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Basal cell carcinoma and anthropometric factors in the U.S. Radiologic Technologists Cohort Study

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Abstract

Basal cell carcinoma (BCC) is the most common cancer in Caucasian populations. Although several risk factors are well-established, including ultraviolet radiation (UVR) sensitivity and exposure, few studies have examined anthropometric measures and BCC. Using Cox proportional hazards regression analysis, we prospectively investigated the relationship between height, weight, and body mass index (BMI) and BCC in 58,213 Caucasian participants (11,631 men and 46,582 women) from the United States Radiological Technologists cohort. This analysis was limited to participants who were cancer-free at baseline. The baseline questionnaire provided self-reported anthropometric factors and the subsequent questionnaire collected skin cancer susceptibility factors, lifetime UVR exposure derived from residential and personal UVR exposure (time outdoors), and health outcomes. During 509,465 person-years of follow-up, we identified 2,291 BCC cases (486 men; 1,805 women). BCC risk increased with increasing height, and decreased with increasing weight and BMI in both sexes, even after adjusting for UVR susceptibility factors and exposures. For BMI categories: <25 (reference); 25–<30; 30–<35; and ≥35 kg/m², multivariate hazard ratios (HR) in women were: 1.00; 0.74 (95% CI=0.66–0.83); 0.67 (0.56–0.81); and 0.57 (0.44–0.74) respectively, p-trend = 0.0001. Risks were similar in men. The inverse association between BMI and BCC was unaffected by controlling for sun-related exposures. Nevertheless, it may at least partly reflect residual UVR confounding. Further research with more detailed sun exposure data, including clothing patterns, would help clarify the relationship between BMI and BCC.

Keywords

Basal cell carcinoma; weight; height; body mass index

Introduction

Basal cell carcinoma (BCC) is the most common type of skin cancer and the most common malignancy in Caucasian populations. (1–2) Factors associated with BCC risk include ultraviolet radiation (UVR) exposure, sun sensitivity traits such as fair skin, eye and hair pigmentation, and poor tanning/sun-burning susceptibility, as well as family history of BCC, immune suppression, and ionizing radiation exposure. (1–2).

Studies examining the relationship between BCC and anthropometric factors (3–10), such as height, weight, and body mass index (BMI) have yielded mixed results. Of these, several have found inverse BCC associations with weight and/or BMI. (4, 6, 8–10). Many of the

anthropometric studies, however, have been small(3, 5, 9), have excluded women (6), and/or have had limited information on potentially confounding sun sensitivity and exposure. (5, 9). To further assess these associations, we prospectively examined BCC risk with height, weight, and BMI in the large, nationwide United States Radiological Technologists (USRT) cohort for which collected lifetime sun sensitivity and sun exposure information is available.

Materials and Methods

The USRT cohort study is a collaborative effort between the U.S. National Cancer Institute, the University of Minnesota, and the American Registry of Radiologic Technologists (ARRT) and comprises a nationwide cohort of radiological technologists who resided in any of the U.S. states or territories and were certified by the ARRT for at least 2 years between 1926 and 1982. Detailed information on the cohort and methods were published previously. (11–12).

Briefly, an initial mailed questionnaire (1983–1989) obtained information on demographic, lifestyle, reproductive, occupational, cancer history, and other factors. This was followed by a second self-administered questionnaire (1994–1998), which serves as the baseline for the present study, and which updated collected data and other factors, as well as ascertained new cancers. The response rate for this questionnaire was 72% (90,972 of 126,628). A third questionnaire (2003–2005) collected updated cancer outcomes and obtained additional information on BCC risk factors, particularly sun sensitivity traits, such as skin, hair, and eye pigmentation as well as UVR exposure history and response. Of 90,972 respondents to the second questionnaire, 67,264 (74%) responded to the third questionnaire.

Study Population

We restricted this investigation to Caucasian participants (self-identified) who were cancer-free as of the second questionnaire (baseline for this study) and responded to both the second and third questionnaires through December 2005 ($n = 58,213$). The study was limited to Caucasians because of the small number of BCCs in other racial groups. Eligible cases were limited to participants diagnosed with a primary BCC occurring between the two questionnaires. During the follow-up period, 1994 through 2005, there were no deaths attributed to BCC as the underlying cause, based on linkage with the National Death Index.

