



SUPPLEMENT ARTICLE

Prevalence and determinants of sunbed use in thirty European countries: data from the Euromelanoma skin cancer prevention campaign

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Abstract

Background Although considered as a first-group carcinogen, indoor tanning is a common practice in Europe. Euromelanoma is a pan-European skin cancer prevention campaign.

Objectives To compare several European countries in terms of the prevalence and determinants of sunbed use.

Methods Participants in the Euromelanoma campaigns filled in questionnaires containing demographics and risk factors, including type/duration of sunbed use. Multivariate analyses adjusted for age, gender, education, skin type and year of survey were employed to assess factors independently associated with sunbed use in each country.

Results In total, 227 888 individuals (67.4% females, median age 44, 63.4% highly educated, 71.9% skin types III–VI) from 30 countries participated. Overall, the prevalence of sunbed ever use was 10.6% (≤ 19 -year-olds: 5.9%; 20 to 35-year-olds: 17.0%; > 35 -year-olds: 8.3%). Females displayed a higher prevalence than males in all countries. Balkan countries displayed the highest female/male ratios (≥ 4). Sunbed use was significantly more prevalent among skin type III–VI (14/30 countries) and highly educated participants (11/30 countries). Significant correlations were found between sunbed use prevalence and countries' latitude ($P < 0.001$) and sunshine ($P = 0.002$); Italy and Spain represented exceptions towards excessive exposure. Very different prevalence rates were found for Spain (19.3%) and Portugal (2.0%). Scandinavian countries ranked highest in sunbed use among ≤ 19 -year-olds, Baltic countries among 20 to 35-year-olds.

Conclusions Sunbed use prevalence was higher in northern, sun-deprived countries, with the exception of Italy and Spain. The main determinants of sunbed use were age (young adults) and gender (females), whereas education and skin type had a less relevant effect. Geographic particularities were found in four regions: Iberian (prevalence ten times higher in Spain than Portugal), Balkan (prevalence disproportionately higher among women), Baltic (highest prevalence among young adults) and Scandinavian (highest prevalence among adolescents). These data have public health relevance for future interventions aimed at reducing sunbed use in Europe.

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Conflict of interest

None.

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Introduction

Indoor tanning has been classified as a first-group carcinogen by the World Health Organization (WHO).^{1,2} The use of sunbeds and sunlamps for cosmetic and recreational purposes should therefore be regarded as harmful to the human health. It has been reported that the risk of both melanoma and non-melanoma skin cancer is significantly increased by sunbed use, particularly if exposure occurs at a young age.^{1,3,4} A recent study calculated that the cost of medical care for treating skin cancer attributable to indoor tanning in the United States amounts to \$343 million per year, indicating that sunbed use represents a major burden on post-industrial economies.⁵ Nevertheless, indoor tanning is still alarmingly common, especially in northern/western Europe, where the prevalence of sunbed exposure was shown to be higher than in the United States and Australia by a meta-analysis.⁶ It has been suggested that the prevalence of sunbed use varies greatly not only across demographic variables such as sex, age and education, but also from one country to another.⁷ A comparison of several European countries in terms of prevalence and determinants of indoor tanning might therefore be crucial to better design future preventive messages and legislative actions in order to reduce sunbed use in Europe. Unfortunately, such a comparison has not been made to date.

Euromelanoma is a pan-European campaign for skin cancer primary and secondary prevention. Started in 1999 in Belgium, it now involves more than 30 countries. Euromelanoma aims to improve public awareness of skin tumours and to screen the general public annually. Throughout the years, participants in the screening filled in questionnaires that included demographic characteristics, phenotypic features, constitutional and behavioural risk factors for skin cancer, including sunbed use.^{8–10}

The aim of this study was to compare the prevalence and determinants of indoor tanning in countries participating in the Euromelanoma campaign.

Materials and methods

The Euromelanoma campaign was organized on a yearly basis by the Euromelanoma Networking Group, under the auspices of the European Academy of Dermatology and Venereology (EADV) and the European Association of Dermato-Oncology (EADO). A media campaign targeting the general public and focusing each year on a different aspect of skin cancer prevention was ran on TV, radio and newspapers/magazines during the month of April. Then, the Euromelanoma day took place each

year in May, both in university-based and hospital-based outpatient clinics, and private dermatology surgeries: on the day, participants were screened for suspicious skin lesions and filled in questionnaires on demographics and risk factors, including type and duration of sunbed use, as previously described.^{8–10} Questionnaires were sent to the national coordinator of each country and data were entered in a unique database (developed with Limesurvey version 1.82+), located at the Department of Dermatology, Université Libre de Bruxelles, Brussels, Belgium.

The average latitude of each country was calculated as the mean of the highest and lowest latitude of that country.¹¹ The yearly sunshine hours of capital cities were considered as a proxy of the country's solar irradiation.¹² Age was categorized into three groups: <20 years (adolescents), 20–35 years (young adults) and >35 years (adults/elderly); these cut-offs were chosen based on: (i) the conventional definition of adolescence given by health societies/organizations¹³; and (ii) the evidence that the risk of melanoma is significantly increased if first exposure to sunbeds occurs before age 35 years.^{1,3} Education was categorized into low (no education; primary school; secondary school) and high (vocational training; university degree or higher). Fitzpatrick's skin types were categorized into fair (I–II) and dark (III–VI).¹⁴ Current sunbed use was investigated by the question 'Do you use solarium?' (possible answers 'No', 'Yes, ≤20 sessions/year', 'Yes, >20 sessions/year'). Duration of ever sunbed use was enquired by the question 'Number of years using solarium (including in the past only)' (open answer) and categorized as ≤10 years and >10 years. Participants not reporting current sunbed use but reporting duration of sunbed use were then considered ever users along with those reporting current use. Ever sunbed use was categorized as never and ever used.

Descriptive statistics, with frequencies, median values and interquartile ranges, are presented to define the sociodemographic characteristics of the surveyed population. Percentages and confidence intervals are presented to define the prevalence of sunbed use. Countries were grouped in tertiles based on the distribution of their prevalence of sunbed use. Multivariate generalized linear models (including age, gender, education, skin type and year of survey) with binomial distribution and logit as link function were used to assess factors independently associated with sunbed use in each country. The correlation between prevalence and latitude/yearly sunshine hours was estimated using Spearman's correlation coefficients. We fit smooth non-parametric locally weighted regression (LOESS) function curves

as a robust fitting method to examine the trend between prevalence and latitude/sunshine.¹⁵ All statistical tests were considered significant for P -values ≤ 0.05 . Statistical analyses were carried out using SAS 9.2.

Results

Overall, 227 888 individuals from 30 European countries were screened during the Euromelanoma campaigns 2009–2014 as follows: 28 145 individuals (from 12 countries) participated in 2009; 32 886 (19 countries) in 2010; 35 402 (21 countries) in 2011; 38 307 (21 countries) in 2012; 51 607 (22 countries) in 2013; and 41 541 (25 countries) in 2014.

Descriptive features of the study population are displayed in Table 1. The question about gender was answered by 225 234/227 888 (98.8%) participants, of which 151 747 (67.4%) were females and 73 487 (32.6%) males. Aside from Cyprus (for which number were small), female/male ratios were >1 for all participating countries. Information about age was provided by 219 751/227 888 (96.4%) participants: of those, 16 942 (7.7%) were adolescents (<20 years), 59 396 (27.0%) were young adults (20–35 years) and 143 413 (65.3%) were adults/elderly (>35 years). Median age was 44 years (interquartile range 31–59). Information about education was given by 208 541/227 888 (91.5%) participants: of those, 132 132 (63.4%) attained high education and 76 409 (36.6%) low education. Information about skin type was provided by 222 061/227 888 (97.4%) participants: of those, 62 485 (28.1%) reported skin type I–II and 159 576 (71.9%) skin type III–VI. Data on sunbed use were available for 220 531/227 888 (96.8%) participants: of those 23 334 (10.6%) reported ever use of sunbed.

