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Original Research

Future reduction of cutaneous malignant melanoma due to improved sun protection habits and decreased common melanocytic nevi density among Swedish children?
A follow-up from 2002 to 2012

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Abstract We have previously demonstrated significant improvements in sun protection regimens and significantly fewer common melanocytic nevi (CMN) among 7-year-old children in southern Sweden when comparing year 2007 with 2002. The aim of this study was to investigate whether the observed decreasing trend also can be observed at age 10 and, in addition, to compare the CMN density change between 7 and 10 years of age during two periods of time.

Two open cohorts were used, cohort I with schoolchildren investigated in 2002 at age 7 and in 2005 at age 10 and cohort II with schoolchildren investigated in 2009 at age 7 and in 2012 at age 10.

A significant decrease in CMN density (number/m^2 BSA) at age 10 from 2005 to 2012 was observed: 15.9 (14.7–17.2) and 11.4 (10.1–12.7), respectively. The density growth rate from 7 to 10 years was 2.8 (2.1–3.5) between 2002 and 2005 and decreased significantly to 0.9 (0.2–1.5) between 2009 and 2012. Significant increases were observed for 'often use of sunscreen', 'often staying in shade' and 'often staying indoors' from cohort I to cohort II: 65 vs 80%, 7.6 vs 13% and 7.3 vs 19%, respectively.

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The decrease in number of CMN among 10-year-old children confirms a current trend in Sweden. If this persists, a future reduction of cutaneous malignant melanoma incidence in Sweden might be anticipated. The results also indicate that CMN count could be used as an indicator of ultraviolet exposure.

1. Introduction

The incidence of cutaneous malignant melanoma (CMM) has increased over the past 50 years among fair-skinned populations worldwide and increases currently in Sweden by 5% per year [1]. International trends presented by Erdmann *et al.* [2] show that the incidence continue to rise in most European countries, but there is an indication of a stabilisation or decreasing trend in several high-risk countries in the youngest age group (25–44 years) in recent years. Mortality curves are stable or have even begun to fall, for example, in Scandinavia. The general effects are even more marked for melanoma mortality as pointed out in a study by Autier *et al.* [3], which demonstrated that because of cohort effects, melanoma deaths in Northern Europe (Denmark, Finland, Iceland, Norway and Sweden) concentrate in older age groups.

Wallingford *et al.* [4] compared the incidence rates of CMM among 0- to 24-years-old in Australia and England, two countries with similar ancestry but disparate ambient ultraviolet radiation (UVR). This study has demonstrated and found that the incidence rates increased in England but decreased in Australia. Australia's rigorous primary prevention efforts appear to be effectively reducing CMM incidence even at these young ages, despite the high ambient UVR in the country.

Common melanocytic nevi (CMN) are benign collections of melanocytes, but a high number of these is a risk factor for CMM. A meta-analysis has shown that individuals with more than 100 CMN are at greater risk than individuals with few [5]. Same constitutional pigmentary characteristics, relations to previous ultraviolet (UV) exposure and body-site localisation [6–9] conjoin the number of CMN and the risk of CMM. As in international studies [10–15], blond hair, blue/grey/green eyes, holidays at seaside resorts abroad, more frequent sunburns and parents fancying tanning were significant predictors of higher prevalence of CMN in Swedish children [16]. Meta-analysis has reported increased CMM risk with increasing number of sunburns during all life periods [8]. The incidence of CMM in Sweden is higher in the southern part of the country [1], and the children and adults residing there have significantly more CMN than the population in northern Sweden [16]. By being inducible by UV exposure, CMN *per se* could fit as a tentative objective biomarker, serving as a proxy for CMM risk in the population.

In 2002 and 2007, we performed two population-based, cross-sectional observational studies among 7-year-old children in southern Sweden [16,17]. The results demonstrated significant improvements in parental application of various sun protection regimens and significantly fewer CMN in the children in 2007 than 2002. Smith *et al.* [18] have also reported similar findings in Australian children. These results support that a repeated assessment of CMN density in children, using a standardised, cross-sectional approach, could be used to indirectly monitor changes in children's sun exposure, as initially proposed by Pfahlberg *et al.* [19].

