The athletes' skin types are shown in Table 1. 64 athletes (42.4%) reported that they experienced mild sunburn on the day after unprotected sun exposure but then developed a medium tan over the following week. A large proportion (79%) had few or no nevi (<50).

TABLE 1 Demographic Characteristics

Characteristics	Number (%)
Sex	
Male	118 (71.1)
Female	48 (28.9)
Mean age, y (range)	48 (6–78)
Retired	
Yes	53 (32.9)
No	108 (67.1)
Region	
Europe	77 (46.4)
North America	49 (29.5)
Africa	20 (12.0)
Asia	9 (5.4)
South America	6 (3.6)
Oceania	5 (3.0)
Education	
No schooling	1 (0.6)
Primary	11 (6.6)
Secondary	70 (42.2)
University	84 (50.6)
Marital status	
Single	54 (32.9)
Married	96 (58.5)
Divorced	11 (6.7)
Widower	3 (1.8)
Data missing	2
Children	
Yes	93 (56.0)
No	73 (44.0)
History of skin cancer	
None	127 (84.1)
Nonmelanoma skin cancer	20 (13.2)
Melanoma	4 (2.6)
Don't know/data missing	15
Skin type	
Skin color	
Very fair	5 (3.1)
Fair	71 (43.6)
Medium	63 (38.7)
Brown	23 (14.1)
Black	1 (0.6)
Hair color	
Red	4 (2.5)
Blonde	30 (18.1)
Light brown	50 (31.1)

(Continues)

TABLE 1 (Continued)

Characteristics	Number (%)
Dark brown	52 (32.3)
Black	25 (15.5)
Eye color	
Blue or gray	58 (35.8)
Green	26 (16.0)
Light brown	25 (15.4)
Dark brown	43 (26.5)
Black	10 (6.2)
Organs transplanted	
Kidney	79 (47.9)
Liver	33 (20.0)
Heart	31 (18.8)
Bone marrow	13 (7.9)
Lung	12 (7.3)
Pancreas and/or pancreatic islets	1 (0.6)
Data missing	1
Number of transplants	
One	136 (84.5)
Two	19 (11.8)
Three	5 (3.1)
Four	1 (0.6)
Missing	5

Of the 135 athletes with nevi, 60.2% stated that that none of them were larger than 1 cm.

Twenty-four athletes (15.9%) had a personal history of skin cancer (melanoma in 2.6% of cases).

The vast majority of athletes did not sunbathe or sunbathed very little: 89.9% sunbathed <30 days a year and 80.3% spent <3 h in the sun. Nonetheless, 50.3% played sport outside on >30 days a year and 46.3% did so for ≥3 hours a day. Forty-eight athletes reported having being sunburnt in the past year; 39 (81.3%) said they had been burnt just once or twice, but two participants reported having being burnt >10 times. The overall prevalence of sunburn in the past year was 28.9% (95% CI: 21.7%–36.1%).

In the bivariate analysis stratified by history of sunburn, athletes aged <50 years were significantly more likely to have been burnt in the past year than those aged ≥50 years (37.2% vs 21.6%, $p = .041$). Sunburn episodes were also more common in athletes with no schooling or with primary education only than in those with a secondary or third-level education (58.3% vs 26.6%, $p = .045$) and in athletes not taking cyclosporin (32.6% vs 11.1% for those taking cyclosporin, $p = .044$). The only sport significantly associated with a history of sunburn was basketball, with 75% of players reporting having been burnt in the past year ($p = .009$). The only sun protection measure significantly associated with not

having been sunburnt in the previous year was use of a hat or cap ($p = .026$).

The most common sun protection measures (mentioned as being used always or nearly always) were sunscreen (68.9%), sunglasses (67.3%), and staying in the shade or using a parasol (58.2%). Other measures, such as wearing a hat or cap, using a long-sleeved shirt or long pants, and avoidance of midday sun (12:00–16:00), were mentioned as being used sometimes or not at all (Table 2).

