Comparison of skin cancer awareness and sun protection behaviours between renal transplant recipients and patients with glomerular disease treated with immunosuppressants

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Running head: skin cancer awareness and sun protection behaviours in renal patients

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Abstract:

Background: There is no previous study that compare skin cancer awareness and photoprotective behaviours between renal transplant recipients (RTRs) and patients with glomerular disease (GD).

Objectives/Methods: 61 RTRs and 51 patients with GD were given a self-reported questionnaire to evaluate skin cancer awareness and photoprotective behaviours in this cross-sectional study. The former group received a formal education on skin cancer and the latter an informal session prior to immunosuppressant use.

Results: 93% (n=57) of RTRs and 88% (n=45) of patients with GD responded to the survey. Majority of participants from both groups were aware that ultraviolet radiation could play a role in the occurrence of skin cancers and the awareness increased in participants with higher education (OR=1.50, 95% CI=1.15-1.95, $p=0.003$). 98% versus 71% were aware that immunosuppressants can increase the risk of developing cancer ($p<0.001$) and higher awareness was noted in younger participants (OR=0.92, 95% CI=0.87-0.97, $p=0.003$). Suboptimal photoprotective behaviours (sun avoidance, sunscreen usage, and sun-protective clothing) were noted in both cohorts and slightly lower sun protection rates were reported in RTRs when compared with patients having GD. The level of sun protective measures in RTRs based on high, moderate and minimal use of photoprotective measures were 21%, 46% and 33%, respectively. In terms of patients with GD, the latter practices were 13%, 50% and 37%, respectively ($p=0.560$). Higher educational status was significantly associated with better sunscreen usage in RTRs ($p=0.017$) whereas this finding was not observed in patients with GD.

Conclusion: Patients with GD and RTRs should have formal education on the risks of skin cancers before starting immunosuppressants. Follow-up education and surveillance is required to improve skin protective practices in these patients .

Introduction

Lifestyle factors such as smoking, alcohol, diet, obesity, inadequate physical activity, chronic infection, chronic inflammation, hormone or immunosuppressant use have been linked to a variety of malignancies¹. The Australian Institute of Health and Welfare estimated that 32.9% of the cancer burden in Australia in 2003 was due to 10 modifiable risk factors predominantly linked to life styles¹. Environmental cancer risk factors (sunlight, radiation, pollution, and exposure to chemicals) are potentially modifiable¹. Ultraviolet radiation, a non-ionizing radiation, damages the DNA and causes genetic mutations²⁻³. It is a major carcinogen responsible for skin cancer²⁻³.

Skin cancer is common in the general population as well as among renal transplant recipients⁴⁻¹¹. Amongst patients with kidney diseases, glomerular diseases and renal transplantation are two main renal conditions that require long-term immunosuppressants. The administration of immunosuppressive drugs increases the risk of cancer in patients with glomerular diseases (GD) and renal transplant recipients (RTR)⁶⁻¹². There is limited data to determine skin cancer risk in patients with glomerular disease treated with immunosuppressants^{6,8-10}. Studies suggested the risk of cancer, including skin cancer, was increased in patients with all types of glomerular disease.^{9,30} Risk factors for skin cancers in renal transplant are duration and intensity of immunosuppression, ultraviolet sun exposure, previous history of skin cancer, fair skin complexion or phototype, age at renal transplantation, smoking, male gender, and viral infection with human papillomavirus¹³. Amongst these, a significant modifiable risk factor in skin cancer is the duration and intensity of exposure to ultraviolet radiation²⁵.

Non-melanoma skin cancer (NMSC) is a significant long-term complication of solid organ transplantation, especially in areas of high ultraviolet light exposure¹²⁻¹⁷. Cutaneous squamous cell carcinomas (SCC) and basal cell carcinoma (BCC) occur up to 250 times and

10 times respectively more often in transplant recipients than in the general population¹⁶. In a meta-analysis by geographical locations, the pooled incidence of non-melanoma skin cancer in renal transplant recipients was found to be highest in Australia at 39.1% whereas in Europe was 12.4%¹². The incidence of post-renal transplant non-melanoma skin cancer in Queensland, the second largest state in Australia, is reported to be 52.2% at 10 years and 82% at 20 years post transplantation¹⁷. Excessive sun exposure is likely a major contributing factor for the high incidence of skin cancers in renal transplant patients in Queensland. However, Queensland has an area of 1,852,642 square kilometres and due to its size, climate and ultraviolet exposure in different regions can vary. The characteristics of non-melanoma skin cancer in Central Queensland is not reported separately in previous research in Queensland, Australia. Due to geographical location, the incidence of skin cancer is expected to be higher than reported as patients in Central Queensland are exposed to greater ultraviolet sun exposure than Southeast Queensland and most of other states in Australia. In addition, exposure to ultraviolet radiation depends on patients' awareness of skin cancers and sun-protective behaviours. In North America, Europe and the state of Queensland, Australia, sun protective behaviours in organ transplant recipients were suboptimal^{20,22,24}. To date, skin cancer awareness and photoprotective measures of patients with glomerular disease have not been previously studied.

