



# Tanning habits and sunburn in a Swedish population age 13–50 years

C. Boldeman<sup>a,b</sup>, R. Bränström<sup>a</sup>, H. Dal<sup>a</sup>, S. Kristjansson<sup>a</sup>, Y. Rodvall<sup>a</sup>,  
B. Jansson<sup>b</sup>, H. Ullén<sup>a,\*</sup>

<sup>a</sup>*Department of Cancer Prevention, Karolinska hospital, Stockholm, Sweden*

<sup>b</sup>*Department of Public Health Sciences, Division of Social Medicine, Karolinska Institute, Stockholm, Sweden*

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## Abstract

As part of a skin cancer control programme, we studied the occurrence of self-reported outdoor tanning, sunbed use and ultra-violet (UV)-induced erythema in an urban area. A cross-sectional questionnaire study of 6000 adolescents aged 13–19 years, and 4000 adults aged 20–50 years was applied. Non-response was analysed for outdoor tanning and sunbed use. Results, in general, did not differ between responders and non-responders. Females aged 17–29 years tanned outdoors most frequently. Sunbed use and related erythema was twice as common in young females. In males, outdoor tanning was not age-related. In the past 12 months, 55% reported sunburn and/or burn from sunbed use, one-third were burned in Sweden, one-quarter on sunny resorts abroad. Sunburn occurs frequently. Compliance with recommendations for sunbed use is poor, especially among adolescents and young adults. To reduce the occurrence of erythema, the influence of risk settings upon behaviours is a critical issue for exploration.  
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## 1. Introduction

Self-reported sunburn from ultraviolet radiation (UVR) is known to be associated with an increased risk of skin cancers, especially among populations in western industrialised countries [1,2]. Sunburn that has occurred before the age of 20 years has been observed to be associated with an elevated risk of skin cancer, particularly cutaneous malignant melanoma (CMM), basal cell carcinoma, and to a lesser extent, for squamous cell carcinoma [3,4]. Risk ratios vary depending on the episodes and degree of erythema, defined as painful UV-induced sunburn with or without blistering [2,4,5]. As a major preventable risk factor for skin cancers, sunburn should be the subject of skin cancer control programmes [6].

Several studies have demonstrated that a large number of young people intentionally tan outdoors and/or use

sunbeds, especially females [7–12]. In addition, large proportions of young populations have been burned from both outdoor tanning and sunbed use [7,10,13–15]. Frequent travelling to sunny seaside resorts is also common [16]. For example, in Sweden at least half a million people visit these destinations each year [17]. The widespread use of sunbeds constitutes an increase to UV exposure, which has been suggested to be of the same magnitude as that of the sun [18]. Sunbed use has been observed to increase the risk of non-melanoma skin cancer [19] and CMM [20,21]. Erythema as a result of sunbed use could in theory yield overrisks for CMM similar to those observed for erythema of the sun [22]. However, the risk of skin cancer versus sunbed use, and its dose–response relationships are not yet fully understood [23]. Data on outdoor tanning and sunbed use, including erythema, are therefore warranted.

This study is part of a long-term skin cancer control programme in Stockholm, during the 1990s [24]. In 1999, we collected data for risk group assessment for future evaluation procedures. In this study, data were analysed in order to assess self-reported outdoor tanning

\* Corresponding author. Tel.: +46-8-5177-5077; fax: +46-8-31-95-66.

E-mail address: henrik.ullen@smd.sll.se (H. Ullén).

in Sweden and abroad, sunbed use and the occurrence of UV-induced erythema.

## 2. Materials and methods

### 2.1. Study area and population

The area of this study was Stockholm County, Sweden (59–60°N latitudes, sea level), with a total population 1.8 million. The two study bases for this study comprised 130 000 individuals of ages 13–19 years, and 800 000 individuals of ages 20–50 years. The study was conducted in 1999.

### 2.2. Data collection

The permission of the Ethical Committee at the Karolinska hospital was obtained for the questionnaire and non-response studies. Participation was on a voluntary basis, and did not include written informed consent. A random sample of 10 000 individuals with a permanent abode in Stockholm County were selected from the national census registry. The sample comprised two age groups: (i) 6000 adolescents 13–19 years of age and (ii) 4000 adults 20–50 years of age.