The prevalence of ever sunbed use, latitude and yearly sunshine hours for each participating country are reported in Table 2. Belgium, Latvia, Denmark, Norway, Italy, Hungary, Spain and Estonia topped the list, all showing a prevalence of use $>18\%$ (first tertile; Fig. 1). Latitude spanned from 61° (Norway) to 35° (Cyprus). Yearly sunshine hours ranged from 1447 (Dublin, Ireland) to 3314 (Nicosia, Cyprus).

The prevalence of sunbed use and latitude were positively correlated (Spearman's $\rho = 0.63$, $P < 0.001$), whereas the prevalence of sunbed use and yearly sunshine hours showed a negative correlation (Spearman's $\rho = -0.54$, $P = 0.002$) among participating countries. The non-parametric LOESS function curves examining these correlations are shown in Figs 2 and 3, respectively. In both curves, exceptions towards excessive sunbed use included Italy, Spain, Hungary, Belgium: all displayed a higher prevalence than expected taking into account latitude and, to a lesser extent for Belgium, yearly sunshine hours.

Details on intensity of sunbed use by country are provided in Table S1 (Supporting Information). The majority of sunbed users were light users (<20 sessions/year, <10 years) for all countries but Turkey (40.0%). The highest proportion of heavy users

(>20 sessions/year) was found for Turkey (60.0%), Malta (40.0%), Hungary (19.1%), Russia (19.0%) and Spain (17.1%). The highest rate of long-term users (>10 years) was detected for Norway (23.9%), Germany (23.8%) and Belgium (15.1%).

Questions about age and sunbed use were answered simultaneously by 212 967 participants: indoor tanning prevalence was 5.9% (919/15 482) among adolescents, 17.0% (9928/58 367) among young adults and 8.3% (11 608/139 118) among adults/elderly. The prevalence of sunbed use was significantly higher for the young adult group in 23/30 (76.7%) countries, after adjustment for confounders (Table 3). Exceptions were Norway, Sweden, Ireland and Turkey, where adolescents displayed a higher prevalence of use than other age groups, although not significantly for the latter two. The top user countries were for adolescents, Norway (33.3%), Belgium (26.5%), Denmark (23.9%) and Sweden (23.5%); for young adults, Latvia (46.8%), Denmark (36.0%), Lithuania (34.2%) and Estonia (33.4%); and for adults/elderly, Belgium (25.2%), Denmark (20.9%), Norway (19.1%) and Italy (18.9%).

Females displayed higher prevalence of sunbed use than males in all countries (Table 4A), independently from age, education, skin type and year of survey. The difference was not significant for Georgia and Turkey ($P = 0.08$ for both) due to low overall prevalence of use. All countries displayed a female/male ratio ≥ 2 , except Norway (1.9), Switzerland (1.9) and Denmark (1.8). Female/male ratios ≥ 3 were detected in 15/30 (50%) countries. Female/male ratios ≥ 4 were found in Bosnia-Herzegovina (6.6), Croatia (6.3), Macedonia (FYROM) (4.9), Greece (4.8), Romania (4.6), Ukraine (4.6) and Serbia (4.4).

After adjustment for confounders, sunbed use was significantly more prevalent among highly educated participants in 11 countries, and among low educated individuals in Belgium and Germany (Table 4B). Similarly, sunbed use was significantly more prevalent among darker skin types in 14 countries, and among fairer skin types in Switzerland (Table 4C).

Geographic particularities of sunbed use in Europe were detected for the Iberian, Balkan, Baltic and Scandinavian regions and will be debated in the discussion (Fig. 4).

Discussion

To our knowledge, this is the first investigation ever comparing the prevalence and determinants of sunbed use in a vast number of countries participating in the same survey. The study included 30 European countries participating in the Euromelanoma campaign. The screenees were predominantly highly educated females older than 35, similar to previous reports.^{9,10,16–18}

We found an overall European prevalence of sunbed use of 10.6%, with very large variations across countries. This is four times lower than reported by a previous meta-analysis (42%).⁶ The fact that our sample came from a skin cancer prevention

Table 1 Descriptive features of the study population. Number of participants and frequencies of the main variables (gender, age, educational level, skin type and sunbed use) are reported for each participating country

	Number of participants		Gender	n	%	F/M	Age (years)	n	%	Education	n	%	Skin type	n	%	Sunbed use	n	%
Belgium	10 179		Female	6239	61.3	1.7	<20	176	1.7	High	6086	59.8	I-II	3944	38.7	Yes	2646	26.0
			Male	3710	36.4		≥20	8735	85.8	Low	3478	34.2	III-VI	6097	59.9	No	7360	72.3
			Missing	230	2.3		Missing	1268	12.5	Missing	615	6.0	Missing	138	1.4	Missing	173	1.7
Bosnia-Herzegovina	7187		Female	4663	64.9	1.9	<20	537	7.5	High	3825	53.2	I-II	1768	24.6	Yes	354	4.9
			Male	2477	34.5		≥20	6534	90.9	Low	3123	43.5	III-VI	5282	73.5	No	6585	91.6
			Missing	47	0.7		Missing	116	1.6	Missing	239	3.3	Missing	137	1.9	Missing	248	3.5
Croatia	4800		Female	3110	64.8	1.9	<20	414	8.6	High	2054	42.8	I-II	1018	21.2	Yes	563	11.7
			Male	1633	34.0		≥20	4357	90.8	Low	2574	53.6	III-VI	3681	76.7	No	3964	82.6
			Missing	57	1.2		Missing	29	0.6	Missing	172	3.6	Missing	101	2.1	Missing	273	5.7
Cyprus	35		Female	13	37.1	0.9	<20	0	0.0	High	17	48.6	I-II	25	71.4	Yes	2	5.7
			Male	14	40.0		≥20	22	62.9	Low	18	51.4	III-VI	10	28.6	No	33	94.3
			Missing	8	22.9		Missing	13	37.1	Missing	0	0.0	Missing	0	0.0	Missing	0	0
Czech Rep.	16 992		Female	11 334	66.7	2.0	<20	1700	10.0	High	2458	14.5	I-II	4087	24.1	Yes	1769	10.4
			Male	5645	33.2		≥20	15 286	90.0	Low	6753	39.7	III-VI	12 594	74.1	No	15 152	89.2
			Missing	13	0.1		Missing	6	0.0	Missing	7781	45.8	Missing	311	1.8	Missing	71	0.4
Denmark	2487		Female	1661	66.8	2.1	<20	117	4.7	High	1516	61.0	I-II	482	19.4	Yes	570	22.9
			Male	780	31.4		≥20	2368	95.2	Low	835	33.6	III-VI	1911	76.8	No	1804	72.5
			Missing	46	1.8		Missing	2	0.1	Missing	136	5.5	Missing	94	3.8	Missing	113	4.5
Estonia	1318		Female	980	74.4	3.0	<20	132	10.0	High	847	64.3	I-II	699	53.0	Yes	238	18.1
			Male	331	25.1		≥20	1186	90.0	Low	385	29.2	III-VI	583	44.2	No	1079	81.9
			Missing	7	0.5		Missing	0	0.0	Missing	86	6.5	Missing	36	2.7	Missing	1	0.1
Georgia	2689		Female	2013	74.9	3.0	<20	193	7.2	High	2104	78.2	I-II	605	22.5	Yes	37	1.4
			Male	669	24.9		≥20	2439	90.7	Low	555	20.6	III-VI	2076	77.2	No	2639	98.1
			Missing	7	0.3		Missing	57	2.1	Missing	30	1.1	Missing	8	0.3	Missing	13	0.5
Germany	9347		Female	5749	61.5	1.6	<20	224	2.4	High	3705	39.6	I-II	2174	23.3	Yes	974	10.4
			Male	3488	37.3		≥20	8565	91.6	Low	3379	36.2	III-VI	6845	73.2	No	8222	88.0
			Missing	110	1.2		Missing	558	6.0	Missing	2263	24.2	Missing	328	3.5	Missing	151	1.6
Greece	33 252		Female	21 095	63.4	1.8	<20	2787	8.4	High	24 215	72.8	I-II	10 143	30.5	Yes	988	3.0
			Male	11 680	35.1		≥20	29 408	88.4	Low	8414	25.3	III-VI	22 553	67.8	No	31 836	95.7
			Missing	477	1.4		Missing	1057	3.2	Missing	623	1.9	Missing	556	1.7	Missing	428	1.3
Hungary	13 256		Female	9726	73.4	2.8	<20	1217	9.2	High	6601	49.8	I-II	3377	25.5	Yes	2573	19.4
			Male	3452	26.0		≥20	11 935	90.0	Low	6189	46.7	III-VI	9525	71.9	No	10 208	77.0
			Missing	78	0.6		Missing	104	0.8	Missing	466	3.5	Missing	354	2.7	Missing	475	3.6
Ireland	380		Female	230	60.5	1.6	<20	14	3.7	High	212	55.8	I-II	116	30.5	Yes	40	10.5
			Male	143	37.6		≥20	344	90.5	Low	152	40.0	III-VI	247	65.0	No	263	69.2
			Missing	7	1.8		Missing	22	5.8	Missing	16	4.2	Missing	17	4.5	Missing	77	20.3
Italy	3529		Female	2150	60.9	1.6	<20	351	9.9	High	1093	31.0	I-II	895	25.4	Yes	700	19.8
			Male	1361	38.6		≥20	3150	89.3	Low	2215	62.8	III-VI	2552	72.3	No	2822	80.0
			Missing	18	0.5		Missing	28	0.8	Missing	221	6.3	Missing	82	2.3	Missing	7	0.2

