

Appendix S1.**SUPPLEMENTARY MATERIAL***Statistical analysis*

The characteristics of participants and frequencies were stratified by age group and compared using Fisher's exact test (STable I). After testing the variables from the questionnaire and skin cancer screening for significance, a logistic regression model was used. KC was determined to be the dependent variable and years of gliding (0–10, 11–20, 21–30, 31–40, ≥ 41 years) and age group (18–44, 45–54, 55–64, ≥ 65 years) as the independent variables. To avoid potential confounding effects of selected variables, several logistic regression models were implemented adding one variable stepwise, while observing changes in the estimates for the exposure variable. These analyses were performed with KC as the outcome variable and with years of gliding, age group, skin type (I–VI), and SPF on flight days (0, 6–10, 15–25, 30, 50/50+) as explanatory variables (STable II). Adjusting the analysis for gliding days per year in combination with gliding years, variable smoking ("yes" included regular and occasional smokers, "no" included former smokers and non-smokers), or previous sunburn in childhood or within the last few years did not affect the outcome. Associations were expressed as odds ratios (ORs) with 95% confidence intervals (95% CI). The relationships between different potential risk factors and the prevalence of actinic keratosis, basal cell carcinoma, and squamous cell carcinoma were estimated with a contingency Table (STable III). Observations with missing data were excluded. Statistical analyses were performed using SAS version 9.2 software (TS1M0).

SUPPLEMENTARY RESULTS

The overall prevalence of KC in glider pilots in this study was 49% (40/82). Stratification by age showed that KC was more prevalent in older age groups. KC was also more prevalent among those with sunburn during childhood (STable I). The rate of smokers was nearly identical among the 4 age groups (STable I) and was not associated with KC. Headgear (usually a small hat) was worn by 99% (81/82) of the pilots. Almost half of the glider pilots (48%) said that they generally use sunscreen on sunny days. According to their answers to the questionnaire, only 54% (44/81) of pilots had previously undergone a medical skin check by a dermatologist and 78% (64/82) mentioned regular self-examination. Furthermore, 74% (56/76) of the participants stated to be interested in further information about skin cancer and sun protection in general, especially as they relate to gliding.

Outcome data

In order to evaluate variables that may confound the association between years of gliding and KC, the baseline characteristics of the study population were stratified by age (STable II). The prevalence of KC was higher in the groups with increased gliding experience: 30.4% of the pilots gliding for <10 years, 42.8% for 10–20

years, 46.1% for 21–30 years, 54.5% for 31–40 years, and 70.6% for >40 years were diagnosed with KC. KC rates also increased with age: 8.6% of pilots aged 18–44 years, 47.8% of pilots aged 45–54 years, 70% of pilots aged 55–64 years, and 81.2% of pilots aged 65 and over were diagnosed with KC. Interestingly, the darker type IV skin was the most affected (24 of 37 pilots with KC), whereas the fairer-skinned pilots had a lower prevalence of KC (25% of pilots with skin type I and 38.2% of pilots with skin type III). Due to the small number of pilots with skin type V ($n=3$), a comparison is not reasonable. No participant had skin type I. The prevalence of KC did not decrease with higher SPF use on gliding days (STable II).

Logistic regression

The results of the logistic regression analysis are shown in STable II. The raw data without adjusting for potential confounders showed an association of KC with the number of years gliding, age, skin type, and sunscreen used on gliding days. To control for confounding, 2 logistic regression models were performed in which 1 variable at a time was added while observing changes in the risk estimates for the exposure variable. No significant differences ($p=0.95$) were found between the groups stratified by gliding years in the full model. Nevertheless, the ORs in STable II quantify an association between KC and UV radiation exposure in the population of glider pilots. The estimates for 11–20, 21–30, and 31–40 years of experience were higher and, for more than 40 years' experience, lower than that of the 0–10 years group. A significant progression ($p=0.01$) was identified between age and KC; the prevalence of KC was higher among pilots aged 45–54 years (OR 8.49; 95% CI 1.23–58.70), 45–54 years (OR 28.30; 95% CI 3.11–257.35), and >65 years (OR 60.76; 95% CI 4.30–858.57). The skin type with the highest prevalence was skin type IV (OR 3.08; 95% CI 0.28–3.40). The OR (0.62; 95% CI 0.018–21.45) for skin type V predicts a protective impact on KC (STable II), but only 3 participants had this skin type, as noted above.