### 2.3. Questionnaire survey

A mailed questionnaire with two reminders was used (May 1999). Questionnaires to minor participants (<18 years) were sent to their parents/custodians. The questionnaire was designed to cover several aspects of tanning habits, sun protective behaviour, cognitive aspects and background factors. This study focused on intentional outdoor tanning, sunbed use and UV-induced erythema, defined as smarting redness. Questions were asked for (i) present outdoor tanning habits, location (Sweden/abroad) and frequency, (ii) present sunbed use, location, duration of use (12 months/lifetime), and (iii) self-reported sunburn, location (Sweden/abroad) and (iv) burn from sunbed use during the past 12 months. The questions have been constructed by specialists in dermatology, oncology, behavioural and social sciences, respectively, and were validated and used in Swedish surveys. For a methodological study, diary recordings and questionnaires were used to assess under- and overestimation of outdoor tanning and included data on the agreement of the two assessments, and the radiation properties of the tanning devices were physically defined in relation to natural sunlight [25,26].

### 2.4. Statistical methods

Chi<sub>2</sub>-tests for heterogeneity were used for the assessment of correspondence between the observed and

expected values of tanning and erythema in each age group. A control of internal inconsistencies was carried out by linkage of the related answers. The examined inconsistencies ranged between 1 and 7%. In the presentation of data for the different age groups, the divide between secondary and upper secondary school (13–16 and 17–19 years, respectively) was chosen as a cut-off limit in the adolescent group of responders, the ages of adults were presented by decades (20–29, 30–39 and 40–50 years, respectively). The Stockholm county population from 31 December 1998 was used to calculate four separate poststratification weights for each gender in each stratum for comparability of strata and feasibility of estimations for the whole population.

### 2.5. Non-response

Non-response in the total study population was 32% (adolescents 32%, adults 32%). A higher rate was observed for males. Non-response among males was 39%, among females 24%. Among 1903 non-responding adolescents, the cause of non-response was unknown in 1433, 101 refused and 92 had unknown addresses, 270 were erroneously filled in by parent or sibling. Among 1273 non-responding adults, the cause of non-response was unknown in 1033, 36 were erroneous responders, 51 refused and 149 had unknown addresses. 7 adolescents and 4 adults had other causes for non response. Partial non-response of the questions analysed in this study was below 2.5%.

### 2.6. Non-response study

The majority of the questionnaires were returned within 2 months. Seven months after the questionnaires were mailed, an adjacent telephone survey of non-responders was made (December 1999) to analyse any differences between the responders and non-responders. The telephone survey consisted of five questions from the mailed questionnaire: outdoor and sunbed use habits, believed future outdoor tanning habits, attitude to tanning and the fifth question consisting of a set of items regarding knowledge of risk factors and sun protection. Two of these (outdoor tanning and sunbed use) were relevant for this study and presented here. For the non-response telephone survey, 120 18- and 19-year-old adolescents, and 120 adults equally distributed between genders were selected. Included in the non-response analysis were the categories unknown cause of non-response, and refusals which covered 1550/3176 (49%) of all non-responders. Of 1550 eligible non-responders, 96 out of 120 adolescents (50 females, 46 males), and 84 out of 120 adults (42 females, 42 males) could be reached and agreed to participate (Table 1). For practical reasons, we excluded individuals who were of minor age (13–17 years), unavailable by letter,

Table 1  
Non-response study of the population-based survey in Stockholm county, ages 13–50 years, 1999, males and females

	Non-response (unknown/refusal) <sup>a</sup>	Included for analysis	Selected for analysis	Participants <i>n</i> (%)
Adolescents <sup>b</sup>				
Total	1903	465 <sup>b</sup>	120	96 (80)
Males <sup>b</sup>	308		60	46 (77)
Females <sup>b</sup>	157		60	50 (83)
Adults				
Total	1273	1085	120	84 (70)
Males	801	398	60	42 (70)
Females	472	687	60	42 (70)

<sup>a</sup> Criteria for exclusion from analysis: minor age, address unknown, being abroad during the time of the period of study, illness, non-Swedish-speaking, response by wrong person.

<sup>b</sup> Number comprises only adolescents of ages 18 and 19 years. Gender distribution of non-responders of ages 13–17 years was unknown, response rates by gender.

abroad during the time period of the study, ill, not Swedish-speaking and parents and siblings who had erroneously answered the questionnaire.