An American study found organ transplant recipients with a high-level of sun protection knowledge used sunscreen more effectively¹⁸. It was felt that education received with respect to this topic helped reduced the incidence of skin cancer¹⁹. In addition, female organ transplant recipients were more informed about skin cancer and displayed better sun-protective clothing behaviour and use sunscreen more effectively²⁰⁻²³. Overall, organ transplant recipients' photoprotective behaviour was better than that of general population²⁴.

Nevertheless, there is no comparison between organ transplant recipients and patients with GD with regards to skin cancer awareness and photoprotective behaviours.

The aims of this cross-sectional study were to assess (1) the awareness of risks of ultraviolet radiation, and immunosuppressant in skin cancer and (2) sun protective behaviours during outdoor activities among immunocompromised patients with GD and RTRs.

Methodology:

This cross-sectional study was conducted between 1 April 2019 and 31 December 2019. Participants were adult (age ≥ 18 years) RTRs and patients with GD treated with immunosuppressants who resided in Central and Central Western Queensland and were under the care of the Rockhampton Renal Unit. Inclusion criteria for RTRs were first transplant graft recipients who had transplant surgery performed in Australia and post-transplant care in the Rockhampton. The comparative group comprised of adult patients with renal biopsy proven disease such as primary minimal change disease, primary membranous nephropathy, primary focal sclerosing glomerulonephritis (FSGS), anti-neutrophil cytoplasmic antibody (ANCA) positive glomerular nephritis, ANCA negative glomerular nephritis, lupus nephritis, IgA nephropathy or IgG4 related renal disease. Exclusion criteria were patients with dementia, glomerular disease due to infection, paraproteinemia, multiple myeloma, light chain disease, amyloidosis and paraneoplastic glomerulopathy and second or subsequent renal transplantation.

Potential participants were identified through the Renal Unit at Rockhampton Hospital who met the inclusion criteria. Individuals received a pack containing participant information sheet, consent form and return paid envelope. Consent was completed during their clinic visit or as written consent returned by mail. Participants who returned consent via mail then received a phone call from one of the investigators to confirm their participation and help answer any further questions they wished to ask. Potential participants who consented during their clinic visit were given the opportunity to ask one of the investigators any further questions.

Figure 1 details participant recruitment. Among 61 eligible patients with GD attending the nephrology outpatient clinics, 51 patients were included with 10 patients were excluded. Of the 65 eligible RTRs, 61 patients were included with 4 patients excluded. 93% of RTRs (n= 57) and 88 % of patients (n= 45) with GD completed the stipulated

questionnaires (“Skin Health Questionnaire”) with regards to awareness and risk factors of skin cancers. The “Skin Health Questionnaire” was constructed and based on previously published studies that examined sun protection awareness, behaviour and practices in the general population, organ transplant recipients and patients with skin cancer.^{23,28,29}

All renal transplant recipients received a formal education session at the transplant seminar prior to immunosuppressant use concerning risks of skin cancer and prevention. This was facilitated by a nurse coordinator. Patients were provided with a brochure explaining the risk of skin cancer after transplant surgery and the importance of photoprotective measures. In contrast, patients with GD received an informal education without any brochure delivered by the patients’ nephrologists when immunosuppressants were commenced. The “Skin Health Questionnaire” was used to assess participant knowledge of ultra-violet radiation and immunosuppressant risks in relation with risks of skin cancer and respective practices of sun protection. The study was approved by the National Ethics Committee and the local governance authority (LNR/2019/QCQ/50706) in the Central Queensland Hospital and Health Service on 26/03/2018.

Continuous variables were reported as means with standard deviations, medians and interquartile ranges whereas categorical variables were expressed as number (values) and the percentage. Quantitative variables were compared with the use of Student’s t-test, and categorical variables were analysed with two-by-two tables or Fisher’s exact test. Proportions were compared with the use of the chi-square test or correlations. Level of significance was set at a two-tailed p value of ≤ 0.05 . Logistic regression was conducted to identify risk factors that were associated with awareness of ultraviolet radiation and immunosuppressant-related skin cancer for the entire cohort. All analyses were performed using the Statistical Package for Social Sciences (SPSS version 27, IBM, New York, USA).

