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ORIGINAL ARTICLE

Effect of education on sun-safe behaviour in kidney transplant recipients

Vanessza Tári[1] | Eszter Anna Janka[1,2] | Gabriella Emri[1,2] | Balázs Nemes[3] | Éva Remenyik[1,2] | Emese Gellén[1]

[1]Department of Dermatology, MTA Centre of Excellence, Faculty of Medicine, University of Debrecen, Debrecen, Hungary

[2]ELKH-DE Allergology Research Group, Debrecen, Hungary

[3]Department of Transplantation, Institute of Surgery, University of Debrecen, Clinical Center, Debrecen, Hungary

Correspondence
Emese Gellén, Department of Dermatology, MTA Centre of Excellence, Faculty of Medicine, University of Debrecen, Debrecen, Hungary.
Email: emesegellen@med.unideb.hu

Abstract

Background: Organ transplant recipients (OTR) are more likely to develop skin cancer than the general population. One of the main components of the exposome that triggers the development of skin tumours is solar ultraviolet (UV) radiation. To reduce the incidence of harmful consequences of sun exposure, sun protection education is needed for patients taking long-term immunosuppressive drugs.

Methods: In a previous study, we assessed the sun-safe behaviour of 221 OTR using a questionnaire before and after transplantation and personally educated the patients about proper sun protection. After the education, there were no further reminder presentations. Presently, the sun protection and sun seeking habits of the available 176 of these patients were questioned to assess the long-term effect of the previous sun protection education.

Results: Two-four years after the education, more patients wore hats and protected their skin with long-sleeved clothing than before the education. In terms of sun seeking habits, both occupational and recreational sun exposure decreased significantly. Significantly fewer people went on holiday after transplantation, but those who went on holiday spent significantly less time in the sun.

Conclusion: The long-term positive effects of education can be seen both in the patients' sun protection and in their sun seeking habits. However, the long-term goal is to maintain these results and thereby reduce the likelihood of skin tumours and consequently the associated tumour death.

KEYWORDS
education, immunosuppression, skin cancer, sun protection, transplantation

1 | INTRODUCTION

The UV spectrum of sunlight is one of the most important exogenous factors (component of the exposome) in the development of skin cancer. This is supported by the observation that non-melanoma skin tumours such as basal cell carcinoma (BCC) and squamous cell carcinoma (SCC) occur on Caucasian race mainly in areas regularly exposed to sunlight.[1,2] Annual total UV radiation depends primarily on geographical location, as UV radiation increases as one approaches the equator.[3–5] High sun exposure increases the

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incidence of skin cancer over time.[6] The pigmentation characteristics of the skin are important in predicting the carcinogenic risk in the general population and in organ transplant recipients (OTRs) as well.[7] The risk of developing skin tumours is significant for light, less prone to tanning, that is, Fitzpatrick's I-II skin types.[1,8] In addition, age is an independent aetiological factor, the risk of developing skin cancer increases with advancing age.[1] Patients who have undergone organ transplantation have at least a 100-fold risk of SCC and a 10-fold risk of BCC, compared to the immunocompetent population. The UV exposure and high total sun burden before transplantation, along with fair skin, older age, male gender, smoking and a history of previous actinic keratosis or skin cancer, are important risk factors in this population. The risk is also influenced by the type of transplanted organ (heart/lung > kidney > liver), the time elapsed since transplantation, the immunosuppressive drugs used (especially azathioprine, cyclosporine A (CsA) and tacrolimus (Tac)), the presence of p53 gene mutations, lower CD4 cell count, and human papillomavirus infection. All these factors contribute to the development of skin tumours. The immunosuppressive drugs significantly reduce the skin's ability to protect itself from the carcinogenic effects of UV light, indirectly by reducing certain immune functions and directly by sensitising keratinocytes to the DNA-damaging effects of UV light.[1,2,6,9–15] Therefore skin tumours in OTRs usually have a multiplex appearance, behave aggressively and are prone to recurrence.[9]

To avoid deterioration of the population's quality of life and to reduce mortality, it is extremely important to prevent the development of skin cancer. However, in transplant patients, the presence of a skin tumour before transplantation was shown to be associated with a higher risk of subsequent skin tumour development, metastases, graft rejection and death.[16–18]