### 2.7. Statistical methods for non-response

Fisher's Exact test were applied for the comparison between groups, both with the Bonferroni correction for multiple tests and a significance level of 0.01 (0.05/5) [27]. For each group separately, we tested for differences between responders and non-responders in the five questions used in the non-response study. In this study, two of the five questions (outdoor tanning and sunbed use) were subject to analysis.

## 3. Results

### 3.1. Outdoor tanning

In the total study population, 38% of the females and 17% of the males reported frequent outdoor tanning. In all age groups, frequent tanning was twice as common among female as in males (Table 2). Among frequent outdoor tanners, adolescents aged 17–19 years were over-represented. Few reported never to have tanned or given up tanning, and both these groups were especially few among adolescents compared with adults.

Travels to a sunny resort abroad during the 12 months prior to the study was reported by 46% of the female, and by 44% of the male study population, and were irrespective of age. Adolescents, and adults aged 20–29 years were over-represented among the travellers abroad (Table 2). During their lifetime, 85% of the total study population had visited a sunny seaside resort at

least once. One-third in the oldest group (ages 40–50 years) and one out of ten in the youngest group (ages 13–16 years) reported more than 10 visits during their life span, and one out of eight adolescents reported to have travelled to a sunny seaside resort more than 10 times in their lives, compared with one-third of the adults (data not shown in table).

### 3.2. Sunbed use

Sunbed use was twice as common in females, 37% compared with 19% in males. Regardless of the frequency of sunbed use, the observed female over-representation included a dominance of ages under 30 years. In both genders, sunbed use increased with age in adolescents and adults aged 20–29 years. Of all sunbed users, 66% of the males, and 73% of the females were under 30 years of age. Of the female responders aged 17–19 years, one-third reported they had used sunbeds for at least 1 year. One-fifth of all female, and one-tenth of all male responders aged 30–39 years had practiced sunbed use for more than 10 years. The same age group also had the highest representation of sunbed quitters. Sunbed users of both genders were significantly over-represented among adolescents aged 17–19 years, and adults aged 20–29 years (Table 3). Among responders who tan indoors  $\geq 10$  times a year, the same age groups dominated.

A minority of the total study population (1–4%) reported to expose themselves above the recommended time (30 min) per tanning session. Sunbed sessions exceeding 30 min were most commonly reported for sunbed use at home, and by males tanning indoors at swimming pools and training premises. Gyms, tanning parlours, and public indoor swimming pools were the most frequently indicated locations for sunbed use.

### 3.3. Outdoor tanning and sunbed use among the non-responders

The responders' answers did not differ significantly from those of the non-responders, except in the sunbed use of male adults, with non-responding male adults using sunbeds to a lesser extent than responding male adults. All other tests for difference were non-significant (Table 4).

### 3.4. Self-reported sunburn

A majority of the adolescent responders reported sunburn from tanning outdoors in Sweden, females 74%, males 65%. Amongst the adult responders of both genders, a lifetime experience of sunburn from outdoor tanning was reported by 84%. In the whole study population, 14% reported to get burned every year when tanning outdoors (not shown in table).

Table 2

Number and percentage of outdoor tanning by age group and location, males and females of Stockholm county 1999

