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Sunscreen Sales, Socio-Economic Factors, and Melanoma Incidence in Northern Europe: A Population-Based Ecological Study

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Abstract

In this ecological study, we drew upon recently published melanoma prevalence data, and compared them with historical market data and published socio-economic data to test for an association between historical sunscreen sales (1997-1999) and recent melanoma incidences (2008 and 2012) in 24 countries in Northern Europe. We also explored associations between current melanoma incidences and historical data on the following socio-demographic indicators: income, urbanization, and population aging. Melanoma incidences were higher in high-income countries where sales of sunscreen were also higher. Our results show that, at the population level, income was significantly associated with melanoma incidences, $\beta = 0.0003$, $t(19) = 3.104$, $p < .006$, and that increased sunscreen sales has not prevented higher income populations from being at higher risk of melanoma.

Keywords

public health, health communication, melanoma, disposable income, sunscreen

Introduction

The overall global incidence of cutaneous malignant melanoma has been sharply growing over the past 50 years, with the highest rates outside of Australia and New Zealand being seen in a number of Northern European countries (Erdmann et al., 2013). Recent 10-year follow-up evidence from a randomized controlled trial suggests that melanoma may be prevented by using sunscreen, provided it is used optimally (i.e., applied every morning and reapplied after heavy sweating, bathing, or long sun exposure; Green, Williams, Logan, & Strutton, 2011). Despite Green et al.'s (2011) study providing strong evidence for the effectiveness of sunscreen under trial conditions (Robinson & Bigby, 2011), historical evidence from the late 1990s has shown that, in practice, many people do not apply sunscreen optimally (Robinson & Rademaker, 1998; Wartha Wright, Wright, & Wagner, 2001).

Epidemiological evidence from case–control studies is inconclusive, with some studies suggesting that sunscreen can reduce the risk of melanoma and non-melanoma skin cancers, and others suggesting that using sunscreen might actually increase the risk of melanoma by encouraging greater sunbathing time and thus ultraviolet (UV) exposure (Autier, 2001; Burnett & Wang, 2011; LeBoit, Burg, Weedon, & Sarasin, 2006; Planta, 2011; Weinstock, 2001). A meta-analysis by Dennis, Beane Freeman, and VanBeek (2003) identified seven case–control studies that reported a decreased risk of melanoma and nine studies that reported an increased risk of melanoma, although combined odds ratios of these studies failed to show either a significantly protective or harmful association between sunscreen use and melanoma. One of the main limitations of such case–control studies is that they are based on sunscreen use questionnaires, which use broad and sometimes subjective categories to measure the frequency of sunscreen use (e.g., "often"/"rarely"/"always," Wolf et al., 1998) and are subject to recall bias. Although sales do not directly equate to use (as not all product bought is necessarily used), market data can be considered a useful means of estimating use (in volume) because sales data are not subject to recall bias. To date, there have been no cross-national, population-based ecological studies exploring the association between melanoma prevalence and sunscreen sales data.

UV exposure is the only established exogenous *causal* factor for melanoma (Westerdahl, Ingvar, Masback, & Olsson, 2000), and UV radiation has been shown to have a strong negative association with latitude (Elwood et al., 1974). Epidemiologists have also explored whether

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socio-demographic variables, like income, aging, and urbanization, are also *risk* factors for melanoma. A number of studies at the local or national level suggest that risk of melanoma is higher among higher income populations within a country (Bentham & Aase, 1996; Haider, Mamdani, & Shear, 2007; Kerkpatrick, Lee, & White, 1990; Singh et al., 2011; van der Aa, de Vries, Hoekstra, Coebergh, & Siesling, 2011). Perez-Gomez et al. (2008) found that the relative risk of melanoma generally increased with urbanization (i.e., those living in larger towns were at higher risk of melanoma). In addition, increasing age is a risk factor for melanoma, whereby incidence starts to increase throughout adulthood and the highest age-specific incidence is in the older age groups (Marks, 2001). There are to our knowledge no substantial cross-national studies exploring the relationships between melanoma prevalence and income, urbanization, and aging at the population level.

In this ecological study, we drew upon recently published melanoma prevalence data, and compared these data with historical market data and published socio-economic data to test for an association between historical sunscreen sales and recent melanoma incidence in 24 countries in Northern Europe. We also explored associations between current melanoma incidence and historical data on the following socio-demographic indicators: income, urbanization, and population aging.

Our hypothesis is based on best-available evidence, as provided by Green et al.'s (2011) findings, that if applied *consistently* and *optimally*, sunscreen can effectively reduce the risk of melanoma among those at risk (Robinson & Bigby, 2011). Thus, we hypothesized that, after adjusting for income, urbanization, and aging and after controlling for latitude, higher historical sunscreen sales would be associated with lower recent melanoma incidence. Causality of course cannot be inferred from an ecological study, only a significant association. However, the presence of such an association could serve as a basis for further research into whether and why sunscreen has not been applied consistently and optimally across populations in line with recommended guidelines.