The association between the 3 categories of clinical KC and its precursors (actinic keratosis, basal cell carcinoma, and squamous cell carcinoma) and flight years, age, and skin type was investigated (STable II). A Fisher's exact test revealed the prevalence of the 3 subtypes of KC to be 41%, 4%, and 4% and suggested that KC is associated with years of gliding. Though actinic keratosis and squamous cell carcinoma were found in younger pilots as well as older pilots, basal cell carcinoma occurred only in glider pilots older than 55 years of age ($p<0.001$). Notably, 2 pilots had skin lesions highly suspicious of malignant melanoma and were referred to a dermatology department for excision but not followed-up for this study.

STable 1. Age-specific characteristics of participants with suspected keratinocyte carcinoma and without keratinocyte carcinoma. Data were from a population-based health examination including a skin cancer screening and questionnaire among 82 male glider pilots aged 18–83 years from a cross-sectional study performed in Bavaria, Germany in 2015

Skin type ^c	Keratinocyte carcinoma ^{a,c}				No keratinocyte carcinoma ^{a,b,c}				
	18–44 years n/total	45–54 years p-value ^b n/total	55–64 years p-value ^b n/total	≥65 years p-value ^b n/total	18–44 years n/total	45–54 years p-value ^b n/total	55–64 years p-value ^b n/total	≥65 years p-value ^b n/total	p-value ^b All
0	0	0.087 (2/23)	0.3248	0	0.3901	0	0.3248	0.063 (1/16)	0.0786
1	0.087 (2/23)	0.13 (3/23)	0.3248	0.25 (5/20)	0.3901	0.13 (3/23)	0.3248	0.10 (2/20)	0.0786
2	0	0.26 (6/23)	0.3248	0.45 (9/20)	0.3901	0.26 (6/23)	0.3248	0.15 (3/20)	0.0786
3	0	0	0.3248	0	0.3901	0	0.3248	0	0.0786
4	0	0	0.3248	0	0.3901	0	0.3248	0	0.0786
5	0	0	0.3248	0	0.3901	0	0.3248	0	0.0786
Smoker									
Yes	0	0.044 (1/23)	1.0	0.050 (1/20)	1.0	0.067 (1/15)	1.0	0	1.0
No	0.087 (2/23)	0.43 (10/23)	1.0	0.65 (13/20)	1.0	0.73 (11/15)	1.0	0.30 (6/20)	1.0
Years of gliding									
0–10	0	0.6403 (0.87)	2(2/23)	1.0	0.6012 (0.60)	0.13 (2/16)	0.7054 (0.85)	0	0.7054
11–20	0	0.6403 (0.44)	1(1/23)	1.0	0.6012 (0.60)	0	0.7054 (0.37)	0	0.7054
21–30	0	0.6403 (0.13)	3(2/23)	1.0	0.6012 (0.60)	0.063 (1/16)	0.7054 (0.63)	0	0.7054
31–40	0	0.6403 (0.22)	5(2/23)	1.0	0.6012 (0.60)	0.063 (1/16)	0.7054 (0.63)	0	0.7054
≥41	0	0.6403 (0)	1.0	0.15 (3/20)	0.6012 (0.60)	0.56 (9/16)	0.7054 (0.63)	0	0.7054
Gliding days per year									
10–40	0	0.6623 (1.14)	3(2/22)	0.3248	0.55 (11/20)	0.4577 (0.44)	0.7054 (0.71)	0.13 (2/16)	0.2071
41–70	0	0.6623 (1.14)	3(2/22)	0.3248	0.55 (11/20)	0.4577 (0.44)	0.7054 (0.71)	0.13 (2/16)	0.2071
≥71	0	0.6623 (0.23)	5(2/22)	0.3248	0.10 (2/20)	0.4577 (0.63)	0.7054 (1/16)	0.063 (1/16)	0.2071
Sunburns									
Childhood									