Pathology reports and other medical record information were used to validate the self-reported BCCs. Among the 2,258 subjects reporting a BCC, medical records were obtained for 666 (29%) and validated for 638 (96%). We excluded 28 cases (4%) that were incorrectly reported as BCC. An additional 61 cases of medically confirmed BCC (identified while reviewing medical records mostly for misreported skin cancers), were included in the analysis. Because of the high proportion of self-reported BCCs confirmed by medical records, we included potentially eligible cases for whom medical records could not be obtained, for a total of 2,291 BCC cases.

Cohort Maintenance

Follow-up was conducted through annual re-certification with the ARRT and linkage with national mortality databases, as described previously.(13). The Institutional Review Boards of the National Cancer Institute and the University of Minnesota approve this study annually.

Data Collection

Information on race, age, weight, height, physical activity, smoking, and alcohol use, were obtained from responses to the second (our baseline) questionnaire. BMI calculations used

weight and height measurements from the baseline questionnaire, with BMI as weight/height² ((kg)/m²). Cumulative occupational ionizing radiation doses were estimated by a team of radiation dosimetrists based on self-reported work history, occupational badge doses, and medical radiation literature. (14). Doses to the head and neck were used because of the high proportion of BCCs that occur on these anatomic locations (15) and because these areas are unprotected by lead aprons worn by radiologic technologists.

Information obtained from the third questionnaire covered several key sun sensitivity and exposure factors, including hair color; eye color; skin complexion; skin reaction to “acute” sun exposure (defined as 30 minutes of strong sunlight in summer with no sunscreen); skin reaction to “chronic” sun exposure (defined as repeated and prolonged exposure to sunlight); and number of lifetime blistering sunburns. It was also used to obtain geographic or ambient UVR for five age categories (<13 years; 13–19 years; 20–39 years; 40–64 years; and 65 years), as well as time spent outdoors (personal UVR exposure) during the five age periods.

Information on socioeconomic status (SES) was derived from the first and third questionnaires. The first questionnaire provided responses on the respondents’ education and the third, on household income (in \$25,000 increments).

For each age period, ambient noontime UVR (categorized in quintiles) was estimated by linking the city, state, and country in which the participant lived for the longest time to the Total Ozone Mapping Spectrometer (TOMS) database (Version 8). (16). TOMS, which is maintained by NASA, provides a daily noontime estimate of UVR (erythemal) for a given location, in a 1.25° by 1° (longitude by latitude) grid. To provide stable estimates, average annual UVR were used for the period 1978–1993.

We categorized personal summertime UVR exposure during the five age periods based on self-reported total time spent outdoors (0, <1, 1–2, 3–4, 5–6 hours/day) during mid-day (9am–3pm) on weekdays and also on weekends. We categorized the weekly totals into five groups: 3.5, >3.5–7.0, >7.0–14.0, >14.0–28.0 and >28.0 hours/week. Although a long latency period for BCC suggests that exposures during youth may pose the greatest BCC risk, (1), we modeled self-reported UVR exposure information for all age periods that preceded or included age at cancer diagnosis (cases) or end of follow-up (non-cases).

We also examined the association between BMI and melanoma to assess the specificity of the findings. Melanoma is a skin cancer that is also positively related to UVR exposure. (17).

Statistical Methods

We used Cox proportional hazards regression analyses to compute relative risks with 95% confidence intervals, using age as the time-scale (18), beginning at the baseline and stratifying at baseline for birth cohort in five-year intervals to control for secular trends. Participants were followed from the baseline until completion of the third questionnaire or the diagnosis of a first cancer, whichever occurred first.

Multivariate models included: age, hair, eye, and skin color, ambient sun exposure (TOMS) from five age periods, weekly hours outdoors in summer during five age periods, number of lifetime sunburns, acute and chronic reactions to sunlight, history of blistering sunburns, tobacco and alcohol use, physical activity, and cumulative occupational ionizing radiation dose (head and neck). Multivariate models for height and weight were adjusted for each other.