Table 1 Continued

	Number of participants	Gender	n	%	F/M	Age (years)	n	%	Education	n	%	Skin type	n	%	Sunbed use	n	%
Latvia	2400	Female	1865	77.7	3.7	<20	206	8.6	High	1819	75.8	I-II	1398	58.3	Yes	590	24.6
		Male	508	21.2		≥20	2165	90.2	Low	509	21.2	III-VI	937	39.0	No	1784	74.3
		Missing	27	1.1		Missing	29	1.2	Missing	72	3.0	Missing	65	2.7	Missing	26	1.1
Lithuania	5902	Female	4159	70.5	2.5	<20	561	9.5	High	4483	76.0	I-II	1571	26.6	Yes	850	14.4
		Male	1635	27.7		≥20	5157	87.4	Low	1198	20.3	III-VI	4228	71.6	No	4971	84.2
		Missing	108	1.8		Missing	184	3.1	Missing	221	3.7	Missing	103	1.7	Missing	81	1.4
Macedonia (FYROM)	1292	Female	833	64.5	1.9	<20	85	6.6	High	712	55.1	I-II	499	38.6	Yes	59	4.6
		Male	445	34.4		≥20	1120	86.7	Low	560	43.3	III-VI	793	61.4	No	1233	95.4
		Missing	14	1.1		Missing	87	6.7	Missing	20	1.5	Missing	0	0	Missing	0	0
Malta	432	Female	245	56.7	1.3	<20	28	6.5	High	165	38.2	I-II	183	42.4	Yes	2	0.5
		Male	186	43.1		≥20	401	92.8	Low	250	57.9	III-VI	244	56.5	No	424	98.2
		Missing	1	0.2		Missing	3	0.7	Missing	17	3.9	Missing	5	1.2	Missing	6	1.4
Moldova	56	Female	39	69.6	2.3	<20	8	14.3	High	42	75.0	I-II	13	23.2	Yes	2	3.6
		Male	17	30.4		≥20	48	85.7	Low	13	23.2	III-VI	43	76.8	No	54	96.4
		Missing	0	0.0		Missing	0	0.0	Missing	1	1.8	Missing	0	0	Missing	0	0
Norway	1323	Female	794	60.0	1.5	<20	13	1.0	High	1071	81.0	I-II	222	16.8	Yes	296	22.4
		Male	527	39.8		≥20	1300	98.3	Low	243	18.4	III-VI	1090	82.4	No	1011	76.4
		Missing	2	0.2		Missing	10	0.8	Missing	9	0.7	Missing	11	0.8	Missing	16	1.2
Poland	8391	Female	5495	65.5	2.0	<20	866	10.3	High	5249	62.6	I-II	1807	21.5	Yes	1192	14.2
		Male	2683	32.0		≥20	7271	86.7	Low	2759	32.9	III-VI	6388	76.1	No	6672	79.5
		Missing	213	2.5		Missing	254	3.0	Missing	383	4.6	Missing	196	2.3	Missing	527	6.3
Portugal	7655	Female	4749	62.0	1.7	<20	389	5.1	High	2855	37.3	I-II	3451	45.1	Yes	151	2.0
		Male	2802	36.6		≥20	6214	81.2	Low	3403	44.5	III-VI	4099	53.5	No	7455	97.4
		Missing	104	1.4		Missing	1052	13.7	Missing	1397	18.2	Missing	105	1.4	Missing	49	0.6
Romania	2875	Female	1852	64.4	1.9	<20	869	30.2	High	1289	44.8	I-II	942	32.8	Yes	167	5.8
		Male	987	34.3		≥20	1969	68.5	Low	1389	48.3	III-VI	1896	65.9	No	2552	88.8
		Missing	36	1.3		Missing	37	1.3	Missing	197	6.9	Missing	37	1.3	Missing	156	5.4
Russia	19 400	Female	15 965	82.3	5.1	<20	1722	8.9	High	13 714	70.7	I-II	5243	27.0	Yes	1747	9.0
		Male	3151	16.2		≥20	17 182	88.6	Low	4635	23.9	III-VI	13 143	67.7	No	15 923	82.1
		Missing	284	1.5		Missing	496	2.6	Missing	1051	5.4	Missing	1014	5.2	Missing	1730	8.9
Serbia	9080	Female	6055	66.7	2.1	<20	743	8.2	High	4351	47.9	I-II	2475	27.3	Yes	855	9.4
		Male	2880	31.7		≥20	7728	85.1	Low	4471	49.2	III-VI	6510	71.7	No	7715	85.0
		Missing	145	1.6		Missing	609	6.7	Missing	258	2.8	Missing	95	1.0	Missing	510	5.6
Slovenia	808	Female	478	59.2	1.5	<20	43	5.3	High	454	56.2	I-II	168	20.8	Yes	49	6.1
		Male	326	40.3		≥20	763	94.4	Low	350	43.3	III-VI	636	78.7	No	758	93.8
		Missing	4	0.5		Missing	2	0.2	Missing	4	0.5	Missing	4	0.5	Missing	1	0.1
Spain	5191	Female	3382	65.2	1.9	<20	203	3.9	High	3472	66.9	I-II	2303	44.4	Yes	931	17.9
		Male	1809	34.8		≥20	3976	76.6	Low	1709	32.9	III-VI	2779	53.5	No	4260	82.1
		Missing	0	0.0		Missing	1012	19.5	Missing	10	0.2	Missing	109	2.1	Missing	0	0