Yes	0.087 (2/23)	0.0593 (0.044)	1(1/23)	1.0	0.30 (6/20)	0.6285 (0.38)	0.616 (6/16)	0	0.13 (11/82)
No	0	0.0593 (0.43)	10(2/23)	1.0	0.40 (8/20)	0.6285 (0.44)	0.716 (7/16)	0	0.38 (31/82)
Recent years									
Yes	0	0.044 (1/23)	1.0	0.6668 (0.21)	1.0	0.063 (1/16)	1.0	0	1.0
No	0.044 (1/23)	0.30 (7/23)	0.6668	0.47 (9/19)	1.0	0.75 (12/16)	1.0	0.19 (3/16)	1.0
Activity worst sunburn									
Bathing/aquatics	0.091 (2/22)	1.0	0.37 (7/19)	0.3123 (0.57)	0.814 (0.74)	0.2747 (0.57)	0.814 (0.74)	0.071 (1/19)	0.2747
Gliding	0	0.044 (1/23)	1.0	0	0.3123 (0)	0	0.2747 (0.013)	0	0.039 (3/78)
Other	0	0.044 (1/23)	1.0	0	0.3123 (0)	0	0.2747 (0.013)	0	0.039 (3/78)
Outdoor activity	0	0.044 (1/23)	1.0	0.21 (4/19)	0.3123 (0.14)	0.2747 (0.21)	0.3123 (0.14)	0	0.039 (3/78)
Outdoor job	0	0.044 (1/23)	1.0	0.11 (2/19)	0.3123 (0.071)	0.2747 (0.11)	0.3123 (0.071)	0	0.039 (3/78)
Sunbathing	0	0.044 (1/23)	1.0	0	0.3123 (0)	0	0.2747 (0.013)	0	0.039 (3/78)
Sunscreen gliding days									
None	0	0.6206 (0.087)	2(2/23)	0.3932 (0.050)	0.2193 (0.44)	0.716 (7/16)	0.0321 (0.12)	0	0.0321
SPF 6–10	0	0.6206 (0)	0	0.3932 (0.050)	0.2193 (0)	0	0.0321 (0.012)	0	0.0321
SPF 15–25	0.044 (1/23)	0.6206 (0.13)	3(2/23)	0.3932 (0.20)	0.2193 (0.25)	0.416 (4/16)	0.0321 (0.032)	0	0.0321
SPF 30	0	0.6206 (0.087)	2(2/23)	0.3932 (0.20)	0.2193 (0.063)	0.116 (1/16)	0.0321 (0.032)	0	0.0321
SPF 50/50+	0.044 (1/23)	0.6206 (0.17)	4(2/23)	0.3932 (0.20)	0.2193 (0.063)	0.116 (1/16)	0.0321 (0.032)	0	0.0321
Sunscreen usual days									
None	0	0.7866 (0.087)	2(2/23)	0.0331 (0.25)	0.0173 (0.50)	0.816 (8/16)	0.1589 (0.17)	0	0.1589
SPF 6–10	0	0.7866 (0)	0	0.0331 (0.050)	0.0173 (0.063)	0.116 (1/16)	0.1589 (0.024)	0	0.1589
SPF 15–25	0	0.7866 (0.13)	3(2/23)	0.0331 (0.20)	0.0173 (0.19)	0.316 (3/16)	0.1589 (0.12)	0	0.1589
SPF 30	0	0.7866 (0.13)	3(2/23)	0.0331 (0.10)	0.0173 (0)	0	0.1589 (0.073)	0	0.1589
SPF 50/50+	0	0.7866 (0.13)	3(2/23)	0.0331 (0.10)	0.0173 (0.063)	0.116 (1/16)	0.1589 (0.063)	0	0.1589
Hours outside per day									
0–2	0	0.1225 (0.046)	1(1/22)	0.8129 (0.20)	0.4801 (0.40)	0	0.6143 (0.62)	0	0.6143
2–4	0.087 (2/23)	0.1225 (0.23)	5(2/22)	0.8129 (0.15)	0.4801 (0.25)	0.416 (4/16)	0.6143 (0.61)	0	0.6143
4–6	0	0.1225 (0.046)	1(1/22)	0.8129 (0.15)	0.4801 (0.063)	0.116 (1/16)	0.6143 (0.61)	0	0.6143
6+	0	0.1225 (0.14)	3(2/22)	0.8129 (0.20)	0.4801 (0.50)	0.816 (8/16)	0.6143 (0.61)	0	0.6143

^aNon-melanoma skin cancer includes, in this table, the suspicion of actinic keratosis, basal cell carcinoma and squamous cell carcinoma. ^bp-value of Fisher's exact test for the comparison of the different age groups. ^cVariables determined by the investigator; the other variables are self-reported in the questionnaire by the glider pilots.