Missing information was analyzed with separate dummy variables. Tests for trend for weight (kg), height (cm), and BMI (kg/m²) were assessed by assigning a median value to each category and modeling the resulting variable as continuous. Monotonic trends across categorical variables were tested by using an ordinal scale. All tests of statistical significance were two-sided and $p < 0.05$ was considered statistically significant. The statistical analyses were conducted using the PHREG procedure of the Statistical Analysis System (SAS) software package (version 9.13, SAS Institute, Inc, Cary, NC).

Results

This study population of Caucasian cancer-free USRT participants included 46,582 (80%) women and 11,631 (20%) men. Table I shows the distribution by four BMI categories and gender for mean age; ambient and personal sun exposure; hair, eye, and skin color; acute and chronic reactions to the sun; number of lifetime blistering sunburns; cigarette smoking status; alcohol consumption, and physical activity. Average ambient UVR exposure in men fell slightly with increasing adult BMI (at baseline) for each age period, but the pattern was less consistent in women. For men, average summer time hours spent outdoors in childhood, adolescence and young adulthood generally rose with increasing adult BMI (at baseline). The same pattern was observed in women for childhood time spent outdoors. Time spent outdoors at later ages generally decreased with increasing adult BMI for men and women. BMI was higher both in men and in women with greater propensity to sunburn, more lifetime sunburns, lower weekly alcohol consumption, and lower physical activity.

During 509,465 person-years of follow-up (8.75 mean follow-up years), 2,291 BCC cases were identified. In both men and women, we found a statistically significant increased risk for BCC with light pigmentation traits (hair, eye, and skin color), tendency to sunburn with acute sun exposure, poor tanning with chronic sun exposure, and number of lifetime blistering sunburns (Table 2). BCC risk increased significantly with increasing ambient UVR exposures in all age periods under age 65 years for both men and women. Risk also increased significantly with increasing personal UVR exposure (summer time outdoors) in adolescence and young adulthood (and nearly so for childhood) in women. Although there was no significant trend for BCC risk related to summer time outdoors in men, substantially higher BCC risks were observed in the highest categories of childhood and adolescent exposure.

Table 3 shows the univariate (adjusted for age) and multivariate associations for BCC with anthropometric factors. In both men and women, BCC risk increased with increased height, even after controlling for weight and sun-related and other factors. In contrast, in both men and women, increased weight was inversely associated with BCC risk, even after adjusting for height and other factors. There was also a significantly decreased risk of BCC with increasing BMI in both men and women, after adjusting for the various potentially confounding factors. In contrast, there was no association between BMI and melanoma risk for men or women (data not shown).

Discussion

Our study of anthropometric factors and BCC risk found an elevated risk associated with increasing height in men and in women; a significantly decreased risk related to increased weight in both genders; and a significantly reduced risk associated with higher BMI in both men and women, even after adjusting for potentially confounding factors related to UVR susceptibility and exposure and other factors.

Increasing height has been associated with elevated risk for several cancer sites. (19–20). It was also seen as positively, but non-significantly, related to BCC risks in at least two studies (5, 9), but not in others. (3–4, 7). Proposed biological hypotheses for a positive relationship with cancer have suggested that larger numbers of cells (associated with greater height) increase the chances that some cells may become malignant and that early life hormonal influences, for example insulin-like growth factor-1 (IGF-1), may affect both height and carcinogenesis. (19). Elevated levels of IGF-1 or lower IGF-binding protein 3 have been related to higher risk at a number of cancer sites. (21). It has been hypothesized that IGFs may influence cancer risk by protecting damaged cells from apoptosis, by stimulating cell turnover, and by heightening the deleterious effects of some agents on DNA. (20).

Higher BMI has also been related to several cancer sites. (22). In contrast, a few observational studies have found inverse associations between weight or BMI and BCC (6, 8–10) or, in one study, between BMI and truncal BCC. (4). Two studies (4, 6) adjusted for sun exposure without notable effects on the inverse associations with BMI. Similarly, in the USRT study, the multivariate analyses reflected similar inverse associations compared to the univariate results (Table 3). The study by van Dam et al. (6), which also adjusted for UVR exposure, suggested that the inverse association with BMI might nonetheless reflect residual sun exposure. Skepticism about the “validity” of the inverse association is understandable given how difficult it is to assess UVR exposure by survey and the positive associations between BMI and other cancers. Nonetheless, the fact that the sun sensitivity and exposures variables followed the expected BCC risk gradient together with the similarity in our study between the univariate and multivariate analyses (that incorporated sun-related factors) argues against strong confounding by the specific sun-related factors in these analyses.

