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Eye and Hair Colour, Skin Type and Constitutive Skin Pigmentation as Risk Factors for Basal Cell Carcinoma and Cutaneous Malignant Melanoma

A Danish Case-Control Study

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To assess the importance of hair and eye colour, skin type and constitutive skin pigmentation as risk factors for basal cell carcinoma and cutaneous malignant melanoma in fair-skinned Caucasians, we conducted two identical case-control studies in Denmark. We studied 145 cases with basal cell carcinoma and 174 matched controls, and 168 cases with cutaneous malignant melanoma and 176 matched controls. Controls were matched on age, gender and place of residence. Subjects indicated their hair colour before 7 years of age, and at 25 years of age and their skin phototype. Interviewers assessed the present hair colour and eye colour, and the constitutive skin pigmentation was measured objectively by skin reflectance of UV unexposed buttock skin. There were no differences between basal cell carcinoma cases and controls in hair colour or eye colour or constitutive skin pigmentation, but more cases were of skin type II than skin type IV; skin type II was a risk factor for basal cell carcinoma with an odds ratio (OR) of 2.3. For cutaneous malignant melanoma, more cases than controls were red-haired or blond and of skin type II, but there was no difference in constitutive skin pigmentation. Hair colour and skin type were found to be independent risk factors for cutaneous malignant melanoma; red hair vs. black/brown: OR > 9.7, blond hair vs. brown/black: OR = 2.4, and skin type II vs. type IV: OR = 2.0. There were no gender-related differences in risk factors for basal cell carcinoma and cutaneous malignant melanoma. ***Key words: constitutional factors; epidemiology; pigmentary traits; risk factor; skin cancer; skin reflectance.***

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More than 40 years ago an Australian study (1) reported that people with fair hair, eye and skin colour were more prone to cutaneous malignant melanoma (CMM) than those with other pigmentation. This has since been confirmed in other studies (2, 3). Skin colour has in general been assessed non-objectively on scales with few steps, such as light, medium or dark skin colour. The reliability and precision of such methods is questionable (4, 5). Skin colour is often determined at the inside of the upper arm or at other exposed body sites where the skin pigmentation is influenced by seasonal variations, with pigmentation changes amounting to 70–100% (6). Moreover, pigmentation of exposed skin is not representative of the constitutive skin pigmentation, not even when assessed at the inside of the upper arm (6).

Compared with the many studies of risk factors for CMM, relatively few investigations have been performed on risk factors for basal cell carcinoma (BCC) (7–10) and no Scandinavian study has so far been reported. The 4 BCC case-control studies from Australia, Canada, south Europe and England (7–10) reported that fair hair, eyes and skin were also risk factors for BCC. The highest risks for people with fair eye and hair colour are reported from southern Europe (9), but it is doubtful whether risk factors for the more pigmented populations of south Europe can be applied to the lightly pigmented Scandinavians. Furthermore, in a recent study we found that these pigmentary characteristics are also present in the majority of healthy individuals in a Scandinavian population (11).

In this study we investigated the importance of the pigmentary characteristics eye colour, hair colour, skin type and constitutive skin pigmentation as risk factors for BCC and CMM in fair-skinned Scandinavians. The investigation was planned as 2 separate but identically performed case-control studies, thereby enabling the results from the 2 studies to be directly compared.

SUBJECTS AND METHODS

Study design

Patients with primary BCC and CMM and age-, sex-, and residence-matched controls participated in the 2 case-control studies. The subjects were 145 BCC cases and 174 BCC controls, and 168 CMM cases and 176 CMM controls. People younger than 18 years or older than 75 years were excluded. The study was approved by the local Ethics Committee and was performed over the period December 1995 to May 1996. The subjects gave informed consent before participation. All subjects were invited to participate by the same standard letter giving brief information about the study. Subjects were interviewed according to a standardized and pre-tested questionnaire by one of two trained interviewers. Eye colour, hair colour and skin type were assessed and the subjects were interviewed on the use of artificial tanning devices or sunbathing in the nude which might have raised the buttock pigmentation above the constitutive level. Finally buttock skin pigmentation was measured objectively by a skin reflectance apparatus. All interviews and physical examinations were performed at the National University Hospital, Copenhagen, Denmark.