To reduce the risk of developing skin tumours, it is essential to raise awareness of the increased risk of skin tumours among patients receiving long-term immunosuppression, as well as to educate them on proper sun protection and sunbathing habits. For preventive purposes, in 2016, we educated a group of kidney transplant patients at the Transplantation Unit of the Department of Surgery of the University of Debrecen about the increased risk of skin tumours, self-examination, adequate sun protection and sunbathing habits through a PowerPoint presentation that we gave in person. A 1-h training session was conducted once, and afterwards, there were no additional reminder presentations. However, patients were consistently reminded of the importance of sun protection and self-skin examination during periodic dermatological visits. Before the lecture, we conducted a questionnaire survey with these kidney transplant patients about their pre- and post-transplantation sun protection and sunbathing habits, we assessed their accumulated sunburn and asked them if they were informed about the risk of skin tumours. These data have been published.[19] The aim of this study was to assess the long-term effectiveness of the in-person education, how it affected the patients' sun protection and sunbathing habits years after the education.

2 | METHODS

Between October 2018 and December 2020, we evaluated the sunbathing and sun protection habits of patients who received in-person education in 2016 and were cared for at the Transplantation Department of the University of Debrecen ($N = 221$). The study received ethical approval from the National Ethical Committee (certificate number: 20989–1/2016/EKU). In 2016, three dermatologists working at the Department of Dermatology in Debrecen prepared a questionnaire consisting of 105 questions about the history of immunosuppressive drug treatment, the skin type, the time of transplantation, the type and number of transplanted organs, and the information received in the peri transplantation period about the increased risk of skin cancer. Occupational, recreational (weekend), and holiday sun exposure before and after transplantation and sun protection methods used before and after transplantation were evaluated. All those who filled out the questionnaire received in-person education about the increased risk of skin cancer and about proper sun exposure and sun protection habits. In the period 2018–2020, we conducted a follow-up survey among patients who participated in the education in 2016 and were willing to participate in the current study. The structure of the original questionnaire was mainly based on the questionnaires published by Moloney et al.[20] Terhorst et al.[21] and Mihalis et al.[22] then adapted to the local language and circumstances. The number of questions in the original questionnaire was reduced to 51 in accordance with the purpose of this study. A total of 176 patients participated in the present study. Patients who died in the meantime, or who moved away, or whose care was taken over by another specialist care institution, could not be included in the follow-up survey. These exclusion criteria resulted in a lower number of patients in the present study compared to the previous one (Figure 1).

2.1 | Statistical analysis

In the post-education study, the descriptive analysis was performed with continuous variables (expressed as mean ± standard deviation) and categorical data (expressed as a percentage). When comparing the post-education period with the pre-transplantation period and the post-transplantation period, categorical variables were compared using the chi-square test or the Fisher exact test.

The significance level was set to .05 in all cases ($^{*}p < .05$, $^{**}p < .01$ and $^{***}p < .001$). Data were analysed using IBM SPSS Statistics for Windows version 25.0 (IBM Corp., Armonk, NY, USA).

3 | RESULTS

3.1 | Study population

The gender distribution of the 176 patients who participated in the post-education survey was as follows: 67 women and 109 men, with an average age of 55.10 ± 12.6 years at the time of completing the