We cannot, however, address possible confounding by factors that were not surveyed, such as the type of clothing typically worn outdoors, which might add relevant information beyond reported hours spent outdoors. The degree to which clothing covers the body may be related to both BMI and the actual skin exposure to UVR.

The relationship between BMI and other skin cancers such as melanoma is also relevant to evaluating the validity of the inverse BCC finding. Several studies suggest that the relationship between BMI and melanoma is not inverse (10, 22–23), even though UVR is also a known risk factor for melanoma. (17). For example, in their meta-analysis of 221 datasets, Renehan et al. (22) reported a significant positive association between melanoma and BMI in men, but no association in women. An abstract on BMI and skin cancer from the Nurses’ Health Study found no association for melanoma, but an inverse association observed for BCC. (10). An earlier study of melanoma and BMI in the USRT cohort also found no association between melanoma and BMI in either gender (23), as in the present study. Thus, the specificity of the inverse risks for BCC with BMI further supports the possibility that the inverse relationship is not entirely an artifact of unmeasured UVR exposure.

Although differential sun exposure may contribute to the inverse associations observed, it is possible that biologic factors may play a role. For example, adipose tissue (associated with higher BMI) is related to higher estrogen levels in women and possibly in men. (24). That gender differences in skin cancer have been observed in both epidemiologic and animal studies suggest that sex hormones may influence skin carcinogenesis. (25). Epidemiological studies have reported higher rates of non-melanoma skin cancer in men than women. (2). Experimental studies found that exposing male and female mice to equal doses of ultraviolet radiation B (UVB) led to larger, earlier, and more numerous skin tumors in males. (25). Another set of animal studies found that ovarian hormone withdrawal substantially increased

non-melanoma skin carcinogenesis initiated by physical and chemical agents. (26). Thus, there may be merit in exploring possible obesity/estrogen/BCC risk connections.

Strengths of the current study include its prospective collection of anthropometric data; the range of covariate information incorporated in the analytic models, including sun susceptibility and UVR exposure history; the cohort's nationwide character, with residences from Florida to Alaska; and the high validation rate of a sample of self-reported BCCs, an accuracy level likely reflecting the participants' medical experience.

Potential limitations of this study include reliance on retrospective reporting of time spent outdoors, residential history, and some sensitivity factors. Nonetheless, we note that reports of past locations, time outdoors, and sun sensitivity characteristics reflect the generally expected relationships with BCC. We also acknowledge, however, that the absence of information on clothing patterns could affect the estimate of UVR exposure. That the study excluded deaths between the two questionnaires also raises the possibility of survival bias.

Our finding that BMI is inversely associated with BCC risk, after controlling for sensitivity and exposure history, is intriguing. It confirms the observations in a few other studies. Additional research with more detailed sun exposure data, including outdoor clothing patterns, would be helpful to clarify the relationship between BMI and BCC.

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Abbreviations used

BCC	basal cell carcinoma
UVR	ultraviolet radiation
HR	hazard ratios
USRT	United States Radiological Technologists
ARRT	American Registry of Radiologic Technologists
SES	socioeconomic status
TOMS	Total Ozone Mapping Spectrometer

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Impact

Although several risk factors for basal cell carcinoma are well-established, including ultraviolet radiation (UVR) sensitivity and exposure, few studies have examined anthropometric measures and BCC. The study provides additional support for an inverse relationship between BMI and BCC. two brief statements describing the novelty and impact of the paper

Table 1

Baseline characteristics of Caucasian participants in the United States Radiologic Technologists Study (USRT) cohort by body mass index (BMI) categories at baseline.¹