Results

(A) Demographics

The mean age of RTRs at the time of kidney transplant surgery was 48.0 years (standard deviation, SD = 14.4 years) and patients with GD at the time proven by renal

biopsy was 52.8 years (SD= 17.3 years). The mean age at time of assessment in RTR and GD was 56.0 years (SD= 14.3 years) and 58.2 years (SD= 17.3 years), respectively. 62% (n=38) of RTRs and 51% (n=26) of patients with GD were males. All (61) RTRs and 22 out of 51 patients with GD were maintained on immunosuppressive agents ($p<0.001$). The number and type of current immunosuppressants utilised are summarised in table 1. Median time after skin cancer education in both cohorts was 74.0 months (interquartile range: 44.5-100.5 months) versus 52.5 months (interquartile range: 29.8-81.8 -months), respectively. No statistical differences were noted between other demographics of two cohorts in relation to ethnicity, country of birth, body mass index (BMI), smoking status, education, family history of solid cancers and haematological malignancies, skin cancers prior to the exposure of immunosuppressants, skin photo-type, hair colour and eye colour. Detail demographic data are shown in Table 1.

Among RTRs, the most common cause of end stage renal disease was glomerular nephritis (26 %) followed by adult polycystic kidney disease (18%), diabetic nephropathy (16%), other causes (15%) and unknown cause (15%), hypertensive nephrosclerosis (5%) and reflux nephropathy (5%). Among GD cohort, the most common cause of glomerular disease was ANCA associated vasculitis (25%) followed by membranous nephropathy (14%), minimal change disease (11%), IgA nephropathy (9%), lupus nephritis (8%), primary focal segmental glomerular sclerosis (8%) and others (5%).

(B) Awareness of ultraviolet radiation and immunosuppressant-related skin cancer

16% (n=9) of RTRs and 24% (n=10) of patients with GD did not know that ultraviolet radiation can play a role in the occurrence of skin cancer ($p=0.447$) whereas 2% (n=1) and 30% (n=13), respectively, were not aware that immunosuppressants can increase the risk of developing cancers ($p<0.001$). Awareness of ultraviolet radiation and immunosuppressants related skin cancer in both cohorts are summarized in Table 2. Results of logistic regression models [for the entire cohort](#) are presented in Supplementary Table 1. Participants with higher education were more likely aware of ultraviolet radiation-related skin cancer (odds ratio, OR= 1.50, 95% CI 1.15-1.95, $p=0.003$). Older participants were less likely aware of immunosuppressant-related skin cancer (OR= 0.92, 95% CI 0.87-0.97, $p=0.003$).

(C) Sun protection behaviours

There was no difference between both groups regarding current outdoor activities. 78% (n=45) of RTRs and 57% (n=24) of patients with GD used a hat when they spent time outdoors ($p=0.027$). A larger number of RTRs used sunscreen when compared to patients with GD though this finding was not statistically significant (74% versus 57%, $p=0.209$). Approximately, two thirds of both cohorts wore sunglasses and half wore shirts with long sleeves. Between both cohorts, there was no difference in relation to the less popular sun protective measures such as wearing shirts with long sleeves, staying in the shade, wearing light coloured clothes, avoiding outdoor in period with strong sunlight (between 10 am and 4pm) and using an umbrella. The methods of sun protection used in both groups are summarized in Table 2.

21% (n=13) of RTRs and 29% (n=15) of patients with GD never used topical sun protection agents when they were outdoors. During outdoor activities, one third of participants in both cohorts use sunscreen “sometimes” and 31% (n=19) of RTRs and 12%

(n=6) of patients with GD “often/always” use sunscreen. Sunscreens use by seasons between both groups was not different significantly. RTRs tended to use sunscreens throughout all seasons when compared with patients with GD. Further data of sunscreen use by seasons are shown in Table 2.

The percentage of renal transplant recipients using 6-8 (high level of sun protection), 3-5 (moderate level) and 0-2 (minimal level) protective measures were 21.1% (n=12), 45.6% (n=26) and 33.3% (n=19), respectively whereas the level of sun protective measures taken by patients with GD were 11.8% (n=6), 43.1% (n=22) and 33.3% (n=17), respectively among patients with GD ($p=0.466$).

Sun-protective practices were evaluated against age, gender, skin phototype, smoking, education status and personal history of skin cancers. Male RTRs used hats (91.4% versus 56.5%, $p=0.002$) and shirts with long sleeves (68.6% versus 30.4%, $p=0.004$) more frequently when compared with female RTRs. No male RTRs used an umbrella but 17.4% of female RTRs used it ($p=0.011$). Like RTRs, male patients with GD used hats (78.3% versus 36.4%, $p=0.006$) more often than female patients with GD. The higher the status of education, the greater the rate of use of sunscreens in renal transplant patients ($p=0.017$) but this association was not seen in patients with GD ($p=0.262$). RTRs with a history of SCC, BCC, SCC in situ and melanoma after exposure to immunosuppressants tended to stay in the shade more often than those without it but this finding was not clinically significant (59.1% versus 33.3%, $p=0.063$). RTRs with a history of SCC, BCC, SCC in situ and melanoma after exposure to immunosuppressants wore light-coloured clothes more frequently (36.4% versus 11.1%, $p=0.021$) whereas these findings were not observed in patients with GD. No other significant differences were noted when stratified by other risk factors, see Supplementary Table 2.