Sunbathing was not a popular activity; 78.3% of the athletes said that they not like sunbathing and a similar proportion (72.8%) did not consider it to be good for their health. Nonetheless, almost half (45.7%) said that they liked being tanned. Overall, 87% believed that it was worthwhile using sunscreen products, compared with just 27.6% who admitted that they did not like using them. Almost a quarter of the athletes (24.2%) were not worried about sunburn, but 51.5% were worried about developing sun spots and wrinkles.

Over 50% of the athletes scored at least 7 out of 10 in the sun-related knowledge section of the questionnaire. The topics with the most correct answers were on the associations between sunbed use and melanoma risk and between UV radiation exposure and photoaging and skin cancer. The most common misconceptions were that tanned skin did not need to be protected with sunscreen and that light-colored clothing offered greater protection than dark clothing.

In the bivariate analysis stratified by a personal history of skin cancer, no differences were observed between men and women. The mean age of the athletes was 59 years. Athletes in the ≥ 50 age group were significantly more likely to have had skin cancer than those aged < 50 years (24.1% vs 6.9%, $p = .008$). These rates were almost double when we compared athletes aged > 65 years and those aged ≤ 65 years (42.9% vs 11.5%, $p = .001$) (Figure 1). Having children also increased the likelihood of a history of skin cancer (23% vs 6.3%, $p = .011$). The percentage of athletes with a history of skin cancer varied according to country of origin (Table 2) and type of transplant (Table 3). The most common immunosuppressive treatments in the skin cancer group were tacrolimus (62.5%, $n = 15$), mycophenolate mofetil/mycophenolic acid (33.3%, $n = 8$), corticosteroids (20.8%, $n = 5$), sirolimus (16.7%, $n = 4$), azathioprine (16.7%, $n = 4$), cyclosporin (12.5% $n = 3$), and everolimus (8.3% $n = 2$). With the information we had, we were unable to analyze concomitant therapies or doses.

TABLE 2 Solar protection practices followed by athletes

Solar protection practices	Never / almost never / sometimes (%)	Always / nearly always (%)
Shadow/umbrella	41.83	58.17
Sunglasses	32.71	67.29
Hat/Hut use	51.23	48.77
Long T-shirt/trousers	84.37	15.63
Avoid midday time	57.76	42.24
Sunscreens	31.06	68.94

The majority of athletes with a history of skin cancer (79.2%) had been playing sport regularly for over 15 years.

Twenty-three (95.8%) of the 24 athletes with a history of skin cancer described their skin as fair or medium, although no significant association was detected between skin type and skin cancer (Table 4).

Two-thirds of the athletes with a history of skin cancer never sunbathed, and nobody sunbathed on > 30 days a year. The vast majority of those who did sunbathe (95.8%) did so for < 3 hours a day, compared with 77.3% of those without a history of skin cancer ($p = .046$). Again, however, a significant proportion (56.5%) participated in outdoor sports on > 30 days a year.

With the exception of wearing a hat or cap, transplant athletes with a history of skin cancer used more sun protection measures than those who had never had skin cancer and than the group in general. They were also more likely to use long-sleeved shirts and long pants than those without a history of skin cancer (33.3% vs 11.5%, $p = .012$).

Multiple sub-analyses were performed, highlighting the presence of sunburn in the previous summer and the history of skin cancer. In contrast, no results with statistical significance were obtained after performing multivariate analyzes with the intention of adjusting for the presence of sunburn in the previous year, adjusting for age, phototype and history of skin cancer, as well as stratifying by age, phototype and the two main outcome variables (presence of sunburn and history of skin cancer).