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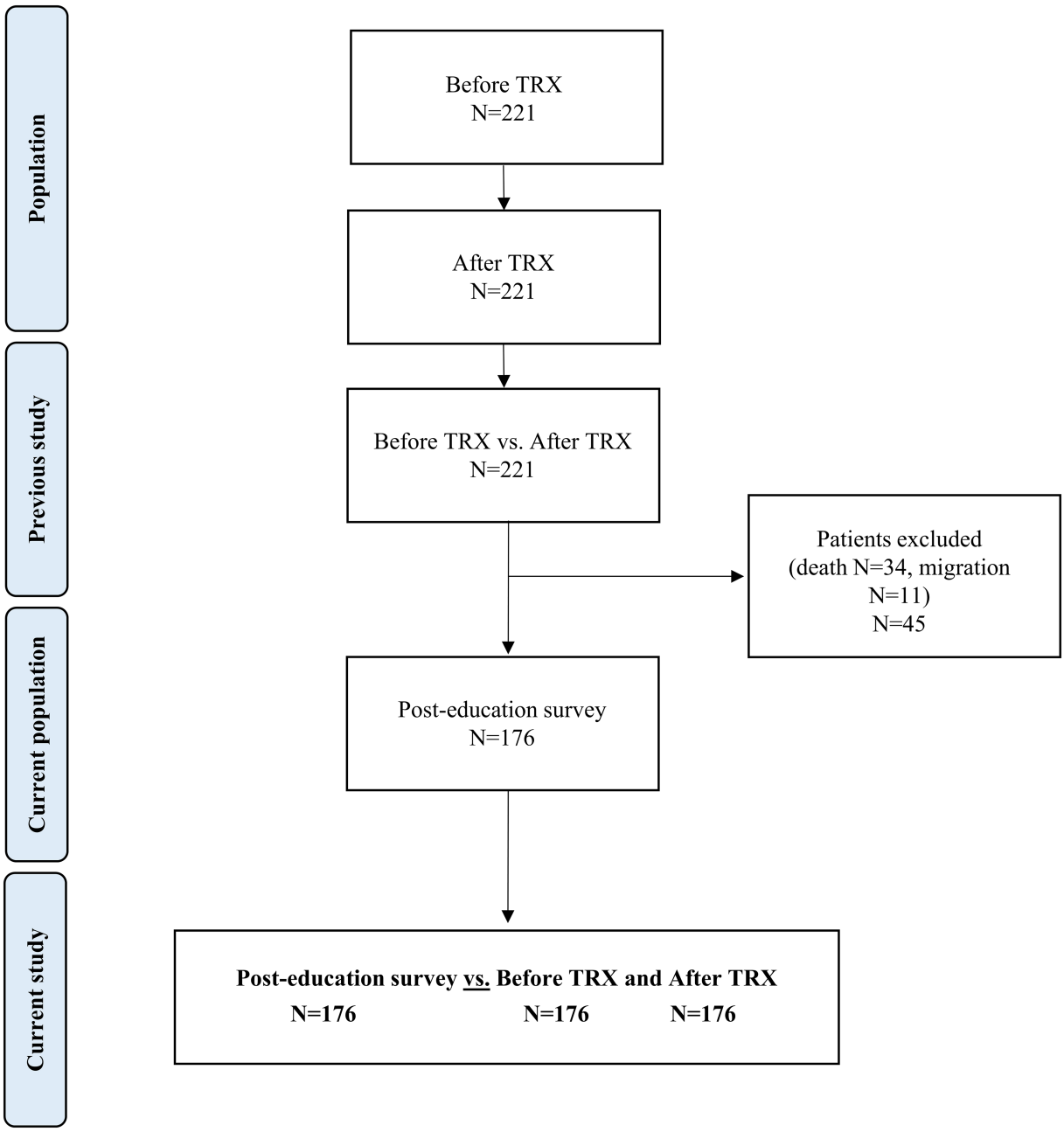

FIGURE 1 Flowchart. N, number; TRX, transplantation.

questionnaire (Table 1). The male:female ratio was 1.63:1. The total number of non-working patients was 117, of whom 53 were retired. Among the actively working patients, we separated in- and out-of-housework. The two categories also overlapped, with some patients spending time both inside and outside during their work. 27.84% of patients worked inside the building and 12.5% outside.

All our participating patients belonged to the Caucasian race and had the following Fitzpatrick skin type: most of the patients had skin type III (44.32%) and II (38.64%). Only 6.82% of the patients who completed the questionnaire has skin type IV and 10.23% skin type I.

Most of the patients were on Tac and mycophenolate mofetil plus prednisolone immunosuppressive treatment (Table 1).

Average time since training was 3.32 ± 0.88 years.

Since the educational session, none of the patients in the study have developed new skin tumours.

3.2 | Effect of education on sun exposure (post-education survey)

On a working day, 59.09% of patients were exposed to sunlight before 11 AM and 56.82% after 3 PM; 32% were exposed for less than 30 min and 39% were exposed for 1–2 h or less.

On weekends, 18.75% of OTRs had no sun exposure and only 7.39% were exposed to sunlight between 11 AM and 3 PM. 30% spent less than 1 h on the sun, mainly before 11 AM or after 3 PM.