	13–16 years <i>n</i> (%)	17–19 years <i>n</i> (%)	20–29 years <i>n</i> (%)	30–39 years <i>n</i> (%)	40–50 years <i>n</i> (%)	Weighted total (%) <sup>a</sup>	Significance of differences between age groups and respective behaviour, $\chi^2$
<b>Outdoor tanning, females</b>							
Frequent	431 (36)	475 (50)	141 (35)	154 (29)	158 (30)	33	
Sometimes	552 (47)	337 (36)	181 (45)	249 (47)	239 (46)	45	
Seldom	157 (13)	98 (10)	65 (16)	100 (19)	91 (17)	17	
Given up tanning	4 (<1)	9 (1)	6 (1)	12 (2)	18 (3)	2	
Never sunbathed	40 (3)	25 (3)	9 (2)	18 (3)	15 (3)	3	
Total	1184 (100)	944 (100)	402 (100)	533 (100)	521 (100)	100	<0.001
<b>Outdoor tanning, males</b>							
Frequent	149 (14)	191 (23)	55 (17)	72 (15)	83 (18)	17	
Sometimes	468 (43)	369 (44)	149 (47)	227 (48)	192 (41)	45	
Seldom	356 (32)	230 (28)	92 (29)	139 (29)	137 (30)	30	
Given up tanning	14 (1)	7 (1)	6 (2)	23 (5)	29 (6)	4	
Never sunbathed	109 (10)	36 (4)	13 (4)	16 (3)	22 (5)	5	
Total	1096 (100)	833 (100)	315 (100)	477 (100)	463 (100)	100	<0.001
<b>Travel abroad in past 12 months, females</b>							
≥ 3 times	31 (3)	47 (5)	13 (3)	10 (2)	11 (2)	2	
1–2 times	526 (45)	402 (43)	189 (47)	206 (39)	204 (39)	42	
Not at all	625 (53)	495 (52)	200 (50)	319 (60)	303 (58)	56	
Total	1182 (100)	944 (100)	402 (100)	535 (100)	518 (100)	100	<0.001
<b>Travel abroad in past 12 months, males</b>							
≥ 3 times	49 (4)	32 (4)	10 (3)	16 (3)	21 (5)	4	
1–2 times	459 (42)	345 (41)	133 (42)	175 (37)	151 (33)	37	
Not at all	586 (54)	455 (55)	172 (55)	287 (60)	290 (63)	59	
Total	1094 (100)	832 (100)	315 (100)	478 (100)	462 (100)	100	0.05

<sup>a</sup> Weighted by the population size of the respective age group.

Table 3

Number and percentage of sunbed use by age group and frequency, males and females of Stockholm county, 1999

	13–16 years <i>n</i> (%)	17–19 years <i>n</i> (%)	20–29 years <i>n</i> (%)	30–39 years <i>n</i> (%)	40–50 years <i>n</i> (%)	Weighted total (%) <sup>a</sup>	Significance of differences between age groups and frequency of sunbed use, $\chi^2$ test for heterogeneity
<b>Sunbed use, females</b>							
≥ 10 episodes/year	34 (3)	89 (9)	58 (14)	32 (6)	16 (3)	7	
< 10 episodes/year	198 (17)	409 (43)	185 (46)	185 (35)	136 (27)	34	
Given up sunbeds	40 (3)	84 (9)	93 (23)	217 (41)	159 (31)	29	
Never used sunbeds	896 (77)	362 (38)	65 (16)	99 (19)	199 (39)	30	
Total	1168 (100)	944 (100)	401 (100)	533 (100)	510 (100)	100	<0.001
<b>Sunbed use, males</b>							
≥ 10 episodes/year	10 (1)	49 (6)	20 (6)	15 (3)	7 (2)	4	
< 10 episodes/year	54 (5)	157 (19)	44 (14)	119 (25)	63 (14)	21	
Given up sunbeds	25 (2)	56 (7)	65 (21)	163 (35)	82 (18)	22	
Never used sunbeds	984 (92)	547 (68)	126 (40)	175 (37)	303 (67)	53	
Total	1073 (100)	809 (100)	313 (100)	472 (100)	455 (100)	100	<0.001

<sup>a</sup> Weighted by the population size of the respective age group.

Sunburn as a result of outdoor tanning during the 12 months preceding the study was reported by 55% of the study population (adolescents 56%, adults 53%). Sunburn on three or more occasions was reported by 8% of all respondents.

Self-reported sunburn as a result of outdoor tanning in Sweden was reported by one-third of the total study population, and almost half of the female adolescents. Female adolescents aged 17–19 years were over-represented in reporting ≥ 3 sunburns (Table 5).