	Men (n = 11631)					Women (n = 46582)				
	<25	25–29.9	30–34.9	35+	<25	25–29.9	30–34.9	35+	<25	25–29.9
BMI (kg/m ²)										
Age at baseline (mean, years)	49.4	49.6	49.8	48.7	46.2	48.3	47.9	47.5		
Average annual ambient UV (TOMS) ²										
ages <13 yrs	118.7	118.4	117.8	116.9	113.3	112.8	113.8	114.2		
ages 13–19 yrs	119.9	118.9	118.8	116.8	113.9	113.4	114.2	114.9		
ages 20–39 yrs	124.9	124.9	124.2	122.7	120.1	118.8	118.8	118.8		
ages 40–64 yrs	126.6	125.6	124.9	124.5	121.7	120.1	119.5	120.5		
ages >65 yrs	130.2	129.4	125.6	125.3	125.9	123.4	123.2	123.0		
Average personal summer sun exposure (h/week)										
ages <13 yrs	25.9	27.1	27.5	27.8	22.6	22.9	23.3	23.6		
ages 13–19 yrs	24.8	25.9	26.1	26.3	20.1	20.1	20.4	20.1		
ages 20–39 yrs	16.0	16.8	17.0	17.5	13.5	13.3	13.3	12.4		
ages 40–64 yrs	14.1	14.7	14.6	13.7	11.2	10.9	10.7	9.6		
ages >65 yrs	15.9	15.6	16.1	13.1	10.5	10.3	10.0	7.8		
Blonde or red hair color ³ (%)	15.3	13.7	15.5	12.2	19.9	18.5	18.3	17.3		
Blue/gray/green/hazel natural eye color ⁴ (%)	67.6	67.8	65.8	65.6	69.5	70.0	68.1	72.3		
Light natural skin color ⁵ (%)	32.3	31.0	31.9	34.9	45.2	46.5	49.4	52.6		
Propensity to severe sunburn ⁶ (%)	30.8	32.2	36.7	38.7	37.7	43.1	49.1	54.8		
Poor tanning ability ⁷ (%)	59.4	58.8	59.1	59.0	63.7	66.2	67.9	68.1		
10+ lifetime blistering sunburns (%)	12.3	13.6	13.3	16.6	13.5	14.6	16.3	18.5		
Ever smokers (%)	53.3	55.4	56.6	54.0	42.8	43.7	39.7	40.1		
5 alcoholic drinks per day (%)	27.9	26.3	22.7	14.0	16.3	11.8	7.6	4.8		
Moderate physical activity ⁸ (%)	17.6	18.0	14.2	11.9	21.6	18.9	15.0	9.5		
Education, 1 yrs college (%)										

¹ Restricted to respondents to baseline and follow-up survey who were cancer-free at baseline.

- ²TOMS is a proxy measure for mean annual UVR exposure derived using the estimated annual solar ultraviolet radiation assigned to each location in which the subject reported residency for the longest time in that age period.
- ³Natural hair color at age 20 defined as the following seven categories: blonde, red, reddish-brown, light brown, medium brown, dark brown, and black.
- ⁴Eye color defined as the following five categories: blue, green/blue or green/grey, hazel, light brown, and dark brown.
- ⁵Skin color defined as the following three categories: light, medium, and dark.
- ⁶Propensity for severe sunburn defined as severe sunburn with blisters or painful sunburn but no blisters after exposure to strong sunlight for 30 minutes in summer without protective sunscreen; other categories were: mild sunburn followed by some suntan, tan without any sunburn, and no change in skin color.
- ⁷Poor tanning ability defined as no tan at all and light tan after repeated and prolonged exposure to sunlight; other categories were very brown and deeply tanned, and moderately tanned.
- ⁸Defined as walking or hiking for exercise 4 hours per week.

Table 2

Univariate hazard ratios (HRs) of Basal Cell Carcinoma with 95% confidence interval (CI) by category of ambient UV, personal time outdoors, and sun sensitivity characteristics in men and women¹

