

Melanoma incidence on the rise again

Following a period of falling rates, the incidence of cutaneous malignant melanoma has increased steadily for the past ten years in Norway. It is therefore time to intensify preventive efforts. Excessive sunbathing should be avoided irrespective of age, and indoor tanning devices should not be used.

Marit B. Veierød

m.b.veierod@medisin.uio.no

In its annual report, presented on 15 May 2014, the Cancer Registry of Norway expressed concern over the high incidence of melanoma in Norwegian men and women alike (1). Incidence rates are almost 11 times higher than 60 years ago for men, and over nine times higher for women (2).

Following a period of falling or non-increasing incidence rates in the 1990s, there has been a steady increase for the past ten years. Melanoma is the type of cancer that increased most in both men (27%) and women (19%) from the five-year period 2003–2007 to the period 2008–2012 (1, 2).

The incidence has also increased in many other countries over the past 50 years (3). More than 85% of melanoma cases in Northern and Western Europe can be attributed to sun exposure (4–6), and 9.4% to indoor tanning (7).

Complex relationships

In 1992, solar radiation was classified as carcinogenic (8), but the relationship between exposure to the sun and melanoma is a complex one. Table 1 presents the results of meta-analyses of sun exposure and the risk of melanoma (9–12). There is solid evidence that intermittent sun exposure (intensive exposure through activities such as sunbathing, outdoor leisure activities and holidays in sunny regions) increases the risk of melanoma. Sunburn is a clear sign of overexposure and also markedly increases this risk.

When it comes to chronic sun exposure (more continuous, primarily occupational exposure) the most recent and most extensive meta-analysis (41 studies) found no significant association with risk of melanoma (10). Total exposure to the sun (the sum of intermittent and chronic exposure) is associated with higher risk of melanoma, but weaker than for intermittent exposure (Table 1).

Table 1 shows the effect of sunburn during different periods of life. The relative risk of highest versus lowest category is

highest for sunburn during childhood (10, 11), but there was no significant difference between the effects of sunburn in childhood and in adulthood ($p = 0.18$) (10). The dose-response analyses in the most recent meta-analysis (9) found that melanoma risk increases with the number of sunburn episodes in *all age groups*, and the effect estimate was highest for adulthood (Table 1).

Indoor tanning and melanoma risk

In 2009, the use of indoor tanning devices was classified as carcinogenic (13). The effect is illustrated by the results of four meta-analyses (Table 2) (14–18). They all found that subjects who have ever used a solarium are at significantly higher risk than subjects who have never used one. Solarium use is an independent risk factor. When adjusted for sun sensitivity and sun exposure in the statistical analysis, the relative risk increased.

According to two of the meta-analyses (15, 16, 18) solarium use before the age of 35 has the most pronounced effect. The effect was significant in both meta-analyses, and the 2012 analysis included almost twice as many studies (13) as the 2006 analysis (seven studies).

Indoor tanning before the age of 25 was investigated in the 2014 meta-analysis (14). There was a somewhat lower, non-significant effect (only six studies), but it was stronger than for use after the age of 25 (also six studies). This meta-analysis presented effect estimates for studies from before and after the year 2000, and there was no difference ($p = 0.43$) – i.e. no indication that there is less risk of melanoma attached to new solariums than to old ones. Risk also increases with extensive use (Table 2).

Melanoma can be prevented

The concern of the Cancer Registry of Norway about the increase in melanoma incidence must be taken seriously. Why has it increased in the last decade – after showing a falling or non-rising tendency in the 1990s? The increase was most pronounced in the cohorts aged over 50, and among men (19).

The reason is presumably a change in sunbathing habits. People aged over 50

undress more than they used to; they holiday in sunny regions, and men use less sun protection than women (19). The most recent meta-analysis (9) found that melanoma risk increases with the number of sunburns throughout a person's life. Reduced exposure in adulthood can reduce the risk.

Unfortunately, it is easy for the young to ignore the fact that excessive tanning, out of doors and in solariums, may result in a higher risk of melanoma in later life. The meta-analyses indicate that indoor tanning in one's youth is associated with a higher risk than use later in life (Table 2). In our study of Norwegian and Swedish women, we found that the risk increased when solarium use extended over several decades (20).

Although some estimates of relative risk are less than 1 for chronic sun exposure (Table 1), it is unlikely that this indicates protection against melanoma. The individuals in question are often outdoor workers with occupational exposure. The reference category (lowest category of chronic sun exposure) may include a mixture of individuals with high and individuals with low intermittent exposure, with the result that the effect estimate may be artificially low (10).

It is relatively simple to urge people to avoid sunburn, and sunburn has been an important and measurable variable in cancer prevention for over 20 years. Nevertheless, the incidence of sunburn is still high in Norway and many other countries (21–23). Sun safety rules, both in Norway (24) and abroad (e.g. the USA) (25), recommend taking breaks from the sun – staying in the shade and using clothing and a hat rather than sunscreen. These measures may be more effective than sunscreen for providing protection against sunburn (22).

Avoiding excessive sun exposure is not in conflict with the fact that the sun is our most important source of vitamin D. The Norwegian Cancer Society's sun safety recommendations start by stating that sun protection does not mean totally avoiding the sun (24).