Table 4

Number and percentage of outdoor tanning and sunbed use among responders and non-responders, males and females of Stockholm county, 1999

	Responders, adolescents <sup>a</sup> n (%)	Non-responders, adolescents <sup>a</sup> n (%)	Fisher's Exact test	Responders, adults n (%)	Non-responders, adults n (%)	Fisher's Exact test
Outdoor tanning, female						
Frequent	327 (50)	18 (39)		453 (31)	9 (21)	
Sometimes	240 (37)	22 (48)		669 (46)	22 (52)	
Seldom	69 (11)	3 (7)		256 (18)	7 (17)	
Given up sunbeds	4 (1)	1 (2)		36 (2)	–	
Never sunbathed	16 (2)	2 (4)		42 (3)	4 (10)	
Total	656 (100)	46 (100)	$P=0.16$	1456 (100)	42 (100)	$P=0.12$
Outdoor tanning, males						
Frequent	141 (25)	15 (31)		210 (17)	11 (26)	
Sometimes	271 (47)	14 (29)		568 (45)	11 (26)	
Seldom	135 (23)	15 (31)		368 (29)	19 (45)	
Given up sunbeds	6 (1)	3 (6)		58 (5)	–	
Never sunbathed	22 (4)	2 (4)		51 (4)	1 (2)	
Total	575 (100)	49 (100)	$P=0.02$	1255 (100)	42 (100)	$P=0.03$
Sunbed use, females						
Frequent	24 (4)	4 (9)		35 (2)	–	
Sometimes	148 (23)	11 (24)		219 (15)	3 (7)	
Seldom	200 (31)	10 (22)		358 (25)	9 (22)	
Given up sunbeds	57 (9)	6 (13)		469 (32)	8 (20)	
Never used sunbeds	225 (34)	15 (33)		363 (25)	21 (51)	
Total	654 (100)	46 (100)	$P=0.26$	1444 (100)	41 (100)	$P=0.01$
Sunbed use, males						
Frequent	11 (2)	3 (6)		13 (1)	1 (2)	
Sometimes	57 (10)	4 (8)		101 (8)	1 (2)	
Seldom	97 (17)	6 (12)		212 (17)	5 (12)	
Given up sunbeds	44 (8)	–		310 (25)	1 (2)	
Never used sunbeds	352 (63)	37 (74)		604 (49)	33 (80)	
Total	561 (100)	50 (100)	$P=0.04$	1240 (100)	41	$P<0.001$

<sup>a</sup> Refers to adolescents 18–19 years of age.

When tanning at a sunny seaside resort abroad, sunburn was reported by one-third of the adolescents, and one-quarter of the adults, irrespective of gender. Females aged 17–19, and 20–29 years were overrepresented ( $P<0.001$ ), adults  $\geq 30$  years of age were under-represented.

### 3.5. Burn from sunbed use during 12 months preceding the study

Of all female responders aged 17–19 years, one out of six, and of all females aged 20–29 years, approximately one out of five reported burning after sunbed use (Table 5). Between 1 and 8% of the rest of the study population reported to have acquired burns from sunbed use in the 12 months preceding the study. Of all responders who had been burned in sunbeds, 71% had also experienced sunburn in connection with outdoor tanning in Sweden, abroad or both.

Among sunbed users, one third of the females, and one-fifth of the males aged 17–19, and 20–29 years reported being burned after sunbed use. Burns of three

times or more were reported by 1–3%, except for males above the age of 30 years who did not report being burned after sunbed use.

## 4. Discussion

Outdoor tanning, sunbed use and related burns was particularly frequent in young females. More than half of the responders had been sunburned in connection with outdoor tanning in Sweden, abroad or both during the 12 months preceding the study. In addition, one-fifth had reported burns after sunbed use during the same time period. The supplementary analysis of a subset of non-responders confirmed the same pattern of tanning habits among non-responders which may have made non-response bias less likely. The only exception was sunbed use which seemed to be lower among adult male non-responders. It is possible that there was an overrepresentation of immigrants among the non-responders whose ethnic origin may have an inverse relationship with sunbed use.

Table 5

Number and percentage of UV-induced erythema by age group and location, males and females of Stockholm county, 1999