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TABLE 1 Patient characteristics.

Variables	N = 176
Age (year), mean ± SD	55.10 ± 12.6
Sex, % (N)	
Man	61.93 (109)
Woman	38.07 (67)
Fitzpatrick skin type, % (N)	
I	10.23 (18)
II	38.64 (68)
III	44.32 (78)
IV	6.82 (12)
Number of TRX, % (N)	
1	90.34 (159)
2	8.52 (15)
3	1.14 (2)
Immunosuppressive drugs, % (N)	
Cyclosporine A	30.11 (53)
Azathioprine	6.25 (11)
Tacrolimus	81.82 (144)
Prednisolon	100 (176)
Mycophenolat mofetil	95.45 (168)
Sirolimus	15.34 (27)
Everolimus	6.82 (12)

Abbreviations: N, number; TRX, transplantation.

28.41% of OTRs went on holiday, and 63.26% spent maximum 2 h on the sun (Table 2).

3.3 | Effect of education on sun protection habits (post-education survey)

Patients were most often in the shade (77.27%) and wearing hats (66.48%). 47.16% applied sunscreens.

Sunscreen was used always or often by 60% of the patients, but most of them applied it once a day. The most popular factor was 50, but 89% only used it in summer.

3.4 | The impact of education on sunbathing habits

Significantly more patients were exposed to less than 30 min of sunlight on a working day following education ($p < .001$) compared to the before and also after transplantation results ($p < .001$). The frequency of people who were exposed to sun between 11 and 15 h was significantly lower after education compared with before transplantation ($p < .001$), however, there was no difference between the post-transplantation and post-education periods ($p = .148$), both rates were low (after transplantation: 23.86%, post-education 17.61%). Significantly more patients were not exposed to sunlight at all on a working day after education compared to the after-transplantation results ($p = .012$) (Figure 2 and Table 2).

Regarding recreational sun exposure, significantly more OTRs were not exposed to sunlight ($p = .023$) or been exposed before 11 AM ($p < .001$) during weekends compared to the before transplantation results. Moreover, significantly less patient was exposed to sunlight independent of the time of day ($p < .001$) and significantly less patient spent more than 4 h on the sun ($p < .001$) or sunbathed daily in the summer ($p < .001$) during weekends, compared to before transplantation period. After transplantation, following education, majority of the patients continued to have no sun exposure ($p = .891$), furthermore, significantly fewer had sun exposure between 11 and 15 h ($p < .001$) (Figure 3 and Table 2).

Significantly less patient went on holidays ($p < .001$). Who have been on holiday, significantly less OTRs sunbathed independent of the time of the day ($p = .019$) and significantly more patients spent less than 30 min on the sun ($p < .001$) (Table 2).

The proportion of patients using tanning beds was already low before transplantation (7.39%), remained low after transplantation (2.27%) and did not increase significantly in the post-transplantation survey (3.41%) (Table 2).

3.5 | The impact of education on sun protection habits

After education, the number of OTRs using sunscreen significantly ($p = .017$) increased (before TRX 38.07%, after TRX 34.66% and post-education survey 47.16%), and significantly more people wore hats ($p < .001$) and long-sleeved clothing ($p < .001$) to protect their skin (Figure 4 and Table 2).

4 | CONCLUSIONS

In our multi-stage questionnaire survey study, we investigated a group of renal transplant patients in terms of their UV exposure and their photoprotection habits. The questionnaire included questions on the amount of time spent outdoors as a prominent part of the questionnaire. UVA rays account for 95% of the UV radiation reaching our planet and can penetrate deep into the dermis[23] and also play a role in the development of skin tumours.[1,24] These rays indirectly cause DNA damage by creating oxygen free radicals (ROS) that penetrate the deeper layers of the skin. However, oxidative stress affects not only DNA but also the lipids and proteins in the membrane.[25,26] It can also induce p53 tumour suppressor gene mutations and thus damage the DNA repair mechanism.[27] A further detrimental effect of these rays is that they reduce the activity of epidermal antigen-presenting cells, impairing the immunological function of the skin.[26] It is important to note that the intensity of UVA radiation emitted by solarium tubes is 10–15 times higher than what we can experience in the summer, at midday, making it a major risk factor for skin tumours.[25] Although the proportion of tanning bed users was already low in the pre-transplant

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TABLE 2 Comparison of sun protection and sun bathing habits during post-transplantation survey versus before and after transplantation.