Table 1 Continued

	Number of participants	Gender	n	%	F/M	Age (years)	n	%	Education	n	%	Skin type	n	%	Sunbed use	n	%
Sweden	17 978	Female	11 507	64.0	1.8	<20	368	2.0	High	11 652	64.8	I-II	3612	20.1	Yes	2884	16.0
		Male	6250	34.8		≥20	17 429	96.9	Low	6124	34.1	III-VI	14 041	78.1	No	14 380	80.0
		Missing	221	1.2		Missing	181	1.0	Missing	202	1.1	Missing	325	1.8	Missing	714	4.0
Switzerland	19 751	Female	11 230	56.9	1.4	<20	826	4.2	High	13 241	67.0	I-II	5368	27.2	Yes	1674	8.5
		Male	8323	42.1		≥20	18 298	92.6	Low	5412	27.4	III-VI	13 681	69.3	No	17 101	86.6
		Missing	198	1.0		Missing	627	3.2	Missing	1098	5.6	Missing	702	3.6	Missing	976	4.9
Turkey	1854	Female	1206	65.0	1.9	<20	203	10.9	High	1076	58.0	I-II	697	37.6	Yes	17	0.9
		Male	635	34.3		≥20	1631	88.0	Low	727	39.2	III-VI	1090	58.8	No	1763	95.1
		Missing	13	0.7		Missing	20	1.1	Missing	51	2.8	Missing	67	3.6	Missing	74	4.0
Ukraine	18 049	Female	12 930	71.6	2.6	<20	1925	10.7	High	11 754	65.1	I-II	3200	17.7	Yes	414	2.3
		Male	4940	27.4		≥20	15 850	87.8	Low	4587	25.4	III-VI	14 022	77.7	No	17 174	95.2
		Missing	179	1.0		Missing	274	1.5	Missing	1708	9.5	Missing	827	4.6	Missing	461	2.6

FYROM, Former Yugoslav Republic of Macedonia.

campaign is likely to account for this finding, as well as a wider geographical inclusion of countries: while the meta-analysis of Wehner *et al.*⁶ included mostly northern and western European countries, we were able to analyse for the first time data coming also from eastern European countries, in which a lower prevalence of sunbed use was generally found. Even so, we were able to detect alarmingly high prevalence rates in several European countries. Our analysis of the trend between prevalence and latitude confirmed the existence of a North-South gradient of sunbed use in Europe, with northern countries more likely to use sunbeds, as previously reported.^{7,19–22} Nonetheless, we found interesting exceptions. Italy and Spain were in this regard the most striking examples: despite being southern and sunny countries, they both showed high prevalence of use (around 20%), as had previously been reported for Italy;^{9,23} additionally, Spain also displayed high intensity of use. Hungary and Belgium could also be considered exceptions, both showing higher prevalence and intensity of sunbed use than countries located at similar latitudes. The role of Belgium as an exception was nevertheless scaled down by taking into account its very limited solar irradiation, which does not reflect its latitude. The reduced amount of yearly sunshine hours of this country might explain why Belgians used sunbeds more than participants from northern states such as Russia, Scandinavian and Baltic countries. Possible explanations for these variations in the prevalence of sunbed use across countries might include discrepancies in sociocultural background, availability of indoor tanning salons and self-service sunbeds, impact of prevention campaigns and presence/efficacy of sunbed regulation. The huge difference in sunbed use prevalence found between Spain (19.3%) and Portugal (2.0%) was intriguing and could be referred to as the *Iberian particularity*. Although neighbouring, these two countries seem to differ greatly in self-image perceptions: compared to the Portuguese, the Spaniards were reported to be more self-centred and focused on physical appearance,^{24,25} and to have different patterns of body dissatisfaction and disordered eating.²⁶ Accordingly, the Spaniards might adopt indoor tanning much more than the Portuguese as a solution to achieve their ideal body image, despite being aware of the sunbed-associated risks.²⁷ Indeed, positive attitudes towards tanning among Spanish adolescents,²⁸ as well as limited prevalence of sunbed use among Portuguese beach-goers, were previously reported.²⁹ Furthermore, differently from Spain, Portugal was part of the Joint Market Surveillance Action on sunbeds and solarium services coordinated by PROSAFE (Product Safety Forum of Europe) and sanctioned the operators non-compliant with the national sunbed regulation.³⁰ This might have possibly contributed to raise awareness of the hazards of sunbed use among the Portuguese population.

Multivariate models showed that the prevalence of sunbed use was higher among young adults than in other age groups. This could be explained by taking into account that:

Table 2 Prevalence of sunbed use for the 30 participating countries

	Prevalence of sunbed use		Latitude (decimal degrees)*	Yearly sunshine hours†	Capital city
	%	95% CI			
Belgium	26.5	25.6–27.4	50.85	1546	Brussels
Bosnia-Herzegovina	5.1	4.6–5.7	44.00	1769	Sarajevo
Croatia	12.5	11.6–13.5	45.80	1888	Zagreb
Cyprus	5.7	0.7–19.2	35.00	3314	Nicosia
Czech Republic	10.5	10–10.9	49.75	1668	Prague
Denmark	24.2	22.4–26.1	55.72	1780	Copenhagen
Estonia	18.1	16.1–20.3	59.00	1826	Tallinn
Georgia	1.4	1.0–1.9	42.00	2046	Tbilisi
Germany	10.5	9.8–11.3	52.52	1626	Berlin
Greece	3.0	2.9–3.3	39.00	2848	Athens
Hungary	20.4	19.7–21.2	47.43	1988	Budapest
Ireland	13.1	9.3–17.7	53.34	1447	Dublin
Italy	20.5	19.1–22.0	41.90	2473	Rome
Latvia	25.2	23.3–27.2	57.00	1754	Riga
Lithuania	14.7	13.7–15.6	55.00	1588	Vilnius
Macedonia (FYROM)	4.6	3.5–5.9	41.60	2339	Skopje
Malta	0.5	0.1–1.7	35.88	3049	Valletta
Moldova	3.6	0.4–12.3	47.00	2126	Chişinău
Norway	22.2	19.9–24.6	61.00	1668	Oslo
Poland	15.3	14.5–16.2	52.22	1571	Warsaw
Portugal	2.0	1.7–2.3	38.70	2806	Lisbon
Romania	6.0	5.2–7.0	44.41	2112	Bucharest
Russia	10.0	9.5–10.6	60.00	1731	Moscow
Serbia	10.1	9.5–10.8	44.80	2112	Belgrade
Slovenia	6.0	4.5–7.9	46.05	1974	Ljubljana
Spain	19.3	18.1–20.6	40.43	2769	Madrid
Sweden	16.9	16.3–17.4	59.35	1821	Stockholm
Switzerland	9.1	8.7–9.6	46.83	1682	Bern
Turkey	1.0	0.6–1.7	39.92	2486	Ankara
Ukraine	2.5	2.2–2.8	49.00	1843	Kiev

*The average latitude of each country was calculated as the mean of the highest (north) and lowest (south) latitude.

†The yearly sunshine hours of the capital city of each country (listed) were considered as a proxy of the solar irradiation of that country.

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(i) with growing age prevalence of ever use will increase; and (ii) the older individuals likely did not have the chance to use sunbeds in their younger years. At any rate, the high prevalence of use among young adults is worrisome as ever use before age 35 as well as repeated/prolonged use between 10 and 39 years of age have been associated with significant melanoma risk increase (75% and 237%, respectively).^{1,3,31} When considering the young adult group only, the three Baltic countries ranked among the top four in terms of prevalence of sunbed use. This *Baltic particularity* could be explained by the rapid globalization process that Estonia, Lithuania and Latvia have experienced in recent years at many different levels.^{32,33} Arguably, the spread of consumerism and the tendency to see beauty as the path to well-being may have prompted young adults in those countries to engage more than ever in indoor tanning practices. We believe this should be taken into consideration when

formulating future preventive messages targeting these countries.