The aim of the present study was to investigate whether the observed decreasing trend in prevalence of CMN at the age of 7 also could be observed at the age of 10 and, in addition, to compare the CMN density change between 7 and 10 years of age during two periods of time, 2002 to 2005 and 2009 to 2012, respectively.

2. Materials and methods

2.1. Study population and design

The project was performed in collaboration with the school health services in Falkenberg, a coastal municipality at latitude 57°N in the south of Sweden. Two open cohorts were used, cohort I with schoolchildren investigated in 2002 at age 7 and in 2005 at age 10 and cohort II with schoolchildren investigated in 2009 at age 7 and in 2012 at age 10 (Table 1). All children in the included age groups were identified and invited to participate in the study, which comprised a parental questionnaire about tanning habits and a clinical

Table 1
Study populations for studies performed in Falkenberg 2002–2012.

Study characteristics	Cohort I		Cohort II	
Year	2002	2005	2009	2012
Age of children	7	10	7	10
Number	396	400	294	235
Response rate %	81	77	71	62
Parental questionnaire	Yes	Yes	Yes	No
Clinical examination	Yes	Yes	Yes	Yes

examination including CMN count. Owing to a restricted budget, no questionnaire was used in 2012. The invitation was sent to the parents with information about the study and requesting written consent for their child's participation in the clinical examination. All children whose parents had responded to the questionnaire were invited to the latter.

2.2. Parental questionnaire

Questions about the child's tanning habits, sun protection, travelling and sunburns were asked. Details from the questionnaires have been reported earlier [16,17,20–22].

2.3. Clinical examination

The examination was performed by a research nurse specially trained for the purpose and was the same from 2002 to 2012. All eligible children had more than one opportunity to attend the examination. The body examination excluded scalp, genitalia, buttocks and abdomen below the umbilicus. The remaining body surface area (BSA), in total 84.5%, was divided into 16 sites, where the numbers of CMN were counted. These were defined as raised or flat brown lesions ≥2 mm on the skin according to an International Agency for Research on Cancer (IARC) protocol [23] and was measured with an overlay of Plexiglas.

Sun-exposed areas are categorised as follows: chronic—face and dorsum of the hands; intermittent—back, chest, lateral aspects of the arms, anterior and posterior aspects of the thighs and lower legs and dorsum of the feet and rare—medial aspects of the arms, palms and soles [22]. The nurse also assessed hair colour, eye colour, height and weight. The BSA was calculated from the height and weight of each child using Mosteller simplified formula [24].

2.4. Ethics

The study was approved by the ethical committees at the Karolinska University Hospital and Karolinska Institutet.

2.5. Statistical analyses

All the statistical analyses were performed with the SAS® software, version 9.4 for Windows. Categorical outcomes of the questionnaire and constitutional factors were analysed with the Cochran–Mantel–Haenszel strategy using PROC FREQ. When the outcome variable was ordinally scaled, the mean score statistics to test the hypothesis of no location shifts was used. For nominally scaled outcomes, the test for general association was used. Trends over time were tested with the Cochrane–Armitage test in PROC FREQ. Continuous variables were tested by the Student's t-test, and corresponding 95% confidence intervals were produced using the PROC TTEST or with the Wilcoxon test when the assumption of normal distribution was not fulfilled.

3. Results

The subject characteristics of the cohorts at 7 and 10 years of age are presented in Table 2. There were no statistically significant differences between the two cohorts for eye or hair colour, skin photo type, gender, BSA, weight or height and at 7 or at 10 years of age.

The number of CMN including the number per m^2 BSA as well as the change between 7 and 10 years of age in cohort I and II are displayed in Table 3. The prevalence of CMN was highest in intermittently UV-exposed areas compared with chronically or rarely UV-exposed areas. A significant decrease in mean CMN density (number of CMN per m^2 BSA) at the age of 10 was observed from 2005 to 2012: 15.9 (14.7–17.2) and 11.4 (10.1–12.7), respectively. Corresponding results in 2002 and 2009 at the age of 7 were 13.2 (12.3–14.1) and 10.3 (9.3–11.2), respectively. CMN develop during childhood, but the change in CMN density from 7 to 10 years of age was 2.8 (2.1–3.5) between 2002 and 2005 and decreased significantly to 0.9 (0.2–1.5) between 2009 and 2012.