UV-induced erythema, cause and location	13–16 years <i>n</i> (%)	17–19 years <i>n</i> (%)	20–29 years <i>n</i> (%)	30–39 years <i>n</i> (%)	40–50 years <i>n</i> (%)	Weighted total (%) <sup>a</sup>	$\chi^2$ -test for heterogeneity <sup>c</sup>
Outdoor tanning, Sweden in past 12 months, females							
≥3 episodes	94 (8)	94 (10)	38 (9)	34 (6)	47 (9)	8	<0.001
1–2 episodes	383 (33)	352 (37)	117 (29)	184 (35)	133 (26)	31	
No episode	629 (54)	433 (46)	214 (53)	266 (50)	297 (57)	53	
Did not sunbathe	69 (6)	62 (7)	33 (8)	47 (9)	42 (8)	8	
Total	1175 (100)	941 (100)	402 (100)	531 (100)	519 (100)	100	
Outdoor tanning, Sweden in past 12 months, males							
≥3 episodes	71 (7)	62 (7)	24 (8)	35 (7)	24 (5)	7	<0.01
1–2 episodes	256 (24)	239 (29)	99 (31)	143 (30)	143 (31)	30	
No episode	608 (56)	453 (55)	162 (51)	243 (51)	241 (52)	52	
Did not sunbathe	152 (14)	77 (9)	31 (10)	53 (11)	52 (11)	11	
Total	1087(100)	831 (100)	316 (100)	474 (100)	460 (100)	100	
Seaside resort abroad in past 12 months, females							
≥1 episodes	366 (31)	331 (35)	148 (37)	131 (25)	111 (22)	28	<0.001
No episode	809 (69)	603 (65)	255 (63)	402 (75)	404 (78)	72	
Total	1175 (100)	934 (100)	403 (100)	533 (100)	515 (100)	100	
Seaside resort abroad in past 12 months, males							
≥1 episodes	291 (27)	244 (29)	104 (33)	127 (27)	110 (24)	28	0.051
No episode	799 (73)	586 (71)	212 (67)	345 (73)	351 (76)	72	
Total	1090(100)	830 (100)	316 (100)	472 (100)	461 (100)	100	
Sunbed use in past 12 months, female							
≥1 episodes	42 (4)	162 (17)	75 (19)	42 (8)	22 (4)	10	<0.001
No episode <sup>b</sup>	188 (16)	335 (36)	170 (42)	176 (33)	132 (26)	32	
Do not use sunbeds	936 (80)	446 (47)	158 (39)	316 (59)	358 (70)	58	
Total	1166 (100)	943 (100)	403 (100)	534 (100)	512 (100)	3558 (100)	
Sunbed use in past 12 months, males							
≥1 episodes	6 (1)	44 (5)	22 (7)	18 (4)	7 (2)	4	<0.001
No episode <sup>b</sup>	59 (5)	161 (20)	99 (32)	144 (29)	60 (13)	21	
Do not use sunbeds	1009 (94)	603 (75)	191 (61)	338 (68)	385 (85)	75	
Total	1074 (100)	808 (808 (100)	312 (100)	500 (100)	452 (100)	3146 (100)	

<sup>a</sup> Weighted by the population size of the respective age group.<sup>b</sup> Sunbed users.<sup>c</sup> Significance of difference between age groups and frequency of ultraviolet (UV)-induced erythema for respective location.

Studies conducted in countries of high and mid latitudes, and based on surveys including 1 year and lifetime recall periods observed that between one-third and half of the studied populations had been sunburned during the 12 months preceding the studies [8,14,15]. The findings were similar to the observations in this study and also apply in equal proportions to adolescents and adults.

A similar result was observed in the UK where 48% of a study population of children <14 years of age reported sunburn at least once per year, and 12% several times per year [28]. In our study, 14% of the whole study population reported sunburn every year as a result of outdoor tanning. It may be that the experience of sunburn is acquired early in life, in spite of residence in high latitudes. This is also supported by a German study in which 81% of school beginners were reported to be burned on a vacation abroad [18]. In addition, after reviewing the international literature, we observed that our study population reported occurrences of

sunburn, based on lifetime recall periods which were similar to occurrences of sunburn in countries of high UV intensities. In a survey made of 14–15-year-old Australian students, 87% had experienced sunburn during their lifetime, and in another survey 51% of 15–65-year-old New Zealanders had reported to have experienced blistering sunburn at least once in their lifetime [29]. There are variations between the surveys regarding the recall periods, age categorisation, classification and frequency of erythema which complicates any comparison. However, it seems obvious that in Sweden, and other high- and mid-latitude areas, sunburn occurs as often as in young populations in low-latitude areas. Extra sparetime and travelling is the most plausible explanation.

When comparing countries in social transition and of Northern climate and ethnicity, e.g. the Baltic states, the incidence of CMM in the 1990s was as low as in Sweden during the 1960s [30]. In theory, the incidence of CMM in Sweden could thus be reversed to the same levels as in the 1960s.