Although the prevalence among adolescents was not excessive overall (5.9%), we found that it was disturbingly high (>20%) for four countries: Norway, Belgium, Denmark and Sweden. Of these, three are Scandinavian countries. Additionally, for Norway and Sweden, teenagers were the most likely age group to engage in indoor tanning. This *Scandinavian particularity* of high sunbed use among adolescents is in line with previous studies carried out in Denmark,^{34–36} Sweden^{37–40} and Norway⁴¹ and raises important issues such as the need for more stringent legislation and/or enforcement of the existing regulations in those countries, especially for young individuals. In Denmark, efforts have been made in recent years to reduce sunbed use among adolescents. An antisunbed campaign raised awareness of the sunbed-related risks among Danish adolescents, and indeed, sunbed use decreased substantially; yet, it remained considerable

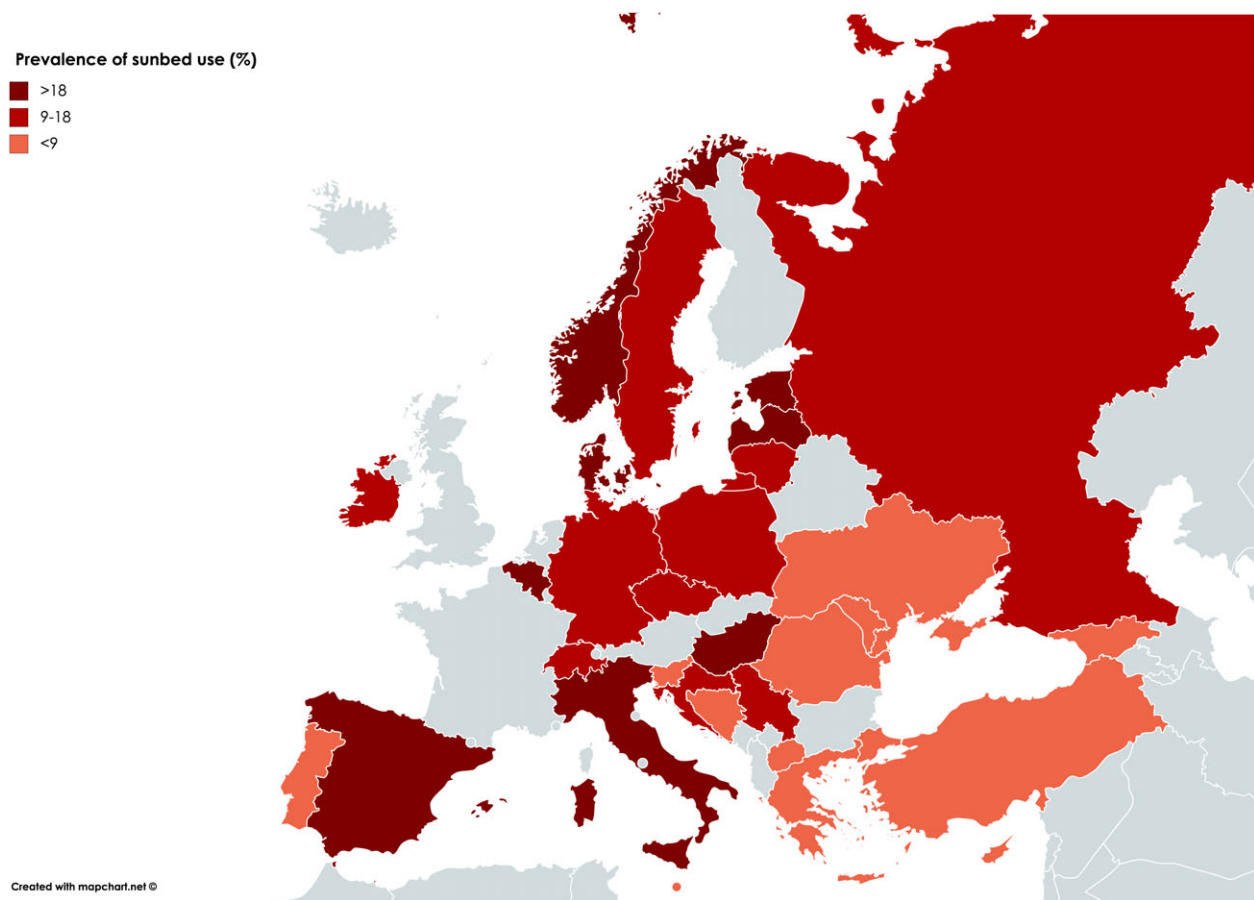


Figure 1 Prevalence of ever use of sunbed in the 30 participating countries. Countries were grouped in tertiles based on the distribution of their prevalence of sunbed use. Image created with mapchart.net ©.

(>30%).^{42,43} Moreover, an educational intervention in Danish schools produced a significant reduction in sunbed use, but failed to change pupils' intentions and attitudes towards artificial tanning.⁴⁴ Importantly, all three Scandinavian countries displayed high rates of long-term sunbed users (>10 years) in our analysis.

Women are known to use sunbeds more than men.^{6,45,46} Our data confirmed this evidence beyond any doubt. A more prevalent use by females was observed for each participating country and was statistically significant after adjustment for important confounders such as age, education and skin type (Georgia and Turkey were exceptions due to low overall prevalence of use; Cyprus, Malta and Moldova were exceptions due to all users being females in those countries). While many studies reported that women are two-to-three times more likely than men to engage in indoor tanning,^{19–22,27,34,39,41,42,44,47–61} we found that the predominance of female users was even higher (females/males ≥ 3) in half of the participating countries. Interestingly, the highest disproportions (females/males ≥ 4) were detected in the

Balkans, which we refer to as the *Balkan particularity* of sunbed use. It has been suggested that gender role differences are particularly strong in certain Balkan countries because the difficult post-war times shaped masculinities towards traditional/patriarchal norms.⁶² This might have reinforced the differences between men and women, including social norms about body appearance. Since the view of masculinity has recently become less unbalanced among Balkan young generations,⁶³ we speculate that sunbed use in the Balkan Peninsula will become more even across gender in the future. Conversely, the female predominance in sunbed use was less pronounced in Denmark, Switzerland and Norway. Interestingly, all three are at the top of the European ranking by gross domestic product (GDP) per capita.⁶⁴ Because gender equality is usually proportional to GDP per capita,⁶⁵ it is plausible that in wealthy countries, men and women might have aesthetic needs and sun-seeking behaviours more and more similar to each other.

Although sunbed use has been widely associated with high educational level,^{22,42,47,48,53,55,66} we were able to confirm this

