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### Sun exposure among teenage and young adult cancer survivors in the United Kingdom

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1 **Sun exposure among teenage and young adult cancer**  
2 **survivors in the United Kingdom**

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22

TYACS	Teenage and young adult cancer survivors
TYA	Teenagers and young adults
COG	Childrens Oncology Group
GP-TYAs	general population controls

23

1 **Abstract**

2 Skin cancers are a common form of second malignant neoplasm among teenage and  
3 young adult cancer survivors (TYACS). The Children's Oncology Group specify that  
4 TYACS should adhere to safe sun practices and be screened for skin cancer annually.  
5 Cross-sectional self-report data collected by our group indicate over a third of TYACS  
6 (n=229; mean age: 19.8yrs) intentionally sunbathe, with many reporting sunburn.  
7 TYACS sunbathing, sunburn and sunbed use are similar to the the general population  
8 (p>0.05). These data suggest TYACS require intervention to limit sun exposure and  
9 improve their sun safety habits.

## 1 **Introduction**

2 In the UK the cancer survival rate among teenagers and young adults (TYA) exceeds  
3 80% [1]. However, TYA cancer survivors (TYACS) are at risk of developing second  
4 primary skin cancer [2-4]. Immunosuppression and treatment with high dose  
5 radiotherapy have been identified as specific risk factors for developing a later skin  
6 cancer [4-6]. Data from the Childhood Cancer Survivor Study indicates among those  
7 diagnosed with second primary non-melanoma skin cancer 46% had multiple  
8 occurrences and 38% reported returning to hospital more than twice to have the  
9 carcinoma treated or surgically removed [7].

10

11 Due to the high incidence and burden of secondary skin cancer among TYACS, the  
12 Children's Oncology Group (COG) specify that TYACS should adhere to safe sun  
13 practices (i.e. wearing sunscreen and protective clothing), avoid UV exposure  
14 (sunbathing, tanning and sunbed use) and be screened for skin cancer annually [8,  
15 9]. These guidelines are based on evidence that skin damage induced from excessive  
16 sun exposure is linked to the development of skin cancer and that early diagnosis of  
17 skin cancer can lead to smaller tumors, potentially less intensive treatment, and better  
18 outcomes [10]. However data on TYACS' sun exposure in the UK is non-existent.  
19 Therefore the aim of this study was to explore the incidence of, and factors associated  
20 with, sunbathing, sunburn and indoor tanning among TYACS and general population  
21 controls (GP-TYAs) in the UK. This information is crucial for developing interventions  
22 aimed at improving sun protection and skin screening among TYACS.

## 23 **Methods**

24 TYACS and GP-TYAs, aged between 13 and 24 years, were invited to complete a  
25 Health and Lifestyle Questionnaire which contained three survey items assessing  
26 incidence of sun-bathing and sunburn last summer and the use of indoor sunbeds  
27 over the past year. TYACS both on (i.e. receiving active cancer treatment) and off  
28 treatment were eligible to participate and were recruited online via CLIC Sargent or  
29 through outpatient clinics at University College London Hospital. GP-TYAs were  
30 recruited in two waves through online channels, schools and UCL participation  
31 networks. These items were taken from a sun health behaviour instrument previously  
32 used to assess sun-related behaviours in Scottish adolescents [11]. The full contents  
33 of the health and lifestyle questionnaire has been published elsewhere [12].

34 Descriptive statistics were produced to determine the proportion of TYACS and GP-  
35 TYAs in each group reporting intentional tanning, sunburn or sunbed use and the

1 proportion meeting current COG sun safety lifestyle guidelines on UV exposure.  
2 Statistical comparisons between each group were made using chi-square tests and  
3 logistic regression analysis for categorical variables and ANOVAs for continuous  
4 variables. Multivariable models were adjusted for age and gender. Only data from  
5 Wave 1 of GP-TYA recruitment was available for analysis.

## 6 **Results**

7 From the original sample (n= 295 TYACS; n= 370 Wave 1 GP-TYAs) complete data  
8 on sun exposure was available from 229 TYACS (n=76 on treatment; n=149 off  
9 treatment) and 311 GP-TYAs. Participant characteristics and sun-exposure  
10 behaviours are reported in Table 1. Over a third of TYACS (35.5%, n=27 on treatment;  
11 45.6%, n=68 off treatment) and GP-TYAs (49.8%, n=155) reported intentionally  
12 tanning with approximately 40% reporting sunburn (pinkness/redness from being in  
13 the sun) in the past year (42.1%, n=32 on treatment; 41.6%, n=62 off treatment) and  
14 47.6% (n=148) of GP-TYAs. Very few young people within any group used sunbeds  
15 (6.6%, 6% and 8.4% respectively). As shown in Table 2, less than a third of  
16 participants were meeting COG sun safety guidelines on UV exposure. After adjusting  
17 for age and gender there were no significant differences ( $p>0.05$ ) in the behaviours  
18 of young people on cancer treatment, off cancer treatment, and in the general  
19 population.