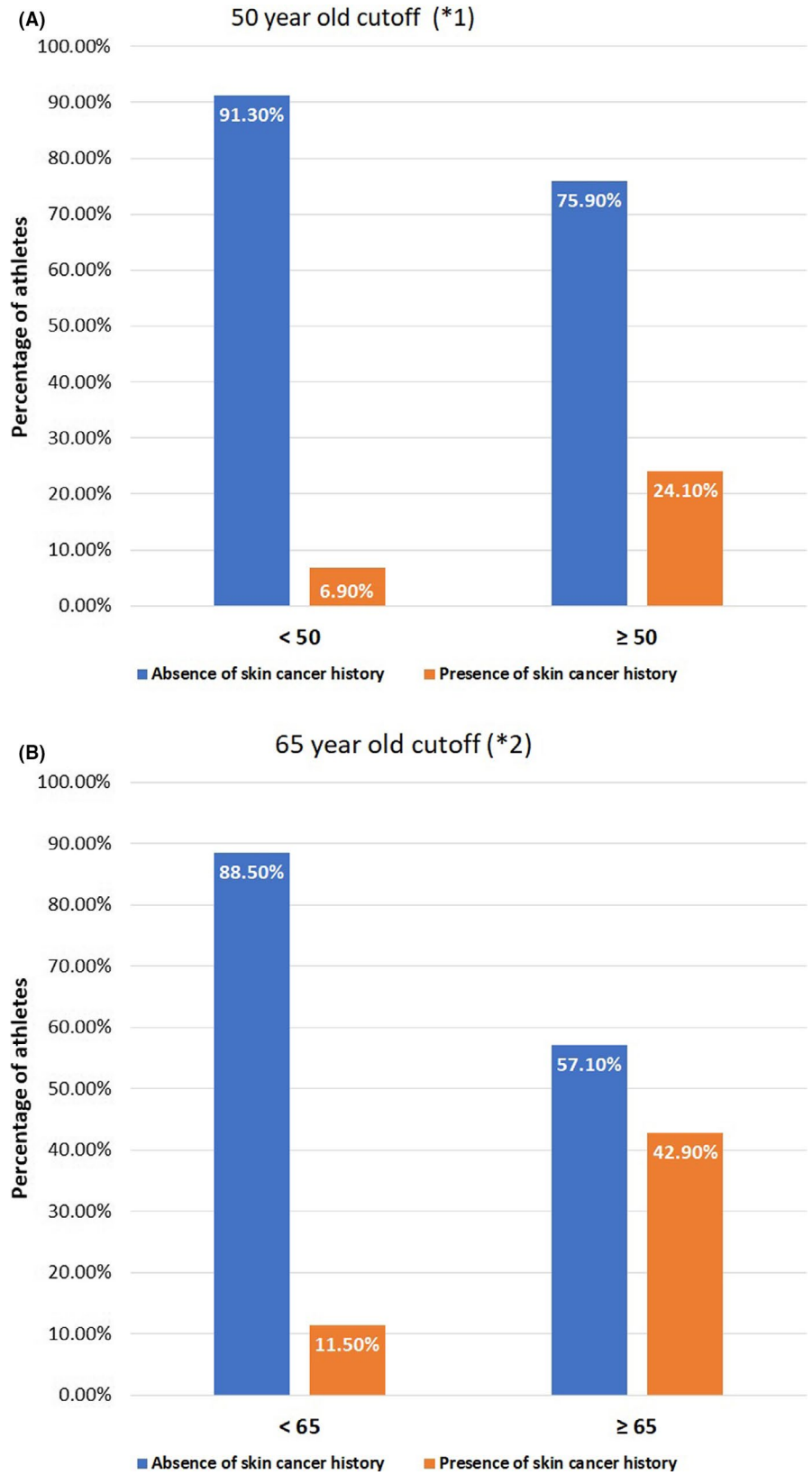
4 | DISCUSSION

We have analyzed sun protection and exposure behaviors, attitudes, and knowledge in an international sample of transplant recipients of the 5 continents and from more than 15 sports modalities who regularly engage in outdoor sport. Our analyses were stratified by sunburn in the previous year and a personal history of skin cancer and highlight a number of risk behaviors in this population who are already more prone to developing skin cancer as they are on life-long immunosuppressive therapy and are exposed to UV radiation during the practice of outdoor sport.⁸

The most widely used protection measures were sunscreen and sunglasses. Long-sleeved shirts and long pants were used by a significantly higher proportion of athletes with a history of skin cancer, although the only measure significantly associated with a lower prevalence of sunburn was wearing a hat or cap.