Discussion:

This is the first study to compare skin cancer knowledge and photoprotective behaviours between RTRs who received a formal education on skin cancer and patients with GD treated with immunosuppressants, who only received informal education on this topic.

Central and Central West Queenslanders reside in regions with a very high ultraviolet index. Even though these patients living in region of high ultraviolet exposure, 88% of RTRs and 75% of patients with GD knew that ultraviolet radiation can play a role in the occurrence of skin cancer whereas awareness of immunosuppressant related skin cancer risk was 99% and 90% respectively. Participants with higher education and younger ones were more likely aware of skin cancer risks. Many participants were not sun-smart and ignored simple and effective ways to reduce risks of developing skin cancer. Overall, sun-protective behaviours were slightly better in renal transplant recipients who had a formal education on skin cancer knowledge prior to transplant surgery when compared with patients with GD who received an informal education in either inpatient or outpatient setting.

To our knowledge, there are currently no previous studies in the literature that assessed the knowledge of skin cancer and photoprotective behaviours of patients with GD treated with immunosuppressants. Due to the paucity of studies focusing on skin cancer risks in patients with glomerular diseases, we hope that our findings will help fill the gap in the literature. The latter is a contrast to many prior studies on sun protection measures in organ transplant recipients around the world^{20,22,24,26,27}. Previous studies published in Australia did not include regional transplant recipients who overall have lower education attainment and employment opportunity which may affect patients' awareness of skin cancers and sun protection measures.^{14,17,23} A limitation of our study is the relatively small sample size. However, 94% (61 out of 65) of all eligible first-time renal transplant recipients and 84% (51 out of 61) of patients with glomerular disease in the whole Central and Central West regions

of Queensland were included in the study. As 88% of patients with GD and 93% of renal transplant recipients in this study answered survey questionnaires, Central and Central West Queensland data is generalisable and should provide insight into photoprotective behaviours of immunocompromised patients residing in regional areas in Australia.

It was not possible to determine if differences in skin cancer awareness and photoprotective behaviours were mainly dependent on education of skin cancer and protection alone. There were no significant differences in photoprotective practice with age, gender, skin phototype, smoking, educational status and personal history of skin cancers. The educational status played a significant role in safe sun-practices only in the renal transplant cohort and gender significantly influenced photoprotective behaviours in both cohorts. The median time to recruitment since education in renal transplant recipients and patients with GD was 74.0 months and 52.5 months, respectively and neither group received any additional education. Our findings suggest that initial education alone is insufficient in altering behaviour positively in individuals highly susceptible to skin cancers. Hence, follow-up education and assessments to reinforce preventative and protective behaviours as well as awareness of the risks of skin cancer are recommended. This is particularly important in high risk patients with light-skin type (Fitzpatrick type I-II) and a history of chronic ultraviolet radiation exposure, skin cancers and additional intensive immunosuppressant exposure for graft rejection or recurrence of glomerular disease, or both.

Many studies suggested that patient compliance with photoprotective measures would improve if education is emphasized repeatedly at regular intervals after immunosuppressant exposure^{7,15,25}. Frequent assessment on patient compliance of sun protective practices and launching skin cancer awareness campaigns should be periodically implemented in regions with high ultraviolet index. A collaboration under the banner of local medical societies and larger organisations such as the International Transplant Skin Cancer Collaborative and Skin

Care in Organ Transplant Patients is urgently required to improve the awareness and practice of skin protective behaviours in high risk immunocompromised patients thus ensuring such individuals are “SunSmart”. It is anticipated that appropriate primary and secondary risk reduction in this patient group at higher risk of skin cancer will help reduce long-term morbidity and mortality.

Conclusion

This is the first study comparing skin cancer awareness and photoprotective behaviours after formal and informal skin cancer education sessions between patients with two significant renal conditions requiring long-term immunosuppressants. One-off education with regards to skin cancer risk prior to starting immunosuppressants is likely inadequate in altering behaviour and long-term practice. Further studies are required to determine the effect of skin cancer education programs and other methods of improving awareness and photoprotective behaviours in immunosuppressed patients residing in regional areas with high ultraviolet index.

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Figure Legend

Figure 1: Flow chart of the selection of patients. RTRs: renal transplant recipients; GD: glomerular diseases.