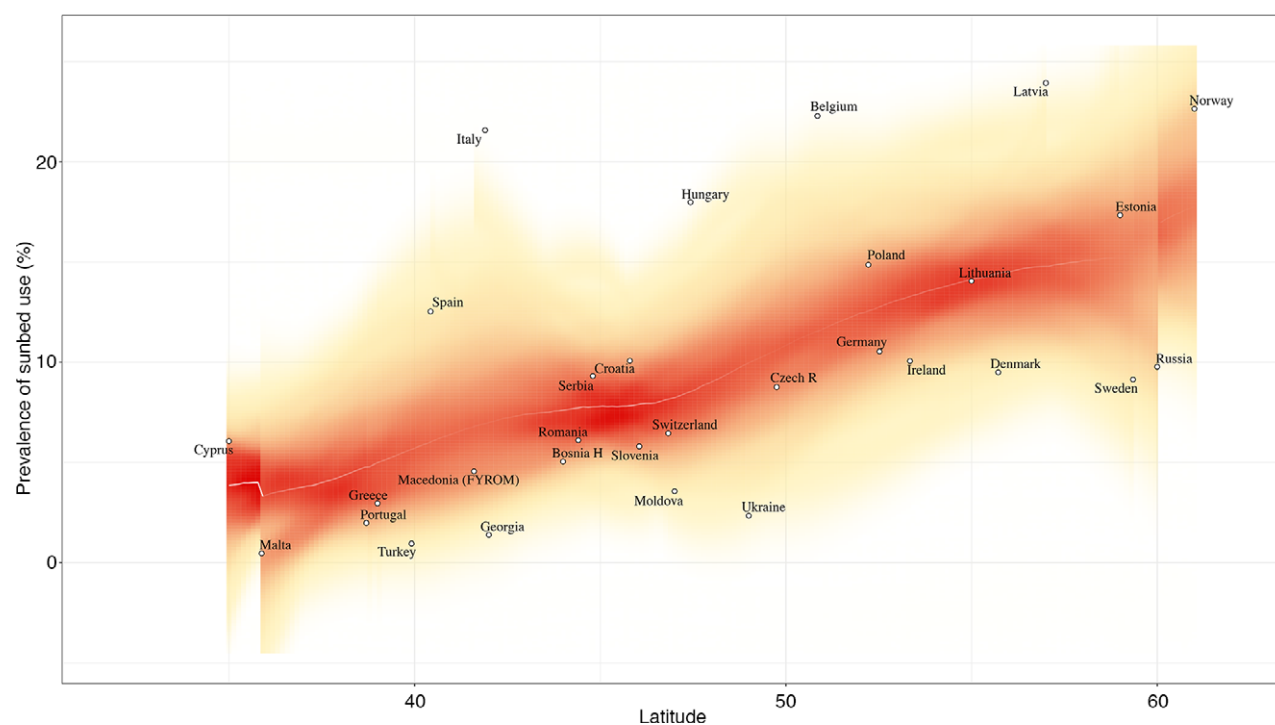


Figure 2 Non-parametric locally weighted regression (LOESS) function curve illustrating the trend between prevalence of sunbed use and latitude (Spearman's $\rho = 0.63$, $P < 0.001$).

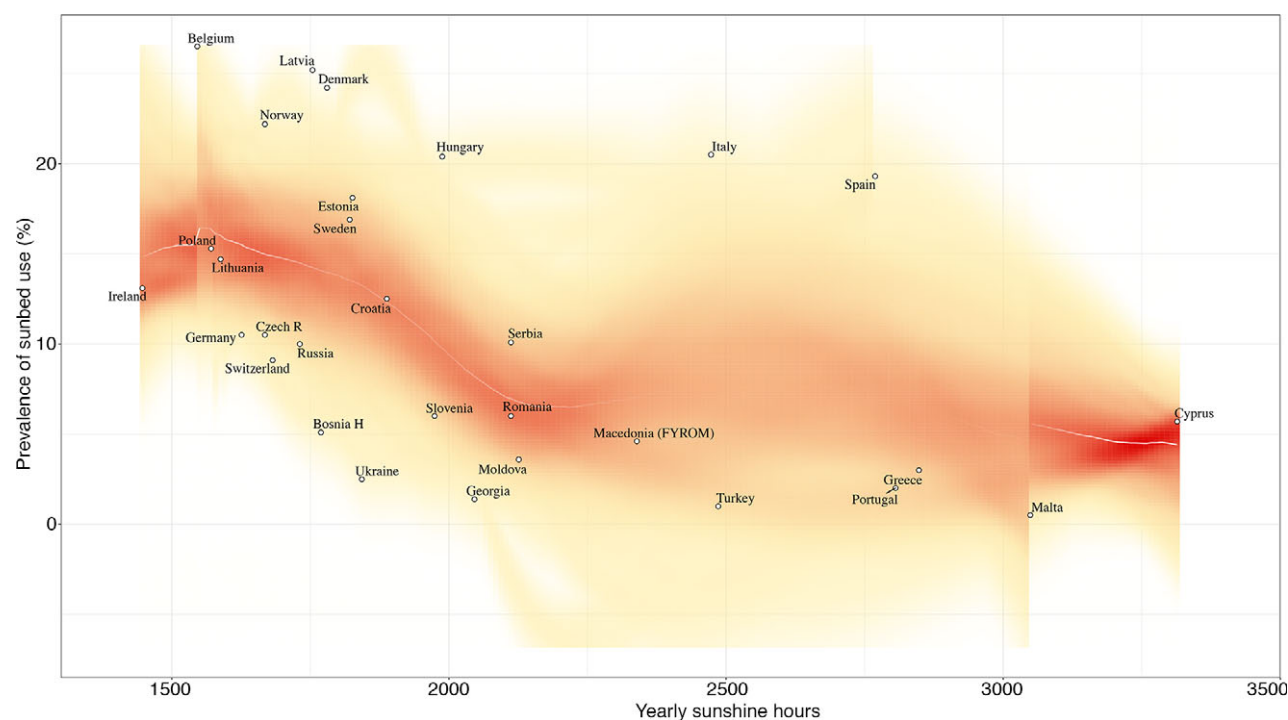


Figure 3 Non-parametric locally weighted regression (LOESS) function curve illustrating the trend between prevalence of sunbed use and yearly sunshine hours (Spearman's $\rho = -0.54$, $P = 0.002$).

Table 3 Prevalence of sunbed use for the 30 participating countries, according to age group (adolescents, young adults, adult/elderly)

	Age <20 years		Age 20–35 years		Age >35 years		<i>P</i> -value*	<i>P</i> -value†
	%	95% CI	%	95% CI	%	95% CI		
Belgium	26.5	24.1–28.9	30.0	28.1–31.9	25.2	24.1–26.3	<0.001	<0.001
Bosnia-Herzegovina	4.0	2.6–6.0	11.2	9.9–12.6	2.2	1.8–2.7	<0.001	<0.001
Croatia	3.9	2.2–6.5	23.2	20.8–25.7	9.2	8.2–10.3	0.01	<0.001
Cyprus	–	–	15.4	1.9–45.5	–	–	–	–
Czech Republic	7.2	6.0–8.6	21.9	20.8–23.1	5.7	5.3–6.2	0.001	<0.001
Denmark	23.9	15.6–33.9	36.0	31.6–40.7	20.9	19.0–23.0	0.30	<0.001
Estonia	11.4	6.5–18.1	33.4	28.4–38.8	13.3	11.1–15.7	0.06	<0.001
Georgia	0.4	0.0–2.2	4.8	3.1–6.9	0.6	0.3–1.0	0.99	<0.001
Germany	11.9	9.4–14.8	18.9	16.6–21.4	8.8	8.0–9.5	0.02	<0.001
Greece	1.5	1.1–2.0	4.5	4.1–4.9	2.3	2.1–2.6	<0.001	<0.001
Hungary	10.6	8.9–12.6	33.4	31.9–35.0	15.0	14.2–15.9	0.08	<0.001
Ireland	15.0	3.2–37.9	10.0	3.3–21.8	13.6	9.2–19.2	0.28	0.76
Italy	5.9	3.7–9.0	32.4	28.9–35.9	18.9	17.3–20.6	<0.001	<0.001
Latvia	16.9	11.8–23.2	46.8	42.7–51.0	15.7	13.7–18.0	0.03	<0.001
Lithuania	11.3	9.0–14.0	34.2	31.8–36.8	6.9	6.0–7.8	<0.001	<0.001
Macedonia (FYROM)	4.1	1.7–8.2	12.2	9.0–16.1	1.2	0.5–2.2	<0.001	<0.001
Malta	–	–	–	–	0.6	0.1–2.2	–	–
Moldova	–	–	–	–	5.3	0.6–17.8	–	–
Norway	33.3	13.3–59.0	32.3	26.8–38.3	19.1	16.6–21.8	0.08	<0.001
Poland	7.0	5.4–9.0	23.1	21.4–24.8	12.0	10.9–13.1	<0.001	<0.001
Portugal	1.6	1.0–2.5	4.5	3.5–5.6	1.2	0.9–1.5	0.88	<0.001
Romania	6.5	4.9–8.5	10.3	8.0–13.1	3.5	2.5–4.7	0.02	<0.001
Russia	7.1	5.7–8.7	20.9	19.5–22.3	5.3	4.8–5.9	<0.001	<0.001
Serbia	9.5	7.8–11.3	19.1	17.4–20.8	6.4	5.8–7.2	0.002	<0.001
Slovenia	–	–	10.8	7.0–15.8	4.6	3.0–6.7	–	0.003
Spain	16.6	14.5–18.9	29.5	26.4–32.6	16.5	14.8–18.2	<0.001	<0.001
Sweden	23.5	19.6–27.7	23.1	21.4–24.8	15.5	14.9–16.1	<0.001	<0.001
Switzerland	5.5	4.2–7.1	12.9	11.9–14.0	8.3	7.8–8.8	0.01	<0.001
Turkey	1.8	0.4–5.1	1.3	0.5–2.7	0.6	0.2–1.5	0.09	0.14
Ukraine	2.6	1.9–3.5	7.0	6.1–8.0	0.9	0.7–1.2	<0.001	<0.001

**P* value refers to the comparison between the <20 years and the >35 years groups.

†*P* value refers to the comparison between the 20–35 years and the >35 years groups. Differences could not be assessed for Cyprus (all users young adult), Malta (all users adults/elderly), Moldova (all users adults/elderly) and Slovenia (no adolescent users).