Sun protection habits at 7 years of age in cohort I and II are presented in Table 4. Significant increases were observed for 'often use of sunscreen', 'often staying in shade' and 'often staying indoors' from cohort I to cohort II: 65 vs 80%, 7.6 vs 13% and 7.3 vs 19%, respectively. There were no differences between the cohorts for 'often use of T-shirt'.

Corresponding results at 7 and 10 years of age in cohort I are presented in Table 5. A statistically significant decrease was observed for 'often use of T-shirt', from 45% at age 7 to 32% at age 10. In contrast, a significant increase for 'often staying indoors' was found at 10 years of age, 13% vs 7.3% at age 7. As no questionnaire was used in cohort II at 10 years of age in 2012, no comparisons over age could be performed.

Table 6 presents comparisons of sunburns and vacations in sunny resorts abroad from birth up to 10 years of age in cohort I. 'Ever sunburnt' increased significantly by age from 15% before the age of 2 to 96% between 7 and 10 years of age. 'Vacation in sunny resort abroad' increased significantly from 16% before 2 years of age to 60% between 7 and 10 years of age.

4. Discussion

The major finding from this study was a significant decrease in mean CMN density (per m^2 BSA), at the age of 10 years from 2005 to 2012. The change in density from 7 to 10 years of age decreased significantly from 2009 to 2012 (cohort II) compared with 2002 to 2005

Table 2
Subject characteristic data at 7 and 10 years of age in cohort I and II.

	Cohort I		Cohort II			
	(year 2002) 7 years of age n = 396 %	(year 2005) 10 years of age n = 400 %	(year 2009) 7 years of age n = 294 %	(year 2012) 10 years of age n = 235 %	Comparison between the open cohorts 7 years of age p-value	10 years of age p-value
Eye colour					0.7121	0.9255
Brown	22	24	24	24		
Blue/grey	74	73	72	74		
Green	3.3	2.9	3.7	2.6		
Hair colour					0.9067	0.6496
Dark	6.6	19	14	20		
Ash blond	26	29	18	25		
Blond	66	51	64	52		
Red	1.8	1.7	3.7	2.6		
Skin photo type					0.4112	
I	1.3	3.3	5.0	No data		No data
II	12	14	19	No data		No data
III	75	68	57	No data		No data
IV	12	15	19	No data		No data
Gender					0.2637	0.6402
Girls	53	51	49	49		
Boys	47	49	51	51		
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)		
Body surface area (m^2)	0.97 (0.10)	1.22 (0.14)	0.96 (0.11)	1.20 (0.15)	0.1302	0.1475
Weight (kg)	26.7 (4.7)	37.5 (7.5)	26.2 (5.1)	36.4 (8.0)	0.1857	0.0834
Height (cm)	127.0 (5.3)	143.4 (6.6)	126.3 (5.9)	143.8 (7.2)	0.1293	0.5213

SD, standard deviation.

Table 3
Number of common melanocytic nevi (CMN) and number of CMN per m^2 body surface area (BSA) by body area in cohort I and II and mean and 95% confidence interval at respective age and of change between 7 and 10 years of age.