Table 1: Demographics of renal transplant recipients and patients with glomerular disease

	Renal transplant (N=61)	Glomerular disease (N=51)	p-value
Age at diagnosis of glomerular disease,years (Mean) (Minimum-Maximum) (SD)	49.0 (20-83) (14.4)	52.8 (14-84) (17.3)	0.071
Current age, years (Mean) (Minimum-Maximum) (SD)	56.0 (25-86) (14.3)	58.2 (20-89) (17.3)	0.248
Sex (N)	Female 23, Male 38	Female 25, Male 26	0.254
Maintenance immunosuppression	Yes (61), No (0)	Yes (22), No (29)	<0.001
Tacrolimus + Mycophenolate sodium/Mycophenolate mofetil +Prednisolone (N)	40	0	
Cyclosporin + Mycophenolate sodium / Mycophenolate mofetil +Prednisolone(N)	4	0	
Tacrolimus + Azathioprine +Prednisolone (N)	3	0	
Sirolimus + Mycophenolate sodium / Mycophenolate mofetil +Prednisolone (N)	3	0	
Tacrolimus + Prednisolone (N)	2	1	
Cyclosporin + Prednisolone (N)	2	1	
Mycophenolate sodium /Mycophenolate mofetil +Prednisolone (N)	0	8	
Azathioprine + Prednisolone (N)	0	4	
Mycophenolate sodium /Mycophenolate mofetil (N)	0	6	
Cyclosporin (N)	1	1	
Azathioprine (N)	0	1	
Others (N)	5	0	
Time since skin cancer education, months (Median) (Interquartile range)	74.0 (44.5-110.5)	52.5 (29.8-81.8)	0.088
Ethnicity (N, %)			0.454
Caucasian	57 (93.4%)	43 (84.3%)	
Aboriginal	2 (3.3%)	3 (5.9%)	
Asian	1 (1.6%)	3 (5.9%)	

Pacific islander	1 (1.6%)	2(3.9%)	
Country of birth (N, %)			0.173
Australia	56 (91.8%)	40 (78.4%)	
Europe	2 (3.3%)	4 (7.8%)	
New Zealand	2 (3.3%)	3 (5.9%)	
Asia	0 (0.0%)	3 (5.9%)	
Pacific islands	1 (1.6%)	2 (2.0%)	
Body Mass Index, BMI (Median/Mean) (Minimum-Maximum) (SD)	30.5/30.6(17.1-63.5) (7.8)	27.9/29.1(18.0-53.8) (7.0)	0.327
Smoking status (N, %)			0.064
Never	33 (55.0%)	21 (41.2%)	
Current smoker	1 (1.7%)	6 (9.2%)	
Ex-smoker	23 (38.3%)	18 (35.3%)	
Unknown	3 (5.0 %)	6 (11.8%)	
Education attained			0.153
Primary (Year 1-6)	1 (1.6%)	3 (5.9%)	
Secondary (Year 7-10)	31 (50.8%)	17 (33.3%)	
Senior Secondary (Year 11-12)	11 (18.0%)	9 (17.6%)	
Vocational education and training (VET)	4 (6.6%)	6 (11.8%)	
Tertiary (University)	11 (18.0%)	7 (13.7%)	
Others	0 (0.0%)	3 (5.9%)	
Not answered	3 (5.0%)	6 (11.8%)	
Time spent in formal academic education years, Mean, (Interquartile range)	11.9 (10.0-14.5)	11.4 (9.5-14.5)	0.531
History of cancer (except skin cancer) in immediate family members (N, %)			0.421
No	27 (44.3%)	17 (33.3%)	
Yes	30 (49.2%)	28 (54.9%)	
Not answered	4 (6.5%)	6 (11.8%)	
Skin cancers prior to exposure of immunosuppressants (N, %)			
Squamous cell carcinoma			1.000
No	57 (93.4%)	48 (94.1%)	
Yes	4 (6.6%)	3 (5.9%)	
Basal cell carcinoma			0.282
No	50 (82.0%)	46 (90.2%)	
Yes	11 (18.0%)	5 (9.8%)	
In-situ squamous cell carcinoma			0.726
No	56 (91.8%)	48 (94.1%)	
Yes	5 (9.2%)	3 (5.9%)	
Melanoma			1.000
No	60 (98.4%)	51 (100%)	
Yes	1 (1.6%)	0 (0.0%)	