Numerous studies have shown that cancer risk is influenced by the degree and duration of immunosuppressive therapy and that transplant recipients are more likely to develop skin cancer than any other type of cancer.^{1,9} Immunosuppressive treatments have changed considerably since the first organ transplants were performed. Regimens are increasingly tailored to individual needs, and protocols also vary depending on the organ.¹⁰ It was difficult to analyze individual drugs in our sample as the athletes had received transplants in different years and would also have been treated with

FIGURE 1 Relationship between age and history of skin cancer. A significant upward relationship between age and history of skin cancer is observed. ⁽¹⁾ $p = .008$. ⁽²⁾ $p = .001$



very different immunosuppressive regimens. In addition, monotherapy is rare in this setting. Our results show that athletes on cyclosporin were significantly less likely to have been sunburnt in the previous year than those on other immunosuppressants. Coghill et al,¹¹ in a study of immunosuppressive medications, found that

organ transplant recipients on tacrolimus were less likely to develop squamous cell skin cancer than those on cyclosporin.

The rate of skin cancer (15.9%) is lower than rates reported in other studies of transplant recipients, such as 18.4% in Saskatchewan, Canada,¹² and 19.5% in Colombia.¹³ The prevalence of sunburn in

the previous year, 28.9%, was also lower than that reported for other populations who engage in outdoor activities, such as skaters¹⁴ (52.1%) and cyclists (45.6%).¹⁵ The group of skaters, however, with a mean age of 14.3, were much younger than the athletes in our series, whose mean age was similar to that of the cyclists. As seen, age is an important factor to evaluate. Higher rates of sunburn in the previous year have also been reported for general populations, such as 34.2% for adults in the United States.¹⁶ Few studies have analyzed history of sunburn in transplant recipients, and it is therefore difficult to draw comparisons. Haney et al,¹⁷ however, reported a rate of just 2.9% for liver transplant recipients in Turkey in 2016, which is almost 10 times lower than the rate detected in our series.

Although having a tan is still widely considered a sign of beauty, <50% of the athletes in our series wanted to have a tan, and in addition, a substantial proportion stated that they did not like sunbathing and did not think that it was healthy. This observation coincides with recent reports for Spanish cyclists.¹⁵

A large percentage of the athletes stated that they always or nearly always used sun protection measures. The rates for use of sunscreen (68.9%) and avoidance of midday sun (42.2%) are higher than those described in previous studies of transplant recipients (eg, 47.9% of transplant recipients in the Canadian study by Walker et al¹²), possibly because of a greater awareness of the need to use protective measures during outdoor activities. That said, almost a quarter of the athletes were not worried about being sunburnt. Another contradictory finding, however, was that over half of them were concerned about photoaging.

Good sun protection behaviors are crucial for anyone doing outdoor exercise. Although 74.8% of the transplant athletes

acknowledged that it was easy to protect themselves from the sun using physical measures, just 48.8% used a hat or cap and just 15.6% wore long-sleeved or long-legged garments while exercising. Rates in the literature vary and may be strongly influenced by type of sport. In their study of cyclists, for example, Doncel et al¹⁵ found that 95.2% wore a hat or cap and 92.8% wore sunglasses. Fernández-Morano et al,¹⁴ in turn, reported that 65.9% of skaters wore long-sleeved shirts or long pants.

Awareness of the importance of sun protection and the association between sun exposure and cancer was relatively high in our series, with the athletes scoring on average 7 out of 10 in the knowledge section of the questionnaire. This is the same score reported for Spanish cyclists.¹⁵ Both groups, however, performed poorly on the same question, with just 34.9% of transplant athletes and 19.8% of cyclists knowing that dark clothing provided better protection from light-colored clothing. Other important misconceptions detected in our series were that it was not necessary to use a sunscreen on tanned skin (78.8%) or sunscreen with a sun protection factor of 30 or higher on children (52%).

Sunburn in the past year was significantly more common in younger transplant athletes, supporting previous results for immunocompetent athletes, including skaters (56.8%),¹⁴ surfers (88%),¹⁸ US collegiate athletes (84%),¹⁹ adolescent athletes in Argentina (73.4%),²⁰ young adult athletes in Australia (69.2%),²¹ and skiers and snowboarders in New Zealand (48%).²² In our study, we observed significant differences in the prevalence of sunburn in athletes aged <50 years vs ≥50 years (37.2% vs 21.6%, $p = .041$); the respective rates, however, were lower than those reported for cyclists aged ≤40 years vs >40 years (60.3% vs 46.2%, $p < .001$).¹⁵

Sunburn was more common in athletes with no studies or with primary education only than in those with a secondary or third-level education (58.3% vs 26.6%, $p = .045$), contrasting with previous reports by Haney et al¹⁷ in their study of liver transplant recipients.