BCC cases

In Denmark, primary BCC is generally treated outside hospitals in dermatology practices. Four dermatology practices in eastern Denmark (Hørsholm, Hundige, Roskilde and Køge) were contacted. In their files they identified 248 persons aged 18–75 years who were

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treated consecutively for primary BCC in the period January 1995 to March 1996 (128 females and 120 males). The incident cases came from 5 of the 7 counties in eastern Denmark (central Copenhagen, Frederiksborg, Roskilde, Vestsjælland and Storstrøm counties). In 1996 these 5 counties had a population of 1.7 million. The diagnosis was verified histopathologically in all cases. A total of 199 of the 248 incident cases were selected randomly and invited to participate and 145 cases accepted giving a response rate of 73% (75 females and 70 males). The most frequent tumour site was the head and neck (48% in females and 53% in males), followed by the trunk (39% in females and 37% in males) and the arms and legs (13% in females and 10% in males). The median time from treatment of BCC to interview was 8 months (range 1 – 16 months). At the time of interview, female cases had a median age of 58 years (range 41 – 75 years) and male cases had a median age of 60 years (range 29 – 73 years).

CMM cases

Most cases of primary CMM in Denmark are treated in specialized hospital departments. The Department of Plastic Surgery at the National University Hospital in Copenhagen in 1994 – 1996 treated the majority of cases in eastern Denmark, which had a population of 2.2 million in 1996. Between October 1994 and January 1996, 197 cases of primary CMM in patients aged 18 – 75 years (level I melanoma and lentigo maligna melanoma were excluded) were referred to this department (109 females and 88 males). Two cases were deceased at the time of our investigation and, of the remaining incident cases, 168 accepted the invitation to participate (91 females and 77 males), giving a response rate of 86%. The diagnosis of invasive melanoma was verified histopathologically in all cases at the National University Hospital. The most frequent melanoma type was superficial spreading melanoma found in 85% of the tumours. The median tumour thickness was 0.8 mm. The most frequent tumour site was the legs in 48% of the females and the trunk in 66% of the males. The median time from melanoma treatment to interview was 15 months (range 3 to 18 months). At the time of interview, female cases had a median age of 50 years (range 22 – 76 years) and male cases had a median age of 55 years (range 24 – 76 years).

Controls

Controls with the same sex, age (within 5 years) and place of residence (the same county) as the BCC and CMM cases were selected randomly from the Danish Central Population Registry which holds information on all Danish inhabitants. A previous history of skin cancer was an exclusion criteria. If an invited person declined to participate they were

Table I. *Hair and eye colour and self-reported skin type in patients with BCC and CMM and matched controls*

	BCC			CMM		
	Cases % $n=145$	Controls % $n=174$		Cases % $n=168$	Controls % $n=176$	
Hair colour before 7 years of age						
Red	8.3	9.2		14.3	5.7	
Blond[1]	84.1	78.7		74.4	80.7	
Brown	6.2	8.0		6.0	11.9	
Black	1.4	1.7		3.0	0.6	
NA	0.0	2.3	$p=0.69$	2.4	1.1	$p=0.02$
Hair colour at 25 years of age						
Red	5.5	7.5		11.3	3.4	
Blond[1]	83.4	79.3		76.8	76.1	
Brown	9.0	10.9		6.5	17.0	
Black	2.1	1.7		3.0	2.8	
NA	0.0	0.6	$p=0.67$	2.4	0.6	$p<0.01$
Hair colour at time of investigation[2]						
Red	2.8	2.9		7.1	0.0	
Blond[1]	55.9	52.9		72.0	61.9	
Brown	4.1	7.5		7.1	11.9	
Black	0.0	0.0		1.2	1.7	
Grey/white	37.2	36.8		12.5	24.4	
NA	0.0	0.0	$p=0.66$	0.0	0.0	$p<0.01$
Eye colour[2]						
Blue	66.2	69.5		64.9	58.5	
Green	15.2	14.4		13.7	15.9	
Grey	12.4	9.2		11.3	11.4	
Brown	6.2	6.9		10.1	14.2	
NA	0.0	0.0	$p=0.80$	0.0	0.0	$p=0.57$
Skin type[3]						
I	11.7	25.3		21.4	21.6	
II	48.3	29.9		44.6	27.8	
III	24.1	20.1		19.0	30.7	
IV	15.9	23.0		13.1	18.8	
V	0.0	0.6		0.6	0.0	
NA	0.0	1.1	$p<0.01$	1.2	1.1	$p<0.01$