	Cohort I		Cohort II	
Number of subjects with data from both 7 and 10 years of age	347		191	
	7 years of age (year 2002)	10 years of age (year 2005)	7 years of age (year 2009)	10 years of age (year 2012)
Number of all CMN	12.9 (11.9–13.9)	19.4 (17.9–21.0)	9.8 (8.9–10.7)	13.5 (12.1–15.2)
Type of UV exposure				
Chronic	1.0 (0.9–1.1)	1.4 (1.2–1.5)	1.0 (0.8–1.2)	1.3 (1.1–1.5)
Intermittent	10.4 (9.6–11.2)	16.5 (15.2–17.9)	7.7 (7.0–8.4)	10.9 (9.6–12.1)
Rare	1.5 (1.3–1.6)	1.5 (1.3–1.8)	1.1 (0.9–1.2)	1.6 (1.2–1.9)
Number of all CMN per m^2 BSA	13.2 (12.3–14.1)	15.9 (14.7–17.2)	10.3 (9.3–11.2)	11.4 (10.1–12.7)
Type of UV exposure				
Chronic	7.2 (6.3–8.1)	8.4 (7.5–9.4)	7.1 (5.9–8.3)	8.0 (6.5–9.5)
Intermittent	16.8 (15.6–18.0)	21.0 (19.3–22.7)	12.8 (11.6–13.9)	14.2 (12.5–15.8)
Rare	6.9 (6.2–7.6)	5.7 (4.8–6.5)	5.1 (4.3–6.0)	5.9 (4.6–7.3)
	Change between 7 and 10 years of age within respective cohort			
Number of all CMN	6.8 (5.9–7.7)		3.8 (2.9–4.7)	
Type of UV exposure				
Chronic	0.4 (0.2–0.5)		0.2 (0.0–0.4)	
Intermittent	6.4 (5.6–7.3)		3.2 (2.4–4.0)	
Rare	0.0 (−0.2 − 0.2)		0.6 (0.3–0.9)	
Number of all CMN per m^2 BSA	2.8 (2.1–3.5)		0.9 (0.2–1.5)	
Type of UV exposure				
Chronic	1.2 (0.3–2.1)		0.0 (−1.3 − 1.3)	
Intermittent	4.4 (3.4–5.4)		1.1 (0.1–2.1)	
Rare	−1.3 (−2.1 −0.6)		1.2 (−0.0 − 2.4)	

UV, ultraviolet.

Table 4
Sun protection habits at 7 years of age in cohort I and II as reported by their parents in a questionnaire.

Sun protection habits	Cohort I (year 2002)	Cohort II (year 2009)	p-value
	%	%	
Use of sunscreen			<0.0001
Never	4.4	1.1	
Seldom	6.2	4.3	
Sometimes	24	14	
Often	65	80	
Use of T-shirts			0.3213
Never	1.8	3.7	
Seldom	6.3	8.8	
Sometimes	47	42	
Often	45	45	
Staying in the shade			0.0001
Never	19	11	
Seldom	35	28	
Sometimes	39	49	
Often	7.6	13	
Staying indoors			<0.0001
Never	35	14	
Seldom	27	24	
Sometimes	31	43	
Often	7.3	19	

(cohort I). Significant increases were observed for 'often use of sunscreen', 'often staying in shade' and 'often staying indoors' from cohort I to cohort II, and these results support the observed changes in CMN prevalence.

CMN develop during childhood, but the findings support previous evidence that the development of CMN is related to the level of sun exposure in childhood. Interestingly, the prevalence of CMN per m^2 BSA is lower at the age of 10 in 2012 (cohort II) than at the age of 7 in 2002 (cohort I). This is in line with the results of an Australian study [18] where they demonstrated that 12- to 35-month-old children on average had fewer CMN compared with the same age group 8 years earlier.

Table 5
Sun protection habits at 7 and 10 years of age in cohort I as reported by their parents in a questionnaire.

Sun protection habits	7 years of age (year 2002)	10 years of age (year 2005)	p-value
	%	%	
Use of sunscreen			0.1616
Never	4.4	3.6	
Seldom	6.2	8.9	
Sometimes	24	27	
Often	65	60	
Use of T-shirts			<0.0001
Never	1.8	7.6	
Seldom	6.3	15	
Sometimes	47	45	
Often	45	32	
Staying in the shade			0.9076
Never	19	22	
Seldom	35	30	
Sometimes	39	41	
Often	7.6	7.4	
Staying indoors			0.0007
Never	35	24	
Seldom	27	29	
Sometimes	31	35	
Often	7.3	13	

Table 6
Sunburns and vacations in sunny resorts abroad in children at ages <2, 2–4, >4–7 and >7–10 years in cohort I as reported by the parents in a questionnaire.