## 20 **Discussion**

21 This study demonstrates TYACS in the United Kingdom have a similar sun-exposure  
22 behaviours to GP-TYAs in that they often sunbathe and burn in the sun.  
23 Encouragingly (given that it is illegal for under 18's to use indoor tanning booths in the  
24 UK) very few young reported using indoor sunbeds.

25 These findings reflect studies of childhood cancer survivors in the United States which  
26 indicate high levels of sun exposure is common [13, 14]. For example, data from  
27 project REACH indicate 60% of TYACS (n=153, mean age: 26 years, time since  
28 diagnosis: 14 years) report more than 8 hours of sun exposure per week with very  
29 little or no use of protection [14]. Deliberate tanning and sunburn among TYACS and  
30 GP-TYAs is concerning given existing data which indicate that neither group are  
31 particularly adherent to sun protection [14, 15]. There are data which indicate that  
32 young people counteract skin protection behaviours by purposely sun-bathing and  
33 that TYACS treated with radiotherapy (despite acknowledging their increased risk of  
34 skin cancer) do not perceive UV exposure as a risk factor for skin cancer [13]. These  
35 data signify psycho-educational interventions which highlight TYACS increased risk

1 of skin cancer and the importance of sun-protection habits are warranted. A  
2 randomised controlled trial group-based educational day intervention which included  
3 risk counselling demonstrated a positive effect on sun safe practices among 75  
4 adolescent survivors of childhood cancer [16]. Whether health messages aimed at  
5 increasing TYACS awareness of secondary skin cancer and perceived benefit of skin  
6 protection could be feasibly incorporated into routine survivorship care, for example  
7 long-term follow up clinics appointments, remains to be explored.

8 However whilst increasing TYACS knowledge of the risks of sun exposure is a  
9 necessary intentional tanning among GP-TYAs is driven by a number of physical,  
10 attitudinal and environmental factors [11, 17, 18]. Interventions targeting sun  
11 exposure among TYACS should incorporate principles of behavioural science and  
12 consider existing interventions conducted in the general population which have shown  
13 promise. For example appearance based interventions [19], mass-media campaigns  
14 [20], community-based interventions [21], and policy changes [22]. Such interventions  
15 tailored to TYACS should be formally tested and be accompanied by robust outcome  
16 measures in order to effectively determine the impact upon behaviour and health.

17

18 This study has a number of limitations; i) Data gathered was self-reported and  
19 therefore subject to recall bias and inaccuracies due to under and over reporting, ii)  
20 TYACS and GP-TYA groups differed significantly therefore limiting the validity of  
21 comparisons and iii) the external validity of the results should also be interpreted with  
22 caution. As participation was voluntary selective bias is present as it is highly likely  
23 that TYACS who participated in this study are engaged in leading a healthy lifestyle.  
24 Furthermore, only data on sun-exposure was gathered. Future studies should aim to  
25 gather both objective and self-report data on the sun-protection habits (sunscreen  
26 use, wearing protective clothing, wearing a hat, wearing sunglasses, and shade-  
27 seeking), tanning attitude and skin cancer awareness of TYACS. Thought must also  
28 be given to when sun protection interventions should be initiated among TYACS. The  
29 finding that TYACS receiving cancer therapy still report sunbathing and sunburn  
30 suggests interventions introduced early during treatment may be beneficial.

31

32 The results of this study demonstrate there is a need to intervene in limiting sun  
33 exposure among TYACS. A recent review of National Institute of Health grant funding  
34 indicate that intervention research which targets dermatologically clinically relevant  
35 outcomes (primarily sunburn and tanning) across all points of the cancer continuum

1 from prevention to survivorship is required [23]. Our data demonstrates need for such  
2 intervention research among TYACS within the UK.