[1] Light blond or dark blond. [2] Assessed by the interviewers. [3] Fitzpatrick skin type classification (12). Statistical analysis of differences between cases and controls by chi-squared test. BCC, basal cell carcinoma. CMM, cutaneous malignant melanoma. NA, no information available.

registered as a non-responder and a new control of the same sex, age and residency was selected and invited. Of the invited persons, 44% of the females and 46% of the males were registered as non-responders with no relation between responder status and place of residence, but female non-responders were in general 5 years older than female responders. There was no age difference for males with regard to responder status. Of 174 BCC controls included, 88 were females with a median age of 59 years (range 29 – 70 years) and 86 were males with a median age of 60 years (range 29 – 70 years). The 176 CMM controls included were 104 females with a median age of 49 years (range 19 – 69 years) and 72 males with a median age of 49 years (range 19 – 69 years). The response rate was 53% for BCC controls and 55% for CMM controls.

Eye and hair colour

All subjects were asked to indicate their natural (undyed) hair colour before 7 years of age and at 25 years of age and the interviewers assessed the present (undyed) hair colour according to the same clinical 6-point scale as red, light blond, dark blond, brown, black or grey/white (11). Eye colour, defined as the dominant colour of the iris, was assessed by the interviewers according to a clinical 4-point scale as blue, green, grey or brown (11).

Self-reported skin type

The anamnestic skin phototype was assessed by the subjects according to the Fitzpatrick classification (12), with individuals recalling burning tendency and tanning ability following two hours of unprotected sun exposure around noon at a sunny day early in summer. This exposure in Denmark (situated at a latitude of 56° N) corresponds to a UV dose of 9 SED (one SED = 100 J/m^2/298 nm (13)). Six skin types were defined; I, always burn, never tan; II, usually burn, tan less than average; III, sometimes mild burn, tan about average; IV, rarely burn, tan more than average; V, brown-skinned and VI, black-skinned.