Sunburns	%	p-value	Vacation in a sunny resort abroad	%	p-value
		<0.0001			<0.0001
< 2 years			*< 2 years*		
Never	85		Never	84	
Ever	15		Ever	16	
2-4 years			*2-4 years*		
Never	52		Never	73	
Ever	48		Ever	26	
>4–7 years			*>4–7 years*		
Never	29		Never	53	
Ever	71		Ever	47	
>7–10 years			*>7–10 years*		
Never	3.5		Never	40	
Ever	96		Ever	60	

The strength of our present study is the population-based design implying that all eligible children were identified and offered participation and was performed in the same geographical area. Another main advantage is that the same research nurse performed CMN counting in all examinations minimising methodological errors. There were no statistically significant differences between the two cohorts for eye or hair colour, skin phototype, gender, BSA, weight or height and at 7 or at 10 years of age, making them comparable for these factors. A limitation is that the study design systematically underestimates the number of CMN because only those with a diameter of ≥2 mm were counted, but when comparing results with the same method at all occasions, this should not have influenced the results. In 2012, the clinical examination was given priority, while the questionnaire was omitted due to financial restriction. The willingness to participate in our studies decreased with age and time, which was also reported in research from Australia [11].

There is strong evidence that intermittent sun-exposed body areas have an increased CMM risk [25,26], and the prevalence of CMN in this report is also higher in these areas compared with chronically and rarely exposed areas.

In 2009, we found significant increase for often use of sunscreen, staying in shade and staying indoors at the age of 7 compared with 2002. Despite fewer CMN, no decrease in sunburns was seen, also reported by Smith *et al.* [18]. In a study by Autier *et al.* [27] where four European cities were included, no association with sunburns and nevus count was found.

A decline in CMM rates has been demonstrated among young people in Australia, and there is a discussion whether the decline may be a consequence of changes in behaviour unrelated to primary prevention activities [28]. Periodic national surveys have documented trends of increasing screen time, less time spent on outdoor playing and fewer children walking or cycling to school; all of which should lead to less sun exposure than for previous generations of Australian children. In a study among Swedish children, the trend of technology-mediated communication also showed an increase between 2001 and 2010 [29] of staying indoors.

Swedish families travel a lot even with very young children, and questionnaires revealed an increase in travels to seaside resorts abroad from birth to the age 10 years over the period of 2002 to 2005, and there was also an increase in sunburns by age. In an earlier report, a doubled risk of sunburn was observed if the child had been at a seaside resort abroad before 2 years of age [20]. However, there was no information as to whether they had been sunburnt abroad or in Sweden. The Swedish Environmental Health Report of 2005 stated that it was more common to protect children when on a seaside vacation abroad than in Sweden [30]. This may perhaps contribute to the observed decrease in the prevalence of CMN despite the increasing travelling to a seaside vacation abroad.

Karlsson *et al.* [21] demonstrated similarities regarding gender profiles, number and anatomic distributions of CMN in children and CMM in young adults residing within the same geographic regions and range of latitudes. CMN were predominantly located on the trunk and matched best with CMM distributions in young and middle-aged adults. This is in keeping with the theory of divergent pathways of CMM, promoting the role of CMN as predictors of CMM risk on the trunk and limbs rather than the face [31]. The relationship between anatomic distribution of CMM and CMN in adulthood has been thoroughly reviewed [32–35], but site comparisons with CMN in childhood have been less studied.

Lifetime risk to die from melanoma increased in successive generations from 1875 until a peak from 1936 to 1957, dependent of where subjects were born [3]. It started in Oceania in 1936–1940, and the peak years in Northern Europe and Central Europe were 1941–1942 and 1957, respectively. Then the death started to decrease in successive generations, and in 1990–1995, the risk levels were the same as for subjects born before 1900–1905. The authors concluded that in the future, melanoma deaths will decrease due to reductions in UV exposure of children over the decades.

However, the decreases in CMN may not only depend on the parental actions as there is an improvement in the sun-safe policy in both preschools and schools during this period.

The information on sun protection in Swedish media and by The Swedish Radiation Safety Authority in recent years should have contributed to the positive effects [36].

5. Conclusion

The decrease in number of CMN and CMN density among 10-year-olds confirms a current trend in Sweden regarding increased awareness of the risk of sun overexposure. Because UV exposure during childhood is considered an important risk factor, this may ultimately affect the CMM incidence positively. Results further support that CMN density in children can be recommended as an objective indicator when following trends. To reduce the incidence of CMM, the change in attitude and behaviour must continue in both parents and their children to limit sun overexposure.

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Conflict of interest statement

None declared.