Variables	Before TRX *N* = 176% (*N*)	After TRX *N* = 176% (*N*)	Post-education survey *N* = 176% (*N*)	*p*-Value before TRX vs. post-education survey	*p*-Value after TRX vs. post-education survey
Sun protection methods					
No sun protection methods	8.52 (15)	5.68 (10)	5.11 (9)	.205	.814
Seeking shade	74.43 (131)	80.11 (141)	77.27 (136)	.533	.515
Sunglasses	48.30 (85)	51.14 (90)	55.68 (98)	.165	.393
Hat	40.91 (72)	48.30 (85)	66.48 (117)	**<.001**	**<.001**
Long-sleeved clothes	18.18 (32)	22.73 (40)	44.89 (79)	**<.001**	**<.001**
Sunscreen	38.07 (67)	34.66 (61)	47.16 (83)	.085	**.017**
Sunbathing habits					
Using of indoor tanning	7.39 (13)	2.27 (4)	3.41 (6)	.099	.521
Go on holidays	52.27 (92)	31.25 (55)	28.41 (50)	**<.001**	.560
Occupational sun exposure					
No sun exposure	5.11 (9)	12.50 (22)	22.72 (40)	**<.001**	**.012**
Before 11 AM	63.07 (111)	56.82 (100)	59.09 (104)	.444	.666
Between 11 AM and 3 PM	44.89 (79)	23.86 (42)	17.61 (31)	**<.001**	.148
After 3 PM	71.02 (125)	52.84 (93)	56.82 (100)	**.006**	.453
Recreational sun exposure					
No sun exposure	10.23 (18)	18.18 (32)	18.75 (33)	**.023**	.891
Before 11 AM	25.57 (45)	42.05 (74)	44.89 (79)	**<.001**	.591
Between 11 AM and 3 PM	15.91 (28)	14.77 (26)	7.39 (13)	**.013**	**.027**
After 3 PM	34.66 (61)	38.07 (67)	44.32 (78)	.064	.234
Independent of the part of the day	38.64 (68)	16.00 (28)	18.18 (32)	**<.001**	.587
Sun exposure on holiday					
	***N* = 92**	***N* = 55**	***N* = 50**		
No sun exposure	35.87 (33)	58.18 (32)	48.00 (24)	.159	.296
Before 11 AM	5.44 (5)	5.45 (3)	6.00 (3)	.889	.904
Sunbathed, but not between 11 AM and 3 PM	15.22 (14)	7.27 (4)	24.00 (12)	.196	**.017**
After 3 PM	9.78 (9)	12.73 (7)	6.00 (3)	.439	.241
Independent of the part of the day	36.96 (34)	20.00 (11)	18.00 (9)	**.019**	.794

Note: Significant results are in bold.

Abbreviations: N, number; TRX, transplantation.

survey, some of the patients had unfortunately still not given up this habit, but they only accounted for 3.41% of the total patient population. They said that their main aim was to get a tan and only a small proportion did so to prevent sunburn. Most UVB is absorbed in the epidermis and causes direct DNA damage by inducing the formation of cyclobutane–pyrimidine dimers.[26,28] A higher incidence of skin tumours has been observed in the transplant patient population, partly due to the use of immunosuppressive drugs for transplantation.[13,14] Patients in our study were given, among others, calcineurin inhibitors: CsA and Tac, and azathioprine, which have been shown to increase the incidence of skin tumours.[29,30] Our main aim in trying to improve patient education was to raise awareness and provide information on sun protection as an effective preventive tool, so that they better understand its importance for protecting their own health. Indeed, it has been shown that appropriate sun protection activities can reduce the amount of UV radiation to the skin and thus reduce the incidence of skin tumours.[31,32] In a previous study, it was reported that the regular use of sunscreen with a factor of at least 50 for 2 years reduced the incidence of several skin tumours such as actinic keratosis, SCC, BCC in organ transplant patients.[32] However, sunscreen is not the only option for patients to protect themselves from the sun's rays. Sun avoidance behaviour or wearing appropriate clothing can also be a solution to protect our skin.[31] Significant improvements were observed in protection with long-sleeved clothing and hat compared to the pre-training condition. For this high-risk patient group, educational efforts as primary and secondary prevention are of paramount importance. In