Indoor tanning is not recommended. On average, Norwegian solariums emit twice as much UVB radiation and around six times as much UVA radiation as the Oslo summer sun (26). Both UVB and UVA



Illustration: Åshild Irgens

radiation are classified as carcinogenic (13). Studies from the last 30 years indicate that there is a 16 % higher risk of melanoma associated with ever having used a solarium, and a 34 % higher risk associated with having used a solarium more than ten times, compared with never (Table 2).

A recent American study found that indoor tanning is a risk factor for melanoma even among individuals who had never experienced burns from either indoor tanning or outdoor sun exposure (27). It is estimated that 5.8 % of the melanoma cases diagnosed each year among men and 9.4 % of cases among women can be attributed to use of solariums (population attributable risk, Norway) (15). These cases could have been avoided.

The new report from the Office of the Surgeon General of the USA has been cited (23). In it, a broad array of players are urged to start primary preventive measures against skin cancer. Five strategic goals were described:

- Increase opportunities for sun protection in outdoor settings

- Provide individuals with the information they need to make informed, healthy choices about UV exposure (from sun and solarium)
- Promote policies that advance the national goal of preventing skin cancer
- Reduce harm from indoor tanning
- Strengthen research, surveillance, monitoring and evaluation relating to skin cancer prevention

Marit B. Veierød (born 1962)

PhD, Professor of Medical Statistics at the Oslo Centre for Biostatistics and Epidemiology, Department of Biostatistics, and at the Department for Nutrition, Institute of Basic Medical Sciences, Faculty of Medicine, University of Oslo. The author has completed the ICMJE form and reports no conflicts of interest.

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Table 1 Estimated relative risk in meta-analyses of sun exposure and risk of melanoma. Relative risk for highest versus lowest value unless otherwise indicated

First author, year (reference)	Studies included	Type of sun exposure			
		Intermittent ¹ RR (95% CI), number of studies	Sunburn ² RR (95% CI), number of studies	Chronic ³ RR (95% CI), number of studies	Total ⁴ RR (95% CI), number of studies
Dennis, 2008 (9)	51 case-control and cohort studies, 1985–2007		<i>Whole life</i> ⁵ 3.24 (2.19–4.66) n = 16 <i>Childhood</i> ⁵ 2.02 (1.20–3.56) n = 10 <i>Adolescence</i> ⁵ 1.42 (1.23–1.66) n = 8 <i>Adulthood</i> ⁵ 3.27 (2.35–4.45) n = 7		
Gandini, 2005 (10)	57 case-control and cohort studies, 1969–2002	1.61 (1.31–1.99), n = 33	<i>Whole life</i> 2.08 (1.70–2.55) n = 19 <i>Irrespective of age</i> 2.03 (1.73–2.37) n = 33 <i>Childhood</i> 2.24 (1.73–2.89) n = 19 <i>Adulthood</i> 1.92 (1.55–2.37), n = 17	0.95 (0.87–1.04), n = 41 ⁶	1.34 (1.02–1.77), n = 14
Elwood, 1997 (11)	29 case-control studies, 1979–1996	1.71 (1.54–1.90), n = 23	<i>Whole life or as adult</i> 1.91 (1.69–2.17), n = 19 <i>Childhood</i> 1.95 (1.66–2.31), n = 9 <i>Adolescence</i> 1.73 (1.44–2.07), n = 7	0.86 (0.77–0.96), n = 20 ⁷	1.18 (1.02–1.38), n = 11
Nelemans, 1995 ⁸ (12)	25 case-control studies, 1979–1990	1.57 (1.29–1.91), n = 6		0.73 (0.60–0.89), n = 6 ⁶	

¹ Intense exposure through activities such as sunbathing, outdoor leisure activities and holidays in sunny climates

² Marker for intermittent exposure

³ Continuous, primarily occupational exposure

⁴ Intermittent plus chronic sun exposure

⁵ Dose-response per 5 sunburns per decade. Dennis et al. also presented results for ever versus never sunburned

⁶ Mainly occupational exposure

⁷ Only occupational exposure

⁸ Included only studies without hospital controls in the calculation of the effect estimates

Table 2 Estimated relative risk in meta-analyses of solarium use and risk of melanoma

First author, year (reference)	Studies included	Ever versus never				
		Total estimate	Adjusted for sun exposure and sun sensitivity	Exposed for first time in early years	Year of publication	High use
		RR (95 % CI), number of studies	RR (95 % CI), number of studies	RR (95 % CI), number of studies	RR (95 % CI), number of studies	RR (95 % CI), number of studies
Colantino, 2014 (14)	31 cohort and case-control studies 1981–2013	1.16 (1.05–1.28), n = 31		< 25 years 1.35 (0.99–1.84), n = 6	< 2000 1.12 (1.00–1.26), n = 21 ≥ 2000 1.22 (1.03–1.45), n = 10	> 10 times versus never 1.34 (1.05–1.71), n = 10
Boniol, 2012 (15, 16)	27 cohort and case-control studies 1981–2012	1.20 (1.08–1.34), n = 27	1.29 (1.13–1.48), n = 18	< 35 years 1.59 (1.36–1.85), n = 13		Highest category versus never 1.42 (1.15–1.74), n = 14
Hirst, 2009 (17)	20 cohort and case-control studies 1981–2006	1.22 (1.07–1.39), n = 20				
IARC working group, 2006 (18)	19 cohort and case-control studies 1981–2005	1.15 (1.00–1.31), n = 19	1.19 (0.33–4.30), n = 8	< 35 years 1.75 (1.35–2.26), n = 7		