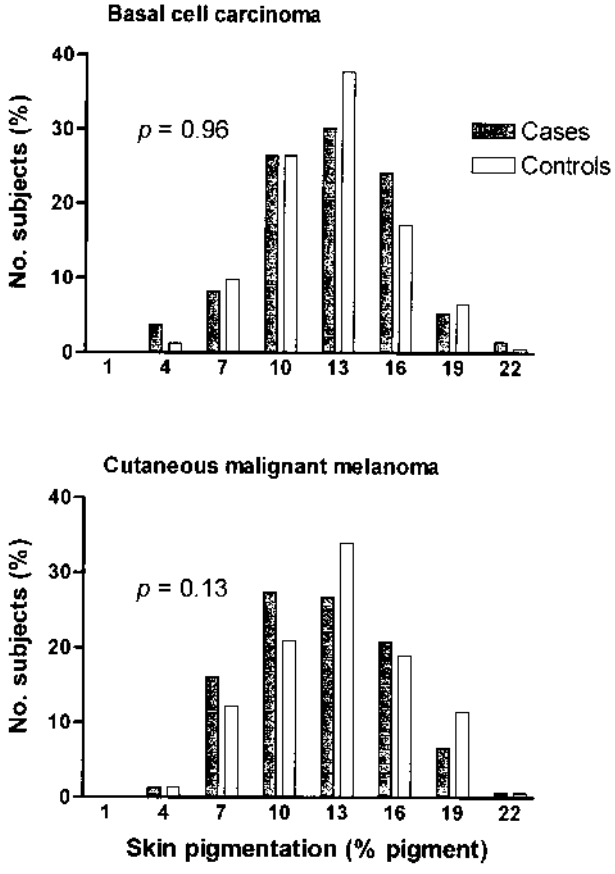

Fig. 1. Constitutive skin pigmentation in patients with BCC and CMM and healthy controls. Skin pigmentation was measured objectively by the skin reflectance principle in UV unexposed buttock skin in 132 BCC cases and 151 BCC controls (top figure) and 149 CMM cases and 147 CMM controls (bottom figure).

Skin pigmentation

Objective measurements of skin pigmentation were performed by a portable skin reflectance device (PBI UV-Optimize, Model 550/660, PBI Medical, Ringsted, Denmark). The apparatus measured the skin pigmentation (melanin content) non-invasively within a few seconds on a continuous scale from 0 to 100% (6, 11, 14). Zero percent pigmentation corresponded to skin with no pigmentation at all, as in an extremely white person, and 100% pigmentation corresponded to no light reflected back, as in theoretical absolutely black skin (11). The apparatus was calibrated on a reference tile before each measurement session (14). Skin pigmentation was measured in the UV-shielded site of the medial and upper quadrants of the left and the right buttock and the average value was used for further data analysis. Buttock skin was chosen as the most accessible site where the constitutive pigmentation could be found in the majority of individuals (6, 11). We have previously demonstrated that the UV sensitivity (as determined by a phototest) can be predicted by the degree of skin pigmentation in unexposed buttock skin in healthy persons and in skin cancer patients (15). Measurements of skin pigmentation in UV unexposed buttock skin is thus an appropriate and convenient way of determining the constitutive UV sensitivity without performing a phototest which would be impossible in a large scale epidemiological investigation (5).

Statistics

Differences in eye colour, hair colour and skin type between cases and controls were analysed by the chi-squared test and differences in skin pigmentation by the unpaired *t*-test (Table I, Fig. 1). Univariate and multivariate risk factor analyses were performed by logistic regression analysis with forward selection and backward elimination of the risk factors (Tables II – IV). We considered p values <0.05 to be significant.

RESULTS

Hair and eye colour

Blond (light and dark blond) was the dominating hair colour, with 75 – 85% of cases and controls having had blond hair in childhood and at 25 years of age, while black hair was found in less than 3% of the subjects (Table I). There was no statistical difference in hair colour between BCC cases and controls in childhood, at 25 years of age, or at the time of investigation. However, for CMM there were significant differences, with more cases having red hair and fewer having brown hair in childhood, at 25 years of age and at the time of investigation. Blue was the most frequent eye colour found in most cases and controls, whereas brown eye colour was observed in only 5 – 15% of subjects (Table I). There was no statistical difference in the distribution of eye colour between cases and controls either for BCC or CMM.

Self-reported skin type

In general, skin type II was the most frequently observed type in cases and controls. There was a significant difference in the distribution of skin types between BCC cases and controls ($p<0.01$; Table I) with more cases being of skin type II and III and fewer cases being skin type IV. For CMM, skin type II was found in more cases than controls while skin type III

and IV were found in fewer cases than controls ($p<0.01$; Table I).

Constitutive skin pigmentation

In some subjects buttock skin had been exposed to sunlight or sun beds, which might have raised the pigmentation above the constitutive level. However, the constitutive skin pigmentation could be measured in the majority of subjects: 91% of BCC cases, 87% of BCC controls, 89% of CMM cases and 84% of CMM controls (Fig. 1). There was no statistical difference between the constitutive pigmentation in BCC cases and controls (12.2% pigment and 12.2% pigment, respectively, $p=0.96$) (Fig. 1). CMM cases were slightly less pigmented than controls but the difference was not significant (12.1% pigment and 12.7% pigment, respectively, $p=0.13$).