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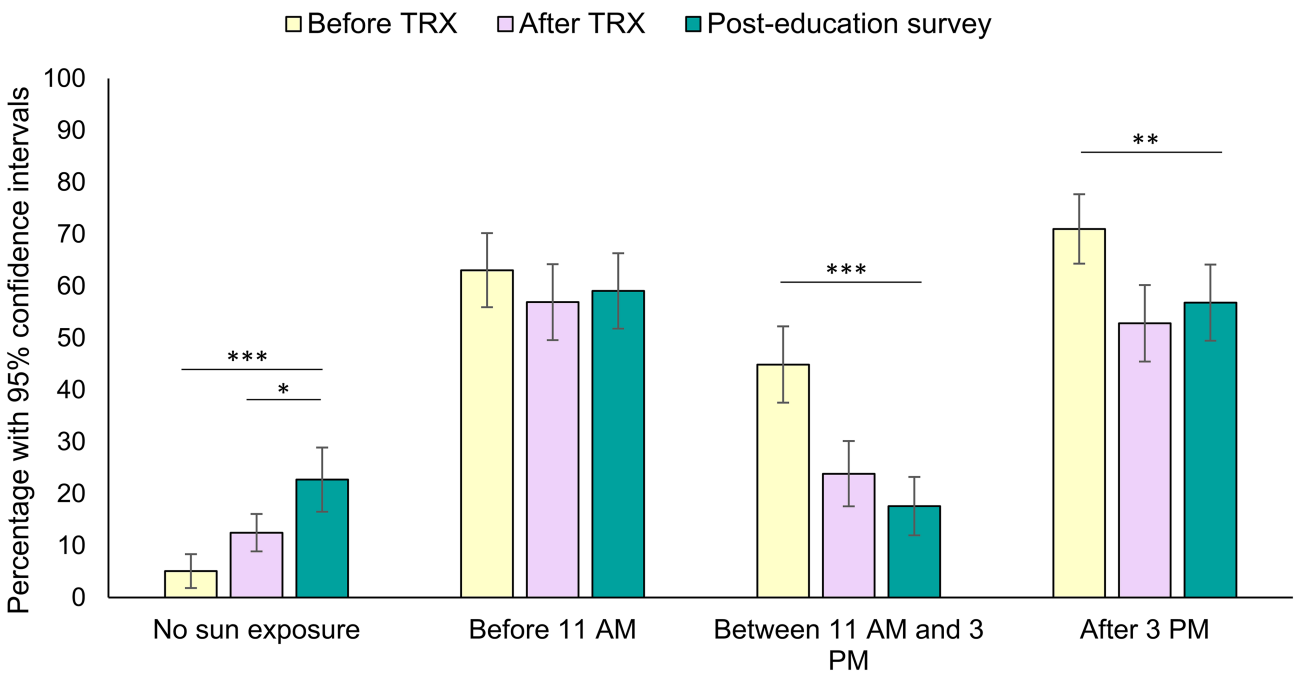

FIGURE 2 Comparison of occupational sun exposure during post-transplantation survey versus before and after transplantation. Decrease of occupational sun exposure after transplantation and after education. TRX, transplantation; *$p < .05$; **$p < .001$; ***$p < .001$.