	Men (n=486)		Women (n=1805)	
	HR	CI	HR	CI
Annual TOMS,² age <13				
1	1.00		1.00	
2	1.04	0.77–1.42	1.09	0.94–1.26
3	1.03	0.78–1.36	1.11	0.96–1.28
4	1.04	0.77–1.39	1.41	1.22–1.63
5	1.58	1.20–2.08	1.45	1.23–1.70
<i>p for trend</i>	0.004		<.0001	
Annual TOMS,² ages 13–19				
1	1.00		1.00	
2	1.07	0.78–1.45	1.10	0.94–1.27
3	0.99	0.75–1.32	1.14	0.98–1.31
4	1.03	0.77–1.38	1.40	1.21–1.62
5	1.55	1.18–2.04	1.48	1.26–1.73
<i>p for trend</i>	0.006		<.0001	
Annual TOMS,² ages 20–39				
1	1.00		1.00	
2	1.00	0.71–1.41	1.02	0.87–1.20
3	0.83	0.61–1.14	1.00	0.86–1.17
4	1.14	0.85–1.52	1.31	1.13–1.51
5	1.40	1.07–1.83	1.46	1.26–1.69
<i>p for trend</i>	0.004		<.0001	
Annual TOMS,² ages 40–64				
1	1.00		1.00	
2	1.05	0.74–1.49	1.09	0.92–1.29
3	0.88	0.63–1.22	1.10	0.93–1.29
4	1.15	0.86–1.54	1.41	1.21–1.64
5	1.55	1.18–2.03	1.58	1.37–1.83
<i>p for trend</i>	0.0004		<.0001	
Annual TOMS,² ages 65				
1	1.00		1.00	
2	1.15	0.57–2.32	1.67	1.07–2.60
3	0.53	0.23–1.23	1.40	0.91–2.17
4	1.41	0.78–2.53	1.60	1.07–2.39
5	1.22	0.69–2.15	1.35	0.90–2.02
<i>p for trend</i>	0.24		0.23	
Summer sun exposure, hrs/wk, ages <13				

	Men (n=486)		Women (n=1805)	
	HR	CI	HR	CI
3.5	1.00		1.00	
>3.5–7.0	1.50	0.52–4.32	1.06	0.76–1.46
>7.0–14.0	2.29	0.98–5.36	1.29	1.01–1.65
>14.0–28.0	2.10	0.93–4.75	1.35	1.08–1.70
>28.0	2.05	0.91–4.63	1.27	1.01–1.60
<i>p for trend</i>	0.28		0.06	
Summer sun exposure hrs/wk, ages 13–19				
3.5	1.00		1.00	
>3.5–7.0	2.80	0.77–10.19	1.12	0.83–1.52
>7.0–14.0	4.86	1.53–15.50	1.36	1.06–1.74
>14.0–28.0	3.77	1.20–11.84	1.32	1.04–1.68
>28.0	3.91	1.25–12.22	1.34	1.05–1.71
<i>P for trend</i>	0.24		0.03	
Summer sun exposure hrs/wk, ages 20–39				
3.5	1.00		1.00	
>3.5–7.0	0.83	0.53–1.29	1.20	1.00–1.44
>7.0–14.0	0.84	0.57–1.25	1.15	0.97–1.36
>14.0–28.0	0.91	0.63–1.33	1.26	1.07–1.48
>28.0	0.93	0.62–1.39	1.24	1.01–1.52
<i>p for trend</i>	0.76		0.02	
Summer sun exposure hrs/wk, ages 40–64				
3.5	1.00		1.00	
>3.5–7.0	1.04	0.72–1.50	1.05	0.90–1.22
>7.0–14.0	1.11	0.80–1.54	1.07	0.93–1.22
>14.0–28.0	0.97	0.70–1.34	0.97	0.84–1.12
>28.0	1.01	0.69–1.48	1.39	1.15–1.67
<i>p for trend</i>	0.73		0.12	
Summer sun exposure hrs/wk, ages 65				
3.5	1.00		1.00	
>3.5–7.0	1.00	0.44–2.24	0.76	0.45–1.28
>7.0–14.0	1.21	0.71–2.06	0.95	0.70–1.28
>14.0–28.0	0.46	0.24–0.89	0.69	0.47–1.02
>28.0	1.04	0.57–1.92	1.07	0.64–1.79
<i>p for trend</i>	0.44		0.42	
Hair Color				
Medium-dark brown or black	1.00		1.00	
Light brown	1.37	1.08–1.72	1.13	1.00–1.28
Reddish brown	1.53	0.96–2.43	1.47	1.23–1.75
Red	1.52	0.89–2.60	1.99	1.59–2.49
Blond	1.54	1.20–1.98	1.51	1.34–1.70