Skin type (N, %) I (always burns and never tans) II (always burns easily and tans minimally) III (burns moderately and tans uniformly) IV (burns minimally and always tans well) V (rarely burns and tans profusely) VI (never burns) Not answered	9 (14.8%) 12 (19.7%) 18 (29.5 %) 13 (21.3%) 1 (1.6%) 1 (1.6%) 7 (11.5%)	4 (6.2%) 7 (10.8%) 17(26.2%) 13(20.0%) 1(1.5%) 2 (3.1%) 7 (10.8%)	0.447
Hair colour (N, %) Brown Blonde Black Red Auburn Not answered	27 (44.3%) 15 (24.6%) 6 (9.8%) 6 (9.8%) 4 (6.6%) 3 (4.9%)	24 (36.9%) 13 (20.0%) 6 (9.2%) 1 (1.5%) 1 (1.5%) 5 (7.7%)	0.391
Eye colour (N, %) Blue Brown Green Hazel Not answered	3 (4.9%) 15 (24.6%) 9 (14.8%) 14 (23.0%) 4 (6.6%)	15 (23.1%) 12 (18.5%) 5 (7.7%) 11 (16.9%) 8 (12.3%)	0.950

Table 2: Analysis of skin cancer awareness, current outdoor activities, and sun-protective measures

		Renal transplant recipients			Patients with glomerular disease			
		N	%	95% CI	N	%	95% CI	p-value
Awareness of Ultraviolet radiation and immunosuppressants related skin cancer								
Do you think ultraviolet radiation can play a role in the occurrence of skin cancer?								0.447
	No	9	15.7	15.0-16.9	10	23.8	22.2-25.6	
	Yes	48	84.2	93.0-95.0	32	76.2	74.4-77.8	
Do you know that immunosuppressive medications can increase the risk of developing skin cancers?								<0.001
	No	1	1.8	1.7-1.9	13	29.5	16.7-43.5	
	Yes	56	98.2	98.1-98.3	31	70.5	56.3-83.3	
Current outdoor activity								
Frequency of outdoor activities for work or recreation or exercise under the sun								0.161
	Never	4	7.0	5.2-8.8	3	7.1	4.7-9.8	
	Rarely/Not often	5	8.8	8.3-9.4	1	2.4	2.2-2.6	
	Monthly	0	0		1	2.4	2.2-2.6	
	Fortnightly	8	14.0	13.3-15.1	4	9.5	8.9-10.3	
	Weekly	13	22.8	20.9-25.0	12	28.6	25.7-31.7	
	Daily/Almost daily	27	47.4	44.8-50.9	20	47.6	43.9-51.2	
	Not answered	0	0		1	2.4	2.2-2.6	
Sun protective measures								
Wearing a hat								0.027
	No	12	21.1	12.0-29.2	18	42.9	32.3-54.0	
	Yes	45	79.9	70.8-88.0	24	57.1	46.0-67.7	
Wearing sunglasses								0.681
	No	19	33.3	30.9-35.3	17	40.5	36.6-44.6	
	Yes	38	66.7	64.7-69.1	25	59.5	55.4-63.4	
Using sunscreens								0.209
	No	15	26.3	23.6-28.3	18	42.9	39.0-46.9	
	Yes	42	73.7	71.7-76.4	24	57.1	53.1-61.0	
Wearing shirts with long sleeves								0.554
	No	26	45.6	43.6-47.7	23	54.8	51.1-58.7	
	Yes	31	54.4	52.3-56.4	19	45.2	41.3-48.9	
Staying in the shade								0.687
	No	32	56.1	52.8-58.3	26	61.9	59.0-64.4	
	Yes	25	43.9	41.7-47.2	16	38.1	35.6-41.0	
Wearing light coloured clothes								0.812
	No	45	78.9	77.4-80.0	33	78.6	76.9-80.0	
	Yes	12	21.1	20.0-22.6	9	21.4	20.0-23.1	
Avoiding outdoor between 10am and 4pm								0.348
	No	41	71.9	69.8-73.3	34	81.0	79.5-82.2	
	Yes	16	28.1	26.7-30.2	8	19.0	17.8-20.5	
Using an umbrella								1.000
	No	53	93.0	92.5-93.3	39	92.9	92.3-93.3	
	Yes	4	7.0	6.7-7.5	3	7.1	6.7-7.7	
Sunscreens use by seasons								
Seasons								0.174
	Never	13	21.3	13.9-29.7	15	29.4	19.0-39.4	
	Summer	13	21.3	13.2-28.1	13	25.5	16.3-34.9	
	Autumn	0			0			
	Winter	0			0			
	Spring	0			0			
	Summer plus Spring or Autumn	4	6.6	3.2-9.5	2	3.9	0.0-8.1	

All seasons except Winter	4	6.6	1.8-10.0	2	3.9	0.0-7.5	
All seasons	23	37.7	28.5-45.3	10	19.6	10.8-30.3	
Not answered	4	6.6	0.0-13.2	9	17.6	10.2-25.6	

Supplementary table 1: Logistic regression analysis on awareness of skin cancer among renal transplant recipients and patients with glomerular disease

Awareness of ultraviolet radiation-related skin cancer			
Variable	Estimated odds ratio	95% CI for odds ratio	p-value
Years of formal education	1.50	1.15-1.95	0.003
Awareness of immunosuppressant-related skin cancer			
Variable	Estimated odds ratio	95% CI for odds ratio	p- value
Age	0.92	0.87-0.97	0.003