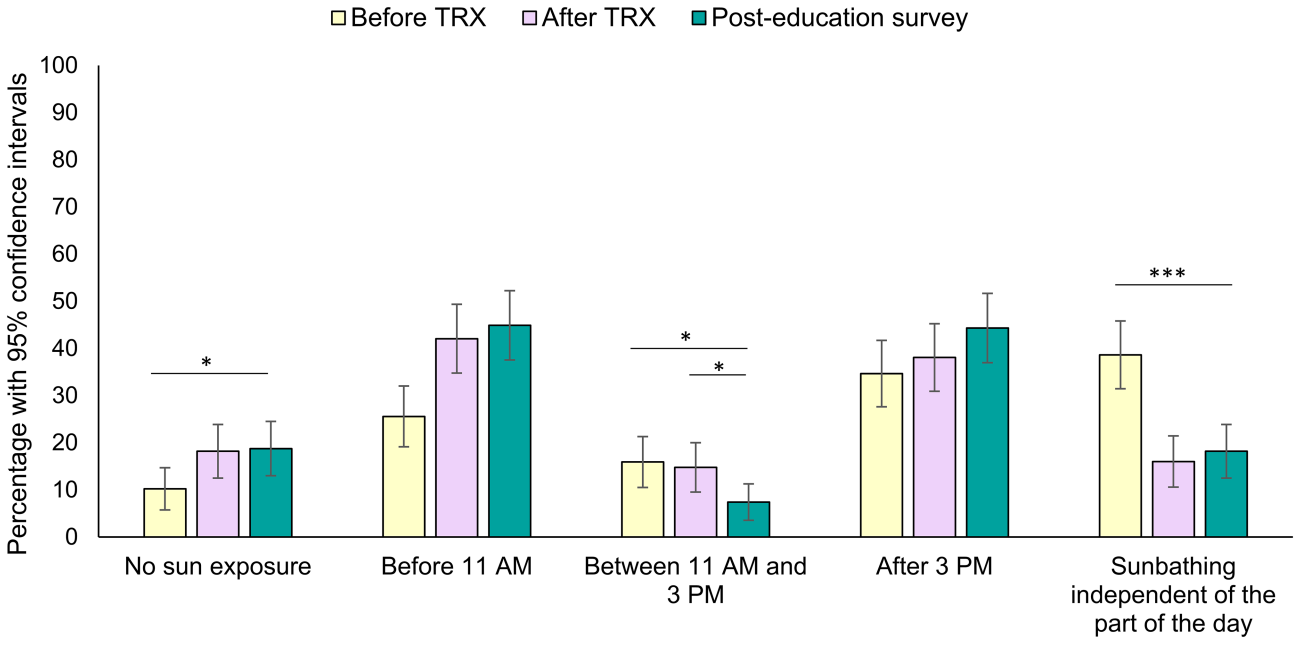

FIGURE 3 Comparison of recreational sun exposure during post-transplantation survey versus before and after transplantation. Decrease of recreational sun exposure after transplantation and after education. TRX, transplantation; *$p < .05$; ***$p < .001$.

recent years, several educational methods such as mobile apps, video interventions, email educational materials, electronic education programme with cognitive interview, intensive sun safety training while camping, face-to-face oral and written instruction have been reported, the most effective of which was face-to-face education with periodic reminders.[33–38] In our Department, we tried to further increase the effectiveness by giving a PowerPoint presentation to patients on the topic, which required personal presence. Our decision was based on the fact that, according to our previous survey, only 65.2% of patients responded that they had received information from their doctor about the increased risk of skin tumours before transplantation.[19] To improve this rate, we wanted to involve all patients in a comprehensive knowledge education.

We compared before and after transplantation results with after education survey results. As detailed above, sun protection and prevention activities were positively influenced at several points. In some sun protection habits, such as using sunscreen, sunglasses or seeking shade, there were no significant differences in the after transplantation and post-education