In the analysis stratified by a personal history of skin cancer, there was a clear association between skin cancer and age: 24.1% of athletes aged ≥50 years had a history of cancer ($p = .008$) compared with 42.9% of those aged >65 years ($p = .001$). This association has been reported in numerous studies.²³ It should also be considered that almost 80% of the transplant athletes with a history of skin cancer had been participating in outdoor sporting activities for over

TABLE 3 Frequency of skin cancer according to the transplanted organ

Transplanted organ	Absence of skin cancer history	Presence of skin cancer history
Kidney	59 (83.1)	12 (16.9)
Lung	8 (72.7)	3 (27.3)
Heart	27 (90.0)	3 (10.0)
Liver	24 (82.8)	5 (17.2)
Bone Marrow	11 (91.7)	1 (8.3)
Pancreas	1 (100.0)	0 (0.0)

Which of the following statements best defines your skin color?	Without skin cancer antecedents	With skin cancer antecedents
I: It always burns initially and never tans.	6 (5.20)	2 (9.10)
II: It always burns initially and then one week later develops a light tan	25 (21.60)	7 (31.8)
III: Sometimes it burns initially, and then one week later develops a moderate tan	49 (42.20)	11 (50.0)
IV: It never burns. It always tans quite well one week later.	36 (31.00)	2 (9.1)
Total	116	22

TABLE 4 Phototypes according to exposure in relation to the history of skin cancer

15 years, suggesting that chronic sun exposure might have led to cancer-causing DNA mutations.²⁴

Our findings show that a personal history of skin cancer is a key determinant of sun exposure awareness and protection practices, as athletes who had had skin cancer spent less time in the sun (hours and days) for each of the three activities analyzed (sunbathing and outdoor work and sport). They were also more likely to use sun protection measures, in particular long-sleeved shirts and long pants ($p = .012$). Nonetheless, they were no less likely than those without a history of skin cancer to have been sunburnt in the previous year (prevalence of around 29% in both groups).

As our study is based on a questionnaire, it has a number of significant limitations. We did not, for instance, have any information on immunosuppressive treatment switches or dosages or on whether the skin cancer had developed before or after the transplant, whether it was a primary or recurrent tumor, and how it had been treated. Using a questionnaire, however, facilitated comparisons with other studies that have used a similar method to explore sun-related behaviors and knowledge in other populations, such as immunocompetent adults,¹⁶ athletes,^{14,15} transplant recipients,^{8,17,25} and beachgoers.²⁶ Given insufficient statistical power, a limitation of the study is the impossibility of performing stratified analyzes for age and skin type to adjust results regarding both the presence of sunburn and skin history. It should also be noted that one particular strength of our study is the size and diverse nature of our sample in terms of type of transplant and geographic origin.

In conclusion, although our study reveals high levels of awareness and knowledge about the potentially deleterious effects of sun exposure and the importance of protection among transplant athletes, a high proportion of the athletes reported sunburn in the past year. A history of skin cancer is a key determinant of sun exposure and protection behaviors. Continued efforts are needed to heighten awareness about the importance of sun protection in the prevention of skin cancer. Multidisciplinary actions involving specialists, dermatologists, and all healthcare professionals caring for transplant recipients are necessary.

4.1 | Summary statement

One of the key aspects of skin cancer prevention in transplant patients is a photoprotective behavior, specially in that recipients who overexpose during outdoor activities. More than 60% of athletes from a set of 170 participants in XXI World Transplant Games make sport over 15 years spending more than 1 hours/day outdoor. Approximately 30% reported sunburns in previous year with only sunscreen and sunglasses use for photoprotection. More educational efforts in sun protection should be made for this photosensitive population.

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CONFLICTS OF INTEREST

None declared.

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SUPPORTING INFORMATION

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