Supplementary table 2: Subgroup analysis of sun-protective behaviours

Renal transplant recipients								
	Avoiding outdoor between 10am-4pm	Staying in the shade	Wearing a hat	Using an umbrella	Wearing shirts with long sleeves	Wearing light coloured clothes	Wearing sunglasses	Using sun protection cream
Age								
• ≤60 years	6 (19.4%)	11 (35.5%)	23 (74.2%)	1 (3.2%)	16 (51.6%)	6 (19.4%)	22 (71.0%)	23 (74.2%)
• >60 years	10 (37.0%)	14 (51.9%)	22 (81.5%)	3 (11.1%)	15 (55.6%)	6 (22.2%)	16 (59.3%)	19 (70.4%)
p-value	0.153	0.289	0.546	0.329	0.797	1.000	0.413	0.776
Gender								
• Male	8 (22.9%)	13 (37.1%)	32 (91.4%)	0 (0.0%)	24 (68.6%)	5 (14.3%)	25 (71.4%)	27 (77.1%)
• Female	8 (34.8%)	12 (52.2%)	13 (56.5%)	4 (17.4%)	7 (30.4%)	7 (30.4%)	13 (56.5%)	15 (65.2%)
p-value	0.376	0.290	0.003	0.021	0.007	0.189	0.271	0.376
Skin phototypes								
• I-II	5 (23.8%)	2 (42.9%)	16 (76.2%)	0 (0.0%)	12 (57.1%)	3 (14.3%)	14 (66.7%)	15 (71.4%)
• III	5 (27.8%)	9 (33.3%)	15 (83.3%)	2 (11.1%)	10 (55.6%)	2 (11.1%)	15 (83.3%)	12 (66.7%)
• IV-V	5 (35.7%)	6 (57.1%)	12 (85.7%)	1 (7.1%)	7 (50.0%)	7 (50.0%)	8 (57.1%)	13 (92.9%)
p-value	0.860	0.605	0.175	0.335	0.902	0.017	0.056	0.118
Smoking								
• Never	11 (33.3%)	16 (48.5%)	24 (72.7%)	3 (9.1%)	17 (51.5%)	9 (27.3%)	24 (72.7%)	22 (66.7%)
• Current smoker	1 (100.0%)	1 (100.0%)	1 (100.0%)	0 (0.0%)	1 (100.0%)	0 (0.00%)	0 (0.0%)	1 (100%)
• Ex-smoker	4 (17.4%)	8 (34.8%)	19 (82.6%)	1 (4.3%)	12 (52.2%)	3 (13.3%)	13 (56.5%)	18 (78.3%)
p-value	0.116	0.311	0.591	0.762	0.632	0.382	0.179	0.522
Education								
• Primary	0 (0.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
• Secondary	8 (25.8%)	15 (48.4%)	22 (71.0%)	2 (6.5%)	14 (45.2%)	3 (9.7%)	19 (61.3%)	18 (58.1%)
• Senior secondary	2 (18.2%)	2 (18.2%)	9 (81.8%)	1 (9.1%)	6 (54.5%)	3 (27.3%)	7 (63.7%)	9 (81.8%)
• Vocational education and training	1 (25.0%)	2 (50.0%)	3 (75.0%)	1 (25.0%)	3 (75.0%)	1 (25.0%)	4 (100.0%)	4 (100.0%)
• Tertiary	5 (45.5%)	6 (54.5%)	10 (90.9%)	0 (0.0%)	7 (63.6%)	5 (45.5%)	8 (72.7%)	11 (100.0%)
p-value	0.586	0.335	0.677	0.554	0.568	0.136	0.340	0.017
History of SCC/BCC/SCC-in situ/Melanoma prior to immunosuppressant use								
• No	13 (27.7%)	21 (44.7%)	37 (78.7%)	4 (8.5%)	25 (53.2%)	11 (23.4%)	32 (68.1%)	35 (74.5%)
• Yes	3 (27.3%)	4 (36.4%)	8 (72.7%)	0 (0.0%)	6 (54.5%)	1 (9.1%)	6 (54.5%)	7 (63.4%)
p-value	1.000	0.742	0.696	1.000	1.000	0.429	0.487	0.475
History of skin cancer after exposure to immunosuppressant use								
• No	6 (27.3%)	13 (59.1%)	16 (72.7%)	3 (13.6%)	10 (45.5%)	8 (36.4%)	14 (63.6%)	18 (81.8%)
• Yes	10 (27.8%)	12 (33.3%)	29 (80.6%)	1 (2.89)	21 (58.3%)	4 (11.1%)	24 (66.7%)	24 (66.7%)
p-value	1.000	0.063	0.529	0.148	0.420	0.042	1.000	0.243
Patients with glomerular disease								
	Avoiding outdoor between 10am-4pm	Staying in the shade	Wearing a hat	Using an umbrella	Wearing shirts with long sleeves	Wearing light coloured clothes	Wearing sunglasses	Using sun protection cream
Age								
• ≤60 years	5 (25.0%)	9 (45.0%)	10 (50.0%)	1 (5.0%)	12 (60.0%)	4 (20.0%)	13 (65.0%)	12 (60.0%)
• >60 years	3 (12.0%)	8 (32.0%)	16 (64.0%)	2 (8.0%)	9 (36.0%)	7 (28.0%)	14 (56.0%)	15 (60.0%)
p-value	0.435	0.537	0.379	1.000	0.140	0.729	0.760	1.000
Gender								
• Male	2 (8.7%)	7 (30.4%)	18 (78.3%)	1 (4.3%)	14 (60.9%)	8 (34.8%)	15 (65.2%)	15 (65.2%)
• Female	6 (27.3%)	10 (45.5%)	8 (36.4%)	2 (9.1%)	7 (31.8%)	3 (13.6%)	12 (54.5%)	12 (54.5%)
p-value	0.135	0.365	0.007	0.608	0.075	0.165	0.550	0.550
Skin phototypes								
• I-II	1 (10.0%)	5 (50.0%)	6 (60%)	1 (10.0%)	6 (60.0%)	4 (40.0%)	7 (70.0%)	9 (90.0%)
• III	4 (23.5%)	7 (41.2%)	11 (64.7%)	2 (11.8%)	7 (41.2%)	5 (29.4%)	12 (70.6%)	11 (64.7%)
• IV-V	3 (21.4%)	5 (35.7%)	9 (64.3%)	0 (0.0%)	6 (42.9%)	2 (14.3%)	7 (50.0%)	6 (42.9%)
p-value	0.617	0.366	0.108	0.537	0.796	0.306	0.280	0.054
Smoking								
• Never	3 (14.3%)	7 (33.3%)	10 (47.6%)	1 (4.8%)	9 (42.9%)	5 (23.8%)	10 (47.6%)	13 (61.9%)
• Current smoker	1 (16.7%)	1 (16.7%)	4 (66.7%)	0 (0.0%)	3 (50.0%)	2 (33.3%)	3 (50.0%)	3 (50.0%)
• Ex-smoker	4 (22.2%)	9 (50.0%)	12 (66.7%)	2 (11.1%)	9 (50.0%)	4 (22.2%)	14 (77.8%)	11 (61.1%)
p-value	0.809	0.293	0.435	0.571	0.892	0.857	0.138	0.865
Education								
• Primary	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
• Secondary	1 (5.9%)	6 (35.3%)	9 (52.9%)	1 (5.9%)	8 (47.1%)	7 (41.2%)	8 (47.1%)	12 (70.6%)
• Senior secondary	3 (33.3%)	2 (22.2%)	6 (66.7%)	0 (0.0%)	5 (55.6%)	2 (11.1%)	6 (66.7%)	6 (66.7%)
	1 (16.7%)	3 (50.0%)	3 (50.0%)	0 (0.0%)	2 (33.3%)	0 (0.0%)	6 (100.0%)	4 (66.7%)