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References

[1] National Board of Health and Welfare. Cancer incidence in Sweden 2016. 2017. Stockholm, Sweden.
[2] Erdmann F, Lortet-Tieulent J, Schuz J, Zeeb H, Greinert R, Breitbart E, et al. International trends in the incidence of malignant melanoma 1953-2008—are recent generations at higher or lower risk? Int J Cancer 2012;132:385–400.
[3] Autier P, Koechlin A, Boniol M. The fortcoming inexorable decline of cutaneous melanoma mortality in light-skinned populations. Eur J Cancer 2015;51:869–78.
[4] Wallingford SC, Iannacone MR, Youlden DR, Baade PD, Ives A, Verne J, et al. Comparison of melanoma incidence and trends among youth under 25 years in Australia and England, 1990-2010. Int J Cancer 2015;137:2227–33.
[5] Gandini S, Sera F, Cattaruzza MS, Pasquini P, Abeni D, Boyle P, et al. Meta-analysis of risk factors for cutaneous melanoma: I. Common and atypical naevi. Eur J Cancer 2005 Jan;41:28–44.

[6] Holman CD, Armstrong BK. Pigmentary traits, ethnic origin, benign nevi, and family history as risk factors for cutaneous malignant melanoma. J Natl Cancer Inst 1984 Feb;72:257–66.
[7] Gallagher RP, McLean DL, Yang CP, Coldman AJ, Silver HKB, Spinelli JJ, et al. Suntan, sunburn, and pigmentation factors and the frequency of acquired melanocytic nevi in children. Similarities to melanoma: the Vancouver Mole Study. Arch Dermatol 1990;126:770–6.
[8] Dennis LK, Vanbeek MJ, Beane Freeman LE, Smith BJ, Dawson DV, Coughlin JA. Sunburns and risk of cutaneous melanoma:does age matter? A comprehensive meta-analysis. Ann Epidemiol 2008;18:614–27.
[9] Ghiasvand R, Robsahm TE, Green AC, Rueegg CS, Weiderpass E, Lund E, et al. Association of phenotypic characteristics and UV radiation exposure with risk of melanoma on different body sites. JAMA Dermatol 2019;155(1):39–49.
[10] Garbe C, Buttner P, Weiss J, Soyer HP, Stocker U, Kruger S, et al. Risk factors for developing cutaneous melanoma and criteria for identifying persons at risk: multicenter case-control study of the Central Malignant Melanoma Registry of the German Dermatological Society. J Investig Dermatol 1994;102:695–9.
[11] Kelly JW, Rivers JK, MacLennan R, Harrison S, Lewis AE, Tate BJ. Sunlight: a major factor associated with the development of melanocytic nevi in Australian schoolchildren. J Am Acad Dermatol 1994;30:40–8.
[12] Luther H, Altmeyer P, Garbe C, Ellwanger U, Jahn S, Hoffmann K, et al. Increase of melanocytic nevus counts in children during 5 years of follow-up and analysis of associated factors. Arch Dermatol 1996;132:473–8.
[13] Wachsmuth RC, Turner F, Barret JH, Gaut R, Randerson-Moor JA, Bishop DT, et al. The effect of sun exposure in determing nevus density in UK adolcent twins. J Investig Dermatol 2005;124:56–62.
[14] Dodd AT, Morelli J, Mokrohisky ST, Asdigian N, Byers TE, Crane LA. Melanocytic nevi and sun exposure in a cohort of Colorado children: anatomic distribution and site-specific sunburn. Cancer Epidemiol Biomark Prev 2007;16:2136–43.
[15] dos Santos Silva I, Higgins CD, Abramsky T, Swanwick MA, Frazer J, Whitaker LM, et al. Overseas sun exposure, nevus counts, and premature skin aging in young English women: a population-based survey. J Investig Dermatol 2009;129:50–9.
[16] Rodvall Y, Wahlgren CF, Ullen H, Wiklund K. Common melanocytic nevi in 7-year-old schoolchildren residing at different latitudes in Sweden. Cancer Epidemiol Biomark Prev 2007;16:122–7.
[17] Karlsson MA, Wahlgren CF, Wiklund K, Rodvall Y. Parental sun protective regimens and prevalence of common melanocytic nevi among 7-year-old children in Sweden:changes over a 5-year period. Br J Dermatol 2011;164:830–7.