Stable II. Relationship of different potential risk factors with the prevalence of keratinocyte carcinoma (KC)

	KC ^a (n of total)	Odds ratio (OR) (95% CI)	Adjusted OR ^b (95% CI)	Adjusted OR ^c (95% CI)
Years of gliding				
0-10	0.085 (7 of 82)	1.00, <i>p</i> =0.95	1.00, <i>p</i> =0.90	1.00, <i>p</i> =0.82
11-20	0.037 (3 of 82)	1.14 (0.10-12.71)	1.30 (0.13-12.75)	1.20 (0.13-11.40)
21-30	0.073 (6 of 82)	1.68 (0.24-11.88)	1.64 (0.25-10.71)	1.36 (0.22-8.37)
31-40	0.15 (12 of 82)	1.40 (0.22-9.13)	0.99 (0.18-5.61)	0.69 (0.14-3.51)
≥41	0.15 (12 of 82)	0.72 (0.066-7.71)	0.52 (0.059-4.64)	0.38 (0.047-3.04)
Age				
18-44 years	0.024 (2 of 82)	1.00, <i>p</i> =0.01	1.00, <i>p</i> =0.009	1.00, <i>p</i> =0.002
45-54 years	0.13 (11 of 82)	8.49 (1.23-58.70)	9.09 (1.36-60.80)	11.48 (1.92-68.78)
55-64 years	0.17 (14 of 82)	28.30 (3.11-257.35)	27.53 (3.19-237.78)	40.88 (5.35-312.18)
≥65 years	0.16 (13 of 82)	60.76 (4.30-858.57)	79.89 (5.84-999.99)	104.63 (8.81-999.99)
Skin type ^a				
2	0.024 (2 of 82)	1.00, <i>p</i> =0.61	1.00, <i>p</i> =0.63	-
3	0.16 (13 of 82)	1.72 (0.17-16.97)	1.92 (0.24-15.57)	-
4	0.29 (24 of 82)	3.08 (0.28-3.40)	2.90 (0.35-23.75)	-
5	0.012 (1 of 82)	0.62 (0.018-21.45)	0.73 (0.029-18.69)	-
Sunscreen on gliding days				
None	0.12 (10 of 82)	1.00, <i>p</i> =0.50	-	-
SPF 6-10	0.012 (1 of 82)	0.19 (0.010-3.64)	-	-
SPF 15-25	0.15 (12 of 82)	1.63 (0.27-9.75)	-	-
SPF 30	0.085 (7 of 82)	0.57 (0.097-3.33)	-	-
SPF 50/50+	0.12 (10 of 82)	1.42 (0.25-8.03)	-	-

^aVariables determined by the investigator, the others are self-reported in the questionnaire by the glider pilots. ^bLogistic regression analysis adjusted for gliding years, age and skin type. ^cLogistic regression analysis adjusted for gliding years and age.

OR: odds ratio; CI: confidence intervals; SPF: sun protection factor.

Stable III. Relationship between different potential risk factors and the prevalence of actinic keratosis (AK), basal cell carcinoma (BCC) and squamous cell carcinoma (SCC)

	AK ^a n/total	BCC ^a n/total	SCC ^a n/total	<i>p</i> -value
Age				
18-44 years	0.012 (1/82)	0	0.012 (1/82)	<0.001
45-54 years	0.13 (11/82)	0	0	<0.001
55-64 years	0.13 (11/82)	0.012 (1/82)	0.024 (2/82)	<0.001
≥65 years	0.13 (11/82)	0.024 (2/82)	0	<0.001
Skin type ^a				
2	0.024 (2/82)	0	0	0.2213
3	0.13 (11/82)	0	0.024 (2/82)	0.2213
4	0.24 (20/82)	0.036 (3/82)	0.012 (1/82)	0.2213
5	0.012 (1/82)	0	0	0.2213
Years of gliding				
0-10	0.073 (6/82)	0	0.012 (1/82)	0.2116
11-20	0.037 (3/82)	0	0	0.2116
21-30	0.073 (6/82)	0	0	0.2116
31-40	0.13 (11/82)	0	0.012 (1/82)	0.2116
≥41	0.098 (8/82)	0.036 (3/82)	0.012 (1/82)	0.2116
All	0.41 (34/82)	0.036 (3/82)	0.036 (3/82)	

^aVariables determined by the investigator during the full-body skin check, the others were self-reported in the questionnaire by the glider pilots.