<ul style="list-style-type: none"> • Vocational education and training • Tertiary 	2 (28.6%) 0.435	5 (71.4%) 0.255	6 (85.7%) 0.217	1 (14.3%) 0.371	5 (71.4%) 0.383	2 (28.6%) 0.256	5 (71.4%) 0.067	4 (57.1%) 0.262
History of SCC/BCC/SCC-in situ/Melanoma prior to immunosuppressant use <ul style="list-style-type: none"> • No • Yes 	7 (18.4%) 1 (14.3%) 1.000	14 (36.8%) 3 (42.9%) 1.000	21 (55.3%) 5 (71.4%) 0.681	3 (7.9%) 0 (0.0%) 1.000	19 (50.0%) 2 (28.6%) 0.422	9 (23.7%) 2 (28.6%) 1.000	24 (63.2%) 3 (42.9%) 0.412	23 (60.5%) 4 (57.1%) 1.000
History of skin cancer after exposure to immunosuppressant use <ul style="list-style-type: none"> • No • Yes 	8(21.1%) 0 (0.0%) 0.321	14 (36.8%) 3 (42.9%) 1.000	21 (55.3%) 5 (71.4%) 0.681	3 (7.9%) 0 (0.0%) 1.000	19 (50.0%) 2 (28.6%) 0.422	11 (28.9%) 0 (0.0%) 0.168	22 (57.9%) 5 (71.4%) 0.684	21 (55.3%) 6 (85.7%) 0.215