Research on sunbed use is characterised by great variations in methodology, definitions of tanning habits and a variety of legislation concerning radiation properties of the tanning devices. Westerdahl and colleagues reported that age <36 years at first exposure was associated with a higher risk of CMM, compared with age  $\geq$  36 years at first use [23]. Studies from Northern Europe and the US indicate that sunbed use is common in young populations in these countries, especially among females [7–10,12]. A majority of sunbed users were reported to be <35 years of age [10]. This was confirmed by the findings in our study. We also observed that reported burn after sunbed use ranged between 9 and 33%, depending on gender and age. However, Oliphant and colleagues reported an erythema incidence of 50% among Minnesota adolescents [21]. Similar findings have been found previously in the Stockholm area [26]. This could be an indication of a reduction in sunbed use and erythema.

This study indicated extensive behavioural over-exposure to UVR in the Stockholm population. It also indicated that adolescents had been burned by the sun and sunbeds almost to the same extent as adults. Thus, the experience of sunburn seems to occur early in life. Furthermore, underreporting of sunburn is likely to have occurred due to certain limitations in the study design. For example, only sunburn as a result of intentional tanning was measured, but not sunburn as a result of unintentional overexposure. Nor was sunburn abroad > 12 months included. In addition, responders who had given up sunbed use were grouped together with never users of sunbeds in the dichotomised analysis. Responders with a history of sunbed use were thus defined as non-users (a few percent of the adolescent population, but almost one-third of the adult population), and in this group any occurrence of burn as a result of sunbed use is unknown. As both present and past sunbed use may put an individual at a higher risk of skin cancer, comparable to that for current outdoor tanners, a theoretical risk elevation thus applies to a considerable part of the studied population who are ex-users of sunbeds.

Transferred to the study base, we estimate that 230 000 individuals tan outdoors frequently. Nearly twice as many (400 000) visit a sunny seaside resort every year, and 300 000 tan indoors (50 000 of those  $\geq$  10 times/year) regularly. We further estimate that more than half a million people aged 13–50 years per year get sunburned as a result of outdoor tanning in Sweden, abroad or both, and 60 000 per year are estimated to burn when tanning indoors.

According to our observations, adolescents and young adults are the most highly exposed to UVR. We recommend initiatives to be taken to promote sun awareness as a conceptual norm from an early age. Tourism related to activities other than tanning should be encouraged. Finally, the observance of international policies regarding sunbed use is warranted.