Risk factor analysis for BCC

Hair colour, eye colour and constitutive skin pigmentation were not found to be risk factors for BCC (Table II). Anamnestic skin type was a risk factor with increased risks for skin type II (OR = 2.3) and skin type III (OR = 1.7) compared with skin type IV. There was no linear trend in skin type as risk factors because OR for skin type I was only 0.7 (Table II). We also performed separate analyses for females and males but found no differences, with skin type being a risk factor for BCC in both females and males.

Risk factor analysis for CMM

A different picture for risk factors was found for CMM. Hair colour in childhood, at 25 years of age, and at the time of investigation, and skin type were all found to be significant risk factors by univariate analysis (Table III). However, by multivariate analysis which assess the simultaneous effects of several risk factors, hair colour in childhood and at 25 years of age were not significant, leaving hair colour at the time of investigation and skin type as independent and significant risk factors for melanoma (Table IV). For hair colour, the highest risk was found for red hair vs. black/brown hair (OR > 9.7) but blond hair was also a risk factor (OR = 2.4) (Table IV). For skin type, an increased risk was found for skin type II vs. type IV (OR = 2.0) but not for type I and III (Table IV). No gender-related differences were found in risk factors for CMM.

DISCUSSION

It is desirable to obtain large subject samples in case-control studies, but due to the seasonal variation of skin pigmentation the optimal period to measure skin pigmentation in the present study was limited to the late winter and spring months (6). The number of subjects included was thus moderate, but still was sufficient to obtain a good statistical analysis. The representativeness of the samples is also crucial for the validity of the study and a response rate of 53–55% for our two control groups could have influenced our findings. However, there

Table II. *Risk of basal cell carcinoma according to hair colour, eye colour, self-reported skin type and constitutive skin pigmentation*

Factor	Category	Number of cases	Number of controls	Odds ratio, crude OR	95% CI	Odds ratio, adjusted* OR	95% CI
Hair colour before age 7 years	Black/brown	11	17	1.0[a]		1.0[a]	
	Blond	120	135	1.4	(0.6–3.1)	1.6	(0.5–5.4)
	Red	12	16	1.2	(0.4–3.4)	1.1	(0.2–8.0)
					$p^b=0.69$		$p^b=0.66$
Hair colour at age 25 years	Black/brown	16	22	1.0[a]		1.0[a]	
	Blond	120	137	1.2	(0.6–2.4)	0.9	(0.3–2.8)
	Red	8	13	0.8	(0.3–2.5)	1.2	(0.1–11.9)
					$p^b=0.67$		$p^b=0.96$
Hair colour at investigation	Black/brown	6	13	1.0[a]		1.0[a]	
	Grey/white	54	64	1.8	(0.7–5.1)	0.9	(0.3–3.4)
	Blond	81	92	1.9	(0.7–5.3)	0.8	(0.2–3.1)
	Red	4	5	1.7	(0.3–8.9)	1.9	(0.2–20.8)
					$p^b=0.65$		$p^b=0.83$
Eye colour	Brown	9	12	1.0[a]		1.0[a]	
	Grey/green	40	41	1.3	(0.5–3.4)	1.1	(0.4–3.2)
	Blue	96	121	1.1	(0.4–2.6)	0.8	(0.3–2.3)
					$p^b=0.71$		$p^b=0.61$
Skin type	IV	23	40	1.0[a]		1.0[a]	
	III	35	35	1.7	(0.9–3.5)	1.8	(0.8–3.8)
	II	70	52	2.3	(1.3–4.4)	2.1	(1.0–4.2)
	I	17	44	0.7	(0.3–1.4)	0.6	(0.2–1.5)
					$p^b<0.01$		$p^b<0.01$
Constitutive skin pigmentation	≥11.0% pigment	90	105	1.0[a]		1.0[a]	
	<11.0% pigment	46	46	1.2	(0.7–2.0)	1.2	(0.7–2.2)
					$p^b=0.30$		$p^b=0.44$

* Adjusted OR: Estimates were mutually adjusted for hair – and eye colour, skin type, and constitutive skin pigmentation. [a] Reference category. [b] p-value for homogeneity by logistic regression analysis.