Age groups were compared by means of multivariate models also including gender, education, skin type and year of survey.

Significant findings are highlighted in bold.

FYROM, Former Yugoslav Republic of Macedonia.

association only partly. Indeed, our multivariate analysis excluded a large effect of educational attainment on sunbed use. This might represent an indication that indoor tanning –traditionally associated with higher socio-economic status^{20,27,55,59,60,66,67}– has started to transcend educational level and possibly social class in Europe, as previously suggested.^{21,34}

In line with previous data,^{45,47,48,50,55,60} we found that sunbed use was more prevalent in darker skin types. However, the prevalence of use in skin types I–II was non-negligible for several countries, in accordance with other previous observations.^{20,23,51,60}

The strengths of the study are that: it is the first investigation ever comparing 30 European countries in terms of prevalence/determinants of sunbed use; the sample size was extremely large; the same questionnaire was used in all

participating countries; and multivariate models were used to find independent determinants of sunbed use. The obvious limitation is that the study was not population-based, but carried out within a skin cancer screening campaign. This might have not only selected a population more responsible towards indoor tanning (selection bias), but also induced participants to under-report a ‘bad’ habit, in order to feel less guilty and please their doctors (social desirability bias). Moreover, skin type was self-reported and we cannot exclude that sunbed users wanted to perceive themselves as darker and therefore reported a darker skin type (reporting bias). Another limitation was that latitude, sunshine and wealth measures were only available for the country as a whole and not for the individual subjects, since the survey did not enquire about city of residence nor personal income

Table 4 Prevalence of sunbed use for the 30 participating countries according to gender, education and skin type

	A. Gender				B. Education				C. Skin type							
	Females		Males		P	Ratio F/M	High education		Low education		P	Skin type III–VI		Skin type I–II		P
	%	95% CI	%	95% CI			%	95% CI	%	95% CI		%	95% CI	%	95% CI	
Belgium	34.6	33.4–35.8	13.1	12.0–14.3	<0.001	2.6	25.5	24.4–26.6	28.1	26.5–29.6	<0.001	28.6	27.5–29.8	23.1	21.8–24.5	<0.001
Bosnia-Herzegovina	7.3	6.5–8.1	1.1	0.7–1.6	<0.001	6.6	6.5	5.8–7.4	3.5	2.8–4.2	0.002	5.4	4.8–6.0	4.3	3.4–5.4	0.10
Croatia	17.6	16.2–19.0	2.8	2.0–3.8	<0.001	6.3	15.2	13.6–16.9	10.4	9.2–11.7	0.21	12.7	11.6–13.9	11.8	9.9–14.0	0.01
Cyprus	7.7	0.2–36.0	–	–	–	–	–	–	11.1	1.4–34.7	–	–	–	8.0	1.0–26.0	–
Czech Rep.	13.7	13.1–14.4	3.9	3.4–4.5	<0.001	3.5	12.0	10.7–13.3	10.6	9.9–11.4	0.62	11.4	10.9–12.0	7.4	6.6–8.2	<0.001
Denmark	28.3	26.0–30.7	15.4	12.7–18.4	<0.001	1.8	26.3	23.9–28.7	19.5	16.7–22.6	<0.001	23.8	21.8–25.9	24.0	20.3–28.1	0.20
Estonia	21.7	19.2–24.4	7.3	4.7–10.7	<0.001	3	19.6	17.0–22.5	17.8	14.1–22.0	0.48	18.3	15.3–21.6	17.5	14.8–20.5	0.53
Georgia	1.7	1.2–2.4	0.5	0.1–1.3	0.08	3.4	1.6	1.1–2.2	0.7	0.2–1.8	0.78	1.6	1.1–2.3	0.5	0.1–1.4	0.06
Germany	13.0	12.0–14.0	6.4	5.5–7.4	<0.001	2	9.8	8.9–10.9	11.2	10.1–12.4	0.01	11.6	10.8–12.5	6.6	5.5–7.9	<0.001
Greece	4.3	4.0–4.6	0.9	0.7–1.1	<0.001	4.8	3.6	3.3–3.8	1.6	1.3–1.9	<0.001	3.0	2.8–3.3	3.1	2.7–3.4	0.25
Hungary	25.0	24.1–25.9	7.6	6.7–8.6	<0.001	3.3	22.7	21.7–23.8	18.9	17.9–20.0	0.02	21.6	20.7–22.5	17.0	15.8–18.3	<0.001
Ireland	16.3	11.1–22.7	7.7	3.2–15.2	0.02	2.1	11.1	6.6–17.2	16.2	9.7–24.7	0.39	13.6	9.0–19.4	12.6	6.7–21.0	0.31
Italy	25.8	23.9–27.8	12.3	10.6–14.3	<0.001	2.1	24.3	21.7–27.1	19.2	17.6–21.0	0.69	19.8	18.2–21.4	21.3	18.6–24.1	0.94
Latvia	29.1	26.8–31.5	10.4	7.6–13.8	<0.001	2.8	26.5	24.3–28.9	22.0	18.0–26.4	0.65	28.7	25.6–32.0	22.2	19.8–24.7	<0.001
Lithuania	18.5	17.3–19.8	5.2	4.2–6.5	<0.001	3.6	15.2	14.1–16.3	13.9	11.9–16.2	0.81	16.0	14.9–17.2	10.9	9.4–12.6	<0.001
Macedonia (FYROM)	6.4	4.8–8.2	1.3	0.5–2.9	0.01	4.9	6.9	5.1–9.0	1.8	0.9–3.3	0.01	5.7	4.2–7.5	2.8	1.5–4.7	0.10
Malta	0.8	0.1–3.0	–	–	–	–	0.6	0.0–3.4	0.4	0.0–2.3	0.35	0.4	0.0–2.2	0.6	0.0–3.1	0.99
Moldova	5.1	0.6–17.3	–	–	–	–	4.8	0.6–16.2	–	–	–	4.7	0.6–15.8	–	–	–
Norway	27.4	24.2–30.8	14.1	11.2–17.6	<0.001	1.9	22.6	20.0–25.3	20.1	15.1–25.9	0.91	22.7	20.1–25.4	19.5	14.4–25.5	0.02
Poland	19.6	18.4–20.8	6.3	5.3–7.4	<0.001	3.1	16.5	15.4–17.6	13.4	12.0–14.9	0.50	16.3	15.3–17.3	11.8	10.2–13.5	<0.001
Portugal	2.5	2.1–3.0	1.1	0.7–1.5	<0.001	2.3	1.9	1.3–2.3	1.8	1.4–2.4	0.03	1.9	1.5–2.4	2.0	1.6–2.6	0.62
Romania	8.3	7.0–9.7	1.8	1.1–3.0	<0.001	4.6	6.3	5.0–7.9	5.8	4.5–7.2	0.94	6.3	5.2–7.5	5.4	4.0–7.1	0.29
Russia	11.1	10.5–11.8	4.1	3.2–5.1	<0.001	2.7	11.7	11.0–12.4	6.1	5.2–7.1	<0.001	11.2	10.6–11.9	7.0	6.2–7.9	<0.001
Serbia	13.3	12.4–14.2	3.0	2.3–3.7	<0.001	4.4	11.6	10.7–12.7	8.6	7.8–9.5	0.003	10.4	9.7–11.2	9.3	8.1–10.6	0.003
Slovenia	8.6	6.3–11.5	2.2	0.9–4.4	<0.001	3.9	7.1	4.9–9.9	4.3	2.5–7.1	0.51	6.5	4.7–8.7	4.1	1.7–8.2	0.12
Spain	25.1	23.4–26.8	8.8	7.4–10.4	<0.001	2.9	23.1	21.5–24.8	12.4	10.7–14.3	<0.001	20.1	18.4–21.9	18.6	16.9–20.4	0.02
Sweden	21.5	20.7–22.3	8.1	7.4–8.8	<0.001	2.7	17.1	16.4–17.9	16.5	15.5–17.5	0.95	17.4	16.7–18.0	14.4	13.2–15.6	<0.001
Switzerland	11.5	10.9–12.1	6.0	5.5–6.6	<0.001	1.9	10.0	9.5–10.6	7.1	6.4–7.9	0.005	8.9	8.4–9.4	9.2	8.5–10.0	0.03
Turkey	1.4	0.7–2.4	0.4	0.1–1.5	0.08	3.5	1.4	0.7–2.5	0.5	0.1–1.6	0.28	1.0	0.5–2.0	0.9	0.3–2.1	0.70
Ukraine	3.2	2.8–3.6	0.7	0.5–1.1	<0.001	4.6	2.7	2.4–3.1	1.5	1.1–2.0	0.002	2.6	2.3–2.9	1.8	1.4–2.4	0.01