## References

- Gallagher RP, Hill GB, Bajdik CD, et al. Sunlight exposure, pigmentation factors, and risk of nonmelanocytic skin cancer. II. Squamous cell carcinoma. *Arch Dermatol* 1995; **131**, 164–169.
- Oesterlind A, Tucker M, Stone B, Jensen O. The Danish case-control study of cutaneous malignant melanoma. II. Importance of UV-light exposure. *Int J Cancer* 1988; **42**, 319–324.
- Armstrong BK, Kricke A. Epidemiology of sun exposure and skin cancer. *Cancer Surv* 1996; **26**, 133–153.
- English DR, Armstrong BK, Kricke A, Winter MG, Heenan PJ, Randell PL. Case-control study of sun exposure and squamous cell carcinoma of the skin. *Int J Cancer* 1998; **77**, 347–353.
- Kricke A, Armstrong BK, English DR, Heenan PJ. A dose-response curve for sun exposure and basal cell carcinoma. *Int J Cancer* 1995; **60**, 482–488.
- Hill D, White V, Marks R, Borland R. Changes in sun-related attitudes and behaviours, and reduced sunburn prevalence in a population at high risk of melanoma. *Eur J Cancer Prev* 1993; **2**, 447–456.
- Boldeman C, Jansson B, Nilsson B, Ullén H. Sunbed use in Swedish urban adolescents related to behavioral characteristics. *Prev Med* 1997; **26**, 114–119.
- Brandberg Y, Ullén H, Sjöberg L, Holm LE. Sunbathing and sunbed use related to self-image in a randomized sample of Swedish adolescents. *Eur J Cancer Prev* 1998; **7**, 321–329.
- Mermelstein R, Riesenber L. Changing knowledge and attitudes about skin cancer risk factors in adolescents. *Health Psychol* 1992; **11**, 371–376.
- Oliphant J, Forster J, McBride C. The use of commercial tanning facilities by suburban Minnesota adolescents. *Am J Public Health* 1994; **84**, 476–478.
- Robinson JK, Rigel DS, Amonette RA. Trends in sun exposure knowledge, attitudes, and behaviors: 1986 to 1996. *J Am Acad Dermatol* 1997; **37**, 179–186.
- Wichstroem L. Predictors of Norwegian adolescents' sunbathing and use of sunscreen. *Health Psychol* 1994; **13**, 412–420.
- Blizzard L, Dwyer T, Ashbolt R. Changes in self-reported skin type associated with experience of sunburning in 14–15 year old children of northern European descent. *Melanoma Res* 1997; **7**, 339–346.
- Melia J, Bulman A. Sunburn and tanning in a British population. *J Publ Hlth Med* 1995; **17**, 223–229.
- Stott MA. Tanning and sunburn: knowledge, attitudes and behaviour of people in Great Britain. *J Publ Hlth Med* 1999; **21**, 377–384.
- Bentham G, Aase A. Incidence of malignant melanoma of the skin in Norway, 1955–1989: associations with solar ultraviolet radiation, income and holidays abroad. *Int J Epidemiol* 1996; **25**, 1132–1138.
- Swedish Civil Aviation Administration. *Non-Scheduled Passenger Statistics, 1962–1994*. Norrköping, Swedish Civil Aviation Administration, 1996.
- Wester U. Measurements of solar UVA, UVB, and of ozone: estimates of population ultraviolet doses. *Radiat Prot Dosim* 2000; **91**, 115–118.
- Diffey B. Analysis of the risk of skin Cancer from sunlight and solarium in subjects living in northern Europe. *Photodermatology* 1987; **4**, 118–126.
- Autier P, Dore JF, Lejeune F, et al. Cutaneous malignant melanoma and exposure to sunlamps or sunbeds: an EORTC multicenter case-control study in Belgium, France and Germany. EORTC Melanoma Cooperative Group. *Int J Cancer* 1994; **58**, 809–813.
- Westerdahl J, Olsson H, Måsbäck A, et al. Use of sunbeds or sunlamps and malignant melanoma in Southern Sweden. *Am J Epidemiol* 1994; **140**, 691–699.

22. World Health Organization. *Protection Against Exposure to Ultraviolet Radiation*. Geneva, WHO/EHC/UNEP, 1995.
23. Westerdahl J, Ingvar C, Måsbäck A, Jonsson J, Olsson H. Risk of cutaneous malignant melanoma in relation to use of sunbeds: further evidence for UV-A carcinogenicity. *Br J Cancer* 2000, **82**, 1593–1599.
24. Boldeman C, Ullén H, Månsson-Brahme E, Holm LE. Primary prevention of malignant melanoma in the Stockholm Cancer Prevention Programme. *Eur J Cancer Prev* 1993, **2**, 441–446.
25. Brandberg Y, Sjoden PO, Rosdahl I. Assessment of sun-related behaviour in individuals with dysplastic naevus syndrome: a comparison between diary recordings and questionnaire responses. *Melanoma Res* 1997, **7**, 347–351.
26. Boldeman C, Beitner H, Jansson B, Nilsson B, Ullén H. Sunbed use in relation to phenotype, erythema, sunscreen use and skin diseases. A questionnaire survey among Swedish adolescents. *Br J Dermatol* 1996, **135**, 712–716.
27. Fleiss J. The Bonferroni criterion for multiple comparisons. In *Design and Analysis of Clinical Experiments*. New York, Wiley-Interscience, 1999.
28. Bourke JF, Graham-Brown RA. Protection of children against sunburn: a survey of parental practice in Leicester. *Br J Dermatol* 1995, **133**, 264–266.
29. McGee R, Williams S, Cox B, Elwood M, Bulliard JL. A community survey of sun exposure, sunburn and sun protection. *New Zeal Med J* 1995, **108**, 508–510.
30. World Health Organization–International Agency for Research on Cancer and International Association of Cancer Registries. *Cancer Incidence in Five Continents*. No. 147. Geneva, WHO–IARC/IACR, 1997.