Table III. *Risk of cutaneous malignant melanoma according to hair colour, eye colour, self-reported skin type and constitutive skin pigmentation*

Factor	Category	Number of cases	Number of controls	Odds ratio, crude OR	95% CI	Odds ratio, adjusted* OR	95% CI
Hair colour before age 7 years							
	Black/brown	15	22	1.0[a]		1.0[a]	
	Blond	124	141	1.3	(0.6 – 2.6)	0.3	(0.1 – 1.4)
	Red	24	10	3.5	(1.3 – 9.5)	0.6	(0.1 – 4.7)
					$p^b = 0.02$		$p^b = 0.19$
Hair colour at age 25 years							
	Black/brown	16	35	1.0[a]		1.0[a]	
	Blond	128	131	2.1	(1.1 – 4.1)	4.5	(0.9 – 22.6)
	Red	19	6	6.9	(2.3 – 20.6)	4.0	(0.3 – 46.2)
					$p^b < 0.01$		$p^b = 0.15$
Hair colour at investigation							
	Black/brown	14	24	1.0[a]		1.0[a]	
	Grey/white	21	43	0.8	(0.4 – 1.9)	0.7	(0.2 – 3.0)
	Blond	121	109	1.9	(0.9 – 3.9)	1.4	(0.4 – 5.6)
	Red	12	0	>9.1[c]	(9.1 – ∞)	>4.4[c]	(4.4 – ∞)
					$p^b < 0.01$		$p^b = 0.01$
Eye colour							
	Brown	17	25	1.0[a]		1.0[a]	
	Grey/green	42	48	1.3	(0.6 – 2.7)	0.8	(0.3 – 2.3)
	Blue	109	103	1.6	(0.8 – 3.1)	0.7	(0.3 – 1.9)
					$p^b = 0.38$		$p^b = 0.74$
Skin type							
	IV	22	33	1.0[a]		1.0[a]	
	III	32	54	0.9	(0.4 – 1.8)	0.9	(0.4 – 2.0)
	II	75	49	2.3	(1.2 – 4.4)	1.8	(0.8 – 3.9)
	I	36	38	1.4	(0.7 – 2.9)	0.8	(0.3 – 2.0)
					$p^b < 0.01$		$p^b = 0.07$
Constitutive skin pigmentation							
	≥11.0% pigment	90	105	1.0[a]		1.0[a]	
	<11.0% pigment	59	42	1.6	(1.0 – 2.7)	1.7	(1.0 – 3.0)
					$p^b = 0.05$		$p^b = 0.06$

Table IV. *Significant risk factors for basal cell carcinoma (BCC) and cutaneous malignant melanoma (CMM)*

Factor	Category	BCC		CMM	
		OR	95% CI	OR adj*	95% CI
Hair colour at investigation	Black/brown	–	–	1.0[a]	
	Grey/white	–	–	1.2	(0.5 – 3.0)
	Blond	–	–	2.4	(1.1 – 5.4)
	Red	–	–	>9.7	(9.7 – ∞)
					$p < 0.01$[b]
Skin type	IV	1.0[a]		1.0[a]	
	III	1.7	(0.9 – 3.5)	0.8	(0.4 – 1.7)
	II	2.3	(1.3 – 4.4)	2.0	(1.0 – 4.3)
	I	0.7	(0.3 – 1.4)	1.1	(0.5 – 2.5)
			$p < 0.01$[b]		$p = 0.02$[b]

Only self-reported skin type was a significant risk factor for BCC, while hair colour and skin type were independent significant risk factors for CMM. adj* = adjusted OR with estimates mutually adjusted for hair colour and skin type. [a] Reference category. [b] Test for homogeneity by logistic regression analysis.

were no differences between responders and non-responders with regard to gender and place of residence and only minor age differences. Furthermore, the constitutive skin pigmentation in the two control groups is comparable to that found in the Danish population (11, 16). The BCC and CMM cases are also age and sex comparable to data from the national Danish cancer registry (17) and CMM tumour thickness and type are comparable to prior Danish data (18). More BCCs were located on the trunk than the 12–14% reported from the period 1943–1982 by the Danish cancer statistics (19), which may represent an increasing trend towards trunkal localization as seen for CMM.