[18] Smith A, Harrisson S, Nowak M, Buettner P, MacLennan R. Changes in the pattern of sun exposure and sun protection in young children from tropical Australia. J Am Acad Dermatol 2013;68:774–83.
[19] Phalberg A, Uter W, Kraus C, Wienecke WR, Reulbach U, Kölmel KF, et al. Monitoring of nevus density in children as a method to detect shifts in melanoma risk in the population. Prev Med 2004;38:382–7.
[20] Rodvall YE, Wahlgren CF, Ullen HT, Wiklund K. Factors related to being sunburnt in 7-year-old children in Sweden. Eur J Cancer 2010;46:566–72.
[21] Karlsson MA, Rodvall Y, Wahlgren C-F, Wiklund K, Lindelöf B. Similar anatomical distributions of childhood naevi and cutaneous melanoma in young adults residing in northern and southern Sweden. Eur J Cancer 2015;51:2067–75.
[22] Karlsson MA, Rodvall Y, Wahlgren C-F, Lindelöf B, Wiklund K. Changes in body-site distribution of common melanocytic nevi among 7-year old Swedish children between 2002 and 2007. Acta Derm Venerol 2015;95:804–8.
[23] English DR, MacLennan R, Rivers J, Kelly J, Armstrong BK. Epidemiological studies of melanocytic naevi:protocol for identifying and recording naevi. IARC internal report no. 90/002. Lyon: IARC; 1990.
[24] Mosteller RD. Simplified calculation of body-surface area. N Engl J Med 1987;317:1098.
[25] Gandini S, Sera F, Cattaruzza MS, Pasquini P, Picconi O, Boyle P, et al. Meta-analysis of risk factors for cutaneous melanoma:II Sun exposure. Eur J Cancer 2005;41(1):45–60.
[26] Berwick M, Buller DB, Cust A, Gallagher R, Lee TK, Meyskens F, et al. Melanoma epidemiology and prevention. Cancer Treat Res 2016;167:17–49.
[27] Autier P, Doré J-F, Cattaeuzza MS, Renard F, Luther H, Gentiloni-Silverj F, et al. Sunscreen use, wearing clothes, and number of nevi in 6-to 7-year old European children. J Natl Cancer Inst 1998;90:1873–80.
[28] Whiteman DC, Green AC, Olsen CM. The Growing burden of invasive melanoma: projections of incidence rates and numbers of new cases in six susceptible populations through 2031. J Investig Dermatol 2016;136:1161–71.
[29] Bjereld Y, Daneback K, Löfstedt P, Bjarnason T, Tynjälä J, Välimaa R, et al. Time trends of technology mediated communication with friends among bullied and not bullied children in four Nordic countries between 2001 and 2010. Child Care Health Dev 2016;3:451–7.
[30] National Board of Health and Welfare. Environmental health report 2005. Stockholm. 2005.
[31] Kvaskoff M, Pandeya N, Green AC, Perry S, Baxter C, Davis MB, et al. Site-specific determinants of cutaneous melanoma. A case-control comparison of patients with tumors arising on the head or trunk. Cancer Epidemiol Biomark Prev 2013;22:2222–31.
[32] Randi G, Naldi L, Gallus S, Di Landro A, Veccia C. Oncology Study group of the Italian Group for Epidemiologic Research in Dermatology (GISED). Number of nevi at a specific anatomical site and its relation to cutaneous malignant melanoma. J Investig Dermatol 2006;126:2106–10.
[33] Chiarugi A, Quaglino P, Crocetti E, Nardini P, De Giorgi V, Borgognoni L, et al. Melanoma density and relationship with the distribution of melanocytic nevi in an Italian population: a GIPMe study- the Italian multidiciplinary group on melanoma. Melanoma Res 2015;25:80–7.
[34] Cho E, Rosner BA, Colditz GA. Risk factors for melanoma by body site. Cancer Epidemiol Biomark Prev 2005;14:1241–4.
[35] Kruger S, Garbe C, Buttner P, Stadler R, Guggenmoos-Holzmann I, Orfanos CE. Epidemiologic evidens for the role of melanocytic nevi as risk markers and direct precursors of cutaneous malignant melanoma. Resultas of a case-control study in melanoma patients and non-melanoma control subjects. J Am Acad Dermatol 1992;26:920–6.
[36] (http://www.ssm.se).