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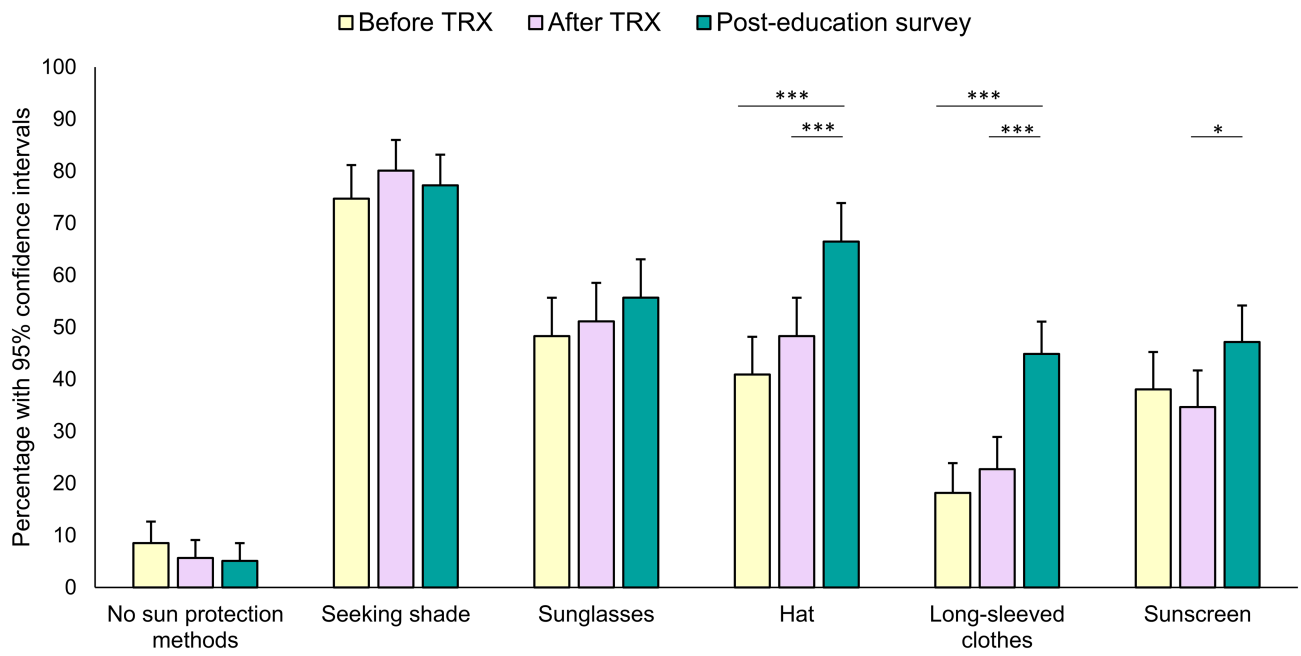

FIGURE 4 Comparison of sun protection methods during post-transplantation survey versus before and after transplantation. Distribution of preferred sun protection methods after transplantation and after education. TRX, transplantation; $^{*}p < .05$; $^{***}p < 0.001$.

results, which suggest that the patients retained the knowledge gained during education and applied them in the everyday practice. Even though, the use of hat and long-sleeved clothes further increased.

Regarding sunbathing habits, there were also factors that did not change as an effect of education like no sun exposure and sun exposure independent of the time of the day on weekends, compared to after transplantation. Moreover, in case of post-education, the frequency of people who sunbathed during the most critical period for UV exposure (11–15 h) was further significantly reduced compared to after transplantation.

Taking these conclusions further, a good way forward might be to make educational presentations to the relevant patient populations a regular feature. Participation in group sessions, which require personal attendance, will also allow to answer questions that patients may have and to explain the main steps to be taken in applying sunscreen. Where appropriate, this can be complemented by additional methods such as written or electronic reminders. The short-term results of patient education are clearly visible in the positive change in habits. The long-term goal, with continued and consistent adherence, would be to reduce the incidence of UV light-induced skin tumours, which could reduce mortality in our patient population. The long-term effectiveness of patient education on the development of tumours could be monitored by prior assessment and regular monitoring of the condition of patients undergoing transplantation in the future.

The study has several limitations. It was a single-centre study. The number of patients who participated in the post-education survey was decreased with 45 patients (34 death, 11 migration). Furthermore, the questionnaire did not contain detailed information about the recreational activities (like hiking, swimming, playing tennis or golf), spring and early autumn recreational (weekend) sun exposure, and preferred UVA protective factor.

However, the strength of our study is the long follow-up period, repeated assessment of sun exposure and sun protection habits with a relatively large number of patients.

5 | SUMMARY STATEMENT

The risk of developing skin tumours in organ transplant patients is several times higher than in the immunocompetent population. Therefore, it is very important to educate patients on proper sun protection methods and sunbathing habits. Educating patients in person with interactive lecture can be a good way to raise their awareness.

AUTHOR CONTRIBUTIONS

Concept and design: VT, EG. Acquisition, analysis or interpretation of data: VT, EAJ, EG. Statistical analysis was performed by a biostatistician: EAJ. Drafting of the manuscript: VT, EAJ, EG, ER. Critical revision of the manuscript: all authors. All the co-authors granted final approval of the version of the article to be published.

CONFLICT OF INTEREST STATEMENT

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Emese Gellén https://orcid.org/0000-0003-4726-4081

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