We expected BCC and CMM cases to be more sun sensitive and therefore more lightly pigmented and we were surprised not to find differences in objectively measured constitutive skin pigmentation between cases and controls, either for BCC or for CMM (Fig. 1). Because pigmentation is the main factor determining the constitutive UV sensitivity (15) we can conclude from the present investigation that no differences were found in constitutive UV sensitivity between BCC and CMM patients and matched controls. This is in accordance with our previous phototest study in two smaller groups of BCC and CMM patients (20). Two other phototest studies on BCC and one study on CMM also did not find any difference between cases and controls in constitutive UV sensitivity evaluated by the 24 h erythema reaction (21–23). The published data is thus consistent and do not demonstrate a higher constitutive UV sensitivity in persons with BCC and CMM.

In contrast to the objective determinations of sun sensitivity, we found self-reported skin type to be a risk factor both for BCC and CMM, with increased risk for skin type II compared to skin type IV, while skin type I was not risk associated (Tables II–IV). This paradoxical finding might be caused by differences in sun exposure habits, with sun sensitive individuals exposing themselves less than more sun resistant individuals. The literature regarding self-reported skin type and BCC is not in agreement, with a British study and a multicentre study from south Europe finding self-reported skin type to be a significant risk factor (OR = 1.7 and OR = 2.7 for skin type I, respectively) (9, 10), a Canadian study finding self-reported skin type was not a risk factor (8), while an Australian study reported inability to tan as a risk factor while propensity to sunburn was not associated with risk (7). For CMM, several studies report self-reported skin type, tendency to sunburn, or poor tanning ability to be significant risk factors (2, 24–26). However, in the Danish study inability to tan and tendency to sunburn was not significant after adjusting for skin, hair and eye colour (25) and in a Swedish study increased risk was found for skin type II and III (OR = 3.0 and 3.1, respectively) but not for skin type I (24).

We can only speculate why objective measurements of constitutive sun sensitivity (skin pigmentation) is not found to be a risk factor for BCC and CMM but other studies have also demonstrated poor correlations between self-reported skin type and sun sensitivity determined objectively by phototest (27, 28) and recall bias may substantially influence subjective assessments of sun sensitivity (29). Many Caucasians do not fit into the skin type classification scheme and may be forced into an erroneous skin type (5, 29) and it has been found that 35% of subjects report a different skin type by repeated questioning after 6–9 months (5). Also, it is unclear in self-reported skin typing how subjects weight burning tendency against tanning ability and it is unknown whether subjects really consider the premises of 2 h of unprotected sun exposure before deciding on their skin type. Furthermore, self-reported skin type is concerned with the response of exposed skin that even early in summer have a different pigmentation than in unexposed skin (6, 16).

We found that hair colour was a risk factor for CMM but not for BCC. Observer-assessed hair colour at time of investigation was better correlated with risk than self-reported hair colour, probably due to better precision and consistency (Table III). A number of studies have reported that eye colour and/or hair colour are associated with risk for BCC (7, 9, 10) and CMM (2, 3, 24, 25, 30) with higher risk estimates for hair colour than for eye colour, but the findings are not uniform. The Scandinavian studies have found hair colour but not eye colour to be CMM risk factors (24–25), which is in agreement with our findings. It appears that hair colour and skin type are weaker risk factors in Scandinavians than in the more pigmented populations in southern Europe which could be caused by the Scandinavians being more homogeneous with respect to pigmentary traits (11).

In conclusion, self-reported skin type was found to be a risk factor for BCC. For CMM, hair colour and self-reported skin type were found to be independent risk factors. Constitutive skin pigmentation was not a risk factor for BCC or CMM.

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