	Men (n=486)		Women (n=1805)	
	HR	CI	HR	CI
Eye Color				
Dark brown	1.00		1.00	
Light brown	0.92	0.57–1.46	1.26	1.00–1.58
Hazel	1.28	0.92–1.78	1.34	1.13–1.59
Green/blue or green/grey	1.45	1.05–2.02	1.26	1.08–1.48
Blue	1.86	1.42–2.42	1.70	1.47–1.97
Skin Color				
Medium/dark	1.00		1.00	
Light	2.12	1.75–2.57	1.67	1.51–1.84
Skin Reaction to First Sunburn				
None	1.00		1.00	
Mild sunburn	1.56	1.12–2.17	1.43	1.20–1.71
Severe/painful	2.93	2.10–4.08	2.09	1.75–2.50
Skin Reaction to Repeated Sun				
Deepest tan	1.00		1.00	
Moderate tan	1.33	1.08–1.65	1.28	1.13–1.45
Light/no tan	2.18	1.69–2.81	1.78	1.56–2.04
Blistering Sunburns				
None	1.00		1.00	
< 10	1.62	1.39–1.99	1.45	1.30–1.62
10	2.43	1.90–3.11	2.16	1.87–2.45

¹ Hazard ratios are derived from Cox proportional hazards regression analysis. P-trends were based on assigning an ordinal value to each category and modeling the variables as continuous.

² Ambient geographical exposure, with categories based on quintiles.

Table 3

Hazard ratios (HRs) of Basal Cell Carcinoma with 95% confidence interval (CI) by quintile and category of anthropometric factors.¹

Anthropometric Factors	No. of cases	Men			Women		
		Univariate		No. of cases	Univariate		Multivariate
		HR	95% CI		HR	95% CI	
Height²							
1 (lowest)	72	1.00		297	1.00		1.00
2	106	1.11	0.82–1.50	510	1.25	1.08–1.44	1.28
3	80	1.18	0.86–1.63	256	1.31	1.11–1.55	1.38
4	135	1.31	0.98–1.74	278	1.42	1.20–1.67	1.56
5 (highest)	88	1.31	0.96–1.80	445	1.48	1.28–1.72	1.66
<i>p for trend</i>		0.04			<0.0001		<0.0001
Weight³							
1 (lowest)	96	1.00		327	1.00		1.00
2	95	0.94	0.71–1.25	424	1.00	0.87–1.16	0.90
3	108	0.98	0.75–1.30	329	1.03	0.89–1.20	0.88
4	105	1.09	0.83–1.44	384	0.93	0.80–1.08	0.77
5 (highest)	81	0.78	0.58–1.05	317	0.71	0.61–0.83	0.56
<i>p for trend</i>		0.32			<0.0001		<0.0001
BMI (kg/m²)							
<25	163	1.00		1163	1.00		1.00
25–<30	242	0.88	0.72–1.07	401	0.73	0.65–0.82	0.73
30–<35	58	0.66	0.49–0.89	141	0.67	0.56–0.80	0.66
35+	17	0.67	0.41–1.10	63	0.61	0.47–0.78	0.55
<i>p for trend</i>		0.005			<0.0001		<0.0001

¹ Hazard ratios are derived from Cox proportional hazards regression analysis. Multivariate HRs were adjusted for age, hair, eye, and skin color, geographic measure of sun exposure (TOMS) from five age periods, hours outdoors in summer in five age periods, number of lifetime blistering sunburns, acute and chronic reactions to sunlight, tobacco and alcohol use, physical activity and cumulative occupational ionizing radiation dose from head/neck. Anthropometric factors are based on baseline reports. Case numbers do not add to totals due to missing data. P-trends were based on assigning an ordinal value to each category and modeling the variable as continuous.

² The multivariate analyses were additionally adjusted for weight. For height, the quintiles for men were: <68, 68–69, 70, 71–72, and 73 inches, and for women: <63, 63–64, 65, 66, and 67 inches.

³The multivariate analyses were additionally adjusted for height. For weight, the quintiles for men were: <165, 165–<180, 180–<195, 195–<215, and ≥215 pounds and for women: <125, 125–<138, 138–<150, 150–<170, and ≥170 pounds.