Groups were compared by means of multivariate models including age, gender, education, skin type and year of survey.

Significant findings are highlighted in bold. Differences could not be ascertained for Cyprus (all users females, with low education and skin type I–II), Malta (all users females) and Moldova (all users females, with high education and skin type III–VI).

FYROM, Former Yugoslav Republic of Macedonia.

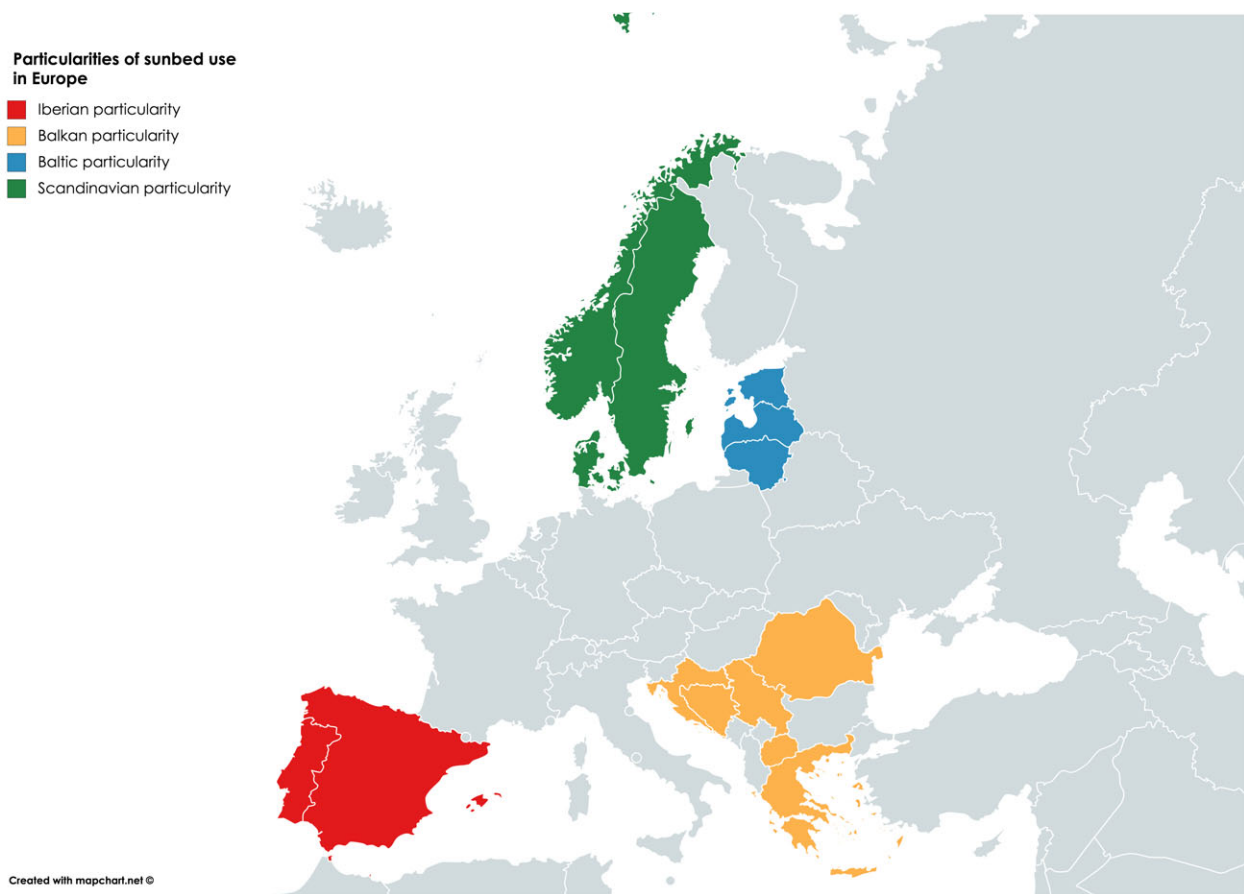


Figure 4 Geographic particularities of sunbed use in Europe: *Iberian particularity*, prevalence of ever use was 10 times higher in Spain than in Portugal; *Balkan particularity*, prevalence of ever use was disproportionally in favour of women; *Baltic particularity*, the highest prevalence of ever use among young adults; *Scandinavian particularity*, the highest prevalence of ever use among adolescents. Image created with mapchart.net ©.

due to privacy issues. Therefore, potentially important differences related to latitude/sunshine or income within each country (especially large ones) could not be assessed at the individual level. Moreover, attitudes, self-image perceptions and motives for sunbed use (which could help explaining the geographic particularities of sunbed use, particularly the Iberian one) were not investigated by the Euromelanoma questionnaire; nonetheless, it should be noted that a choice had to be made between asking the maximum possible amount of sociodemographic, constitutional, behavioural and clinical information and at the same time keeping the length of the questionnaire acceptable for both patients and busy clinicians performing a free-of-charge screening.

In conclusion, we presented a detailed analysis of sunbed use among participants in the Euromelanoma campaign, representative of 30 European countries. Expectedly, we found a prevalence of use lower than previously reported, as our data came from a skin cancer screening campaign and

were extrapolated not only from western countries, but also from eastern European states not included in previous meta-analyses. Prevalence rates were higher in northern, sun-deprived countries, although important exceptions were detected for Italy and Spain. The most important determinants of sunbed use were age and gender, with young adults and women being the most avid sunbed users. Interestingly, the effect of education and skin type on sunbed use was less relevant, suggesting that indoor tanning practices might transcend educational level and ability to tan. Geographic particularities were found in four regions: in the Iberian Peninsula, indoor tanning was around ten times more prevalent in Spain than Portugal despite similar latitude and solar irradiation; in the Balkan Peninsula, the differences in terms of sunbed use were disproportionately in favour of women; the Baltic countries displayed the highest prevalence rates among young adults; and the Scandinavian countries among adolescents. These data have public health relevance for

future, targeted interventions aimed at reducing sunbed use in European countries.

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Supporting information

Additional Supporting Information may be found in the online version of this article:

Table S1. Intensity of Use Among Indoor Tanners for Each Participating Country