3

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11

##### 12 **Conflicts of Interests**

13 The authors declare that there are no competing interests.

14

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**Table 1. Demographic characteristics and sun health behaviours**

	TYA Cancer Survivors On Treatment	TYA Cancer Survivors Off Treatment	General Population TYAs	Difference
	n=76 % (n)	n=149 % (n)	n=311 % (n)	
<b>Age (Mean±SD)</b>	19±3.02	20.0±2.85	17 ± 3.18	2.70±0.26 <sup>a</sup> p<0.001
<b>Gender</b>				
Females	57.9 (44)	62.4 (93)	78.1 (243)	
Males	42.1 (32)	37.6 (56)	21.9 (68)	
<b>Cancer Diagnosis</b>				
Lymphoma	23.7 (18)	36.2 (54)	-	
Leukaemia	34.2 (26)	23.5 (35)	-	
Bone tumour	6.6 (5)	12.1 (18)	-	
Soft tissue sarcoma	17.1 (13)	5.4 (8)	-	
CNS tumour	11.8 (9)	6.7 (10)	-	
Germ cell tumour	0 (0)	4.7 (7)	-	
Carcinoma	3.9 (3)	4.7 (7)	-	
Melanoma	1.3 (1)	0.7 (1)	-	
Other	3.9 (3)	8.1 (12)	-	
<b>Age at diagnosis (Mean±SD)</b>	<b>17.44±3.21</b>	<b>16.47±4.1</b>		0.97±0.57 p= 0.09
0-12 years	5.3 (4)	12.7 (19)	-	
13-18 years	44.7 (34)	53.0 (79)	-	
19-24 years	38.2 (29)	28.8 (43)	-	
Missing data	11.8 (9)	5.4 (8)	-	
<b>Treatment<sup>b</sup></b>				
Surgery	56.1 (32)	54.6 (59)	-	
Radiotherapy	50.9 (28)	46.2 (48)	-	
Chemotherapy	94.4 (67)	97.1 (134)	-	
Hormone therapy	5 (2)	5.9 (5)	-	
Active surveillance	2.6 (1)	8.2 (7)	-	
Other	7.8 (6)	14.0 (21)	-	
<b>Time Since Treatment<sup>c</sup></b>				
<3 months from finishing treatment	-	14.8 (22)	-	
4-11 months since finishing treatment	-	18.8 (28)	-	
1-5 years since finishing treatment	-	47.0 (70)	-	
>5 years since finishing treatment	-	4 (6)	-	
On active surveillance	-	11.4 (17)	-	
I don't know	-	0.7 (1)	-	
Missing data	-	3.4 (5)	-	
<b>Sun Health Behaviours</b>				
Sun-bathed regularly last summer to get a tan	35.5 (27)	45.6 (68)	49.8 (155)	p=0.68
Suffered sun-burn or erythema (pinkness/redness from being in the sun)				
<i>Yes, only on one occasion</i>	28.9 (22)	29.5 (44)	34.4 (107)	p=0.788
<i>Yes, on more than one occasion</i>	13.2 (10)	12.1 (18)	13.2 (41)	
Used a sun-bed in the past 12 months	6.6 (5)	6 (9)	8.4 (26)	p=0.63

<sup>a</sup>Comparison between TYACS and GP-TYACS. Mean difference in age between TYACS-OT and TYACS-OFT was 1.03±0.41 years (p=0.12).

<sup>b</sup>Where percentages do not equal 100% this was due to participants selecting all that applied

<sup>c</sup>Data from those off treatment only (n=149)

<sup>d</sup>Chi-Square Test Output

**Table 2. Adjusted and unadjusted odds ratios for the association between treatment status and health behaviour**

	Proportion meeting current COG guidelines on sun exposure* % (n)	Un-Adjusted		Adjusted	
		Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)
<b>Sun Safety (n=536)</b>					
GP-TYAs	19.9 (62)	1		1	
OFT—TYA	27.5 (41)	0.65 (0.41, 1.03)	1	0.76 (0.45, 1.29)	1
OT-TYA	34.2 (26)	0.47 (0.27, 0.83)	0.94 (0.51,1.74)	0.56 (0.31, 1.04)	1.03 (0.55,1.93)

*TYA, teenager and young adult; GP-TYAs, general population TYAs.; OFT-TYAs, off-treatment TYAs, OT-TYAs on treatment TYAs. Odds-ratios adjusted for age and gender, all regressions  $p < 0.005$ . \*Not meeting current COG guidelines on sun exposure was classified as reporting one or more of sunbathing, sun-burn or indoor sun-bed use. Sunbathing refers to sunbathing regularly last summer to get a tan (i.e. intentionally staying out in the sun with the desire for skin to go browner or more golden in colour), sun-burn refers to skin going red or pink due to being in the sun.*