Method

Comparable melanoma incidences for 2008 and 2012 (per 100,000 of the population) were retrieved from GLOBOCAN—a publically available database produced by the International Agency for Research on Cancer's (IARC, 2014). A full description of the methodology can be found on the IARC website (IARC, 2014). According to IARC (2014), the methods of estimation are country-specific and depend on the quality and amount of the information available for each country. However, of the 24 countries in this sample, 21 were classified as "high quality regional or national data" (17 of which had coverage greater than 50% of a country's population; IARC, 2014). The IARC database provides the general incidence of melanoma, and did not provide information on melanoma incidence according to bodily sites nor according to type (i.e., invasive vs. in situ). Separate incidences for melanoma in men and women were available, as well as combined-sex melanoma incidences. Mean incidences were calculated using data for 2008 and 2012 (Table 1).

Industry data on sunscreen sales (in volume per capita) were obtained from the Euromonitor Passport Global Market Information Database, 2012 Edition (Euromonitor International, 2012).[1] Earliest available data were from 1997. This study uses mean sunscreen sales per capita between 1997 and 1999 (Table 1). It was felt that data from 1997 to 1999 were sufficient to explore its relationship with melanoma rates in 2008 and 2012. Existing research often assumes a minimum 10-year latency period (Liu & Soong, 1996; Mulliken, Russak, & Rigel, 2012). As such, looking at sunscreen sales approximately 10 years prior to recent melanoma rates can allow us to begin to explore whether there is an ecological association between the two.

To explore and adjust for the effect of potential confounding factors, we included three socio-demographic variables in our analyses. Data on income (gross domestic product [GDP] per capita, expressed in constant 2011 international dollars purchasing power parity for comparability), urbanization (the percentage of the population living in urban areas), and population aging (the percentage of the population older than 65 years) were taken from the World Bank World Development Indicators Database (2014 edition; World Bank, 2014). For sunscreen sales, income, urbanization, and population aging, all data were historical, expressed as an average of 3 years from 1997 to 1999 (Table 1).

The model controlled for latitude as a proxy for domestic/everyday UV exposure. Variations in the intensity of UV exposure are known to be related to melanoma incidences (Crombie, 1979), and a country's UV Index is closely correlated with its latitude. Only countries with latitudes of 45°N and above were used.[2] This is consistent with previous studies that have classified latitudes above 45°N as "high latitudes" (Chang et al., 2009). This allowed us to broadly control for a country's general UV exposure.[3] Also, in all countries, the vast majority of the population was Caucasian.[4]

Research has shown how, indoor tanning (in which sunscreen is generally not applied) can also significantly increase the risk of melanoma (Boniol, Autier, Boyle, & Gandini, 2012), thereby making it a target for regulation across Europe (Williams, 2012). Differences in sunbed use between countries may also have contributed to the observed differences in the incidence of melanoma between countries. We were unfortunately unable to find any comparable and consistent data on indoor tanning (sunbed) use for all 24 countries in this sample, despite extensive searching. A meta-analysis by Boniol et al. (2012) provided an estimated fraction of melanoma cases attributed to sunbed use in Europe for 12 countries included in this study.

Table 1. Melanoma Incidences, Sunscreen Sales, and Socio-Demographic Factors by Country.

Region	Country	Melanoma incidences	Sunscreen sales	Population aging (%)	Urbanization (%)	Income	Latitude
Central and Eastern Europe	Belarus	4.00	0.40	13.03	69.08	6,526	53°N
	Czech Republic	12.40	22.10	13.62	74.25	18,446	50°N
	Estonia	6.80	17.70	14.58	69.73	12,877	59°N
	Hungary	7.65	12.63	14.82	64.83	16,399	47°N
	Latvia	5.05	23.20	14.50	68.42	10,114	57°N
	Lithuania	5.05	7.77	13.24	67.11	11,264	56°N
	Poland	4.10	14.87	11.83	61.63	12,966	52°N
	Romania	3.15	3.90	12.83	53.31	9,837	46°N
	Russia	3.90	2.23	12.28	73.36	11,625	60°N
	Slovakia	9.35	5.67	11.17	56.36	14,883	49°N
	Slovenia	15.35	34.00	13.38	50.70	20,346	46°N
	Ukraine	3.95	2.33	13.61	67.07	4,496	53°N
Western Europe	Austria	8.85	61.33	15.32	65.80	35,272	47°N
	Belgium	11.25	47.43	16.59	97.00	34,576	51°N
	Denmark	18.85	42.10	14.99	85.06	38,649	56°N
	Finland	11.70	33.40	14.62	81.71	30,131	64°N
	France	9.15	29.77	15.72	75.43	32,235	46°N
	Germany	11.75	41.60	15.80	73.11	34,228	51°N
	Ireland	13.25	45.33	11.33	58.65	33,412	53°N
	Netherlands	18.05	38.53	13.41	75.24	36,646	52°N
	Norway	17.90	64.50	15.48	74.59	55,832	62°N
	Switzerland	19.75	73.67	15.04	73.42	44,776	47°N
	Sweden	17.00	20.90	17.33	83.97	32,078	62°N
	United Kingdom	13.55	60.83	15.81	78.53	29,393	54°N

Note. Melanoma incidences are new cases per 100,000 men and women per year, average 2008 and 2012. Sunscreen sales are in volume per capita (average 1997-1999). Population aging reflects the percentage of the population aged over 65 years, 1997-1999. Urbanization reflects the percentage of the population living in urban areas, 1997-1999. Income reflects GDP per capita 1997-1999, expressed in constant 2011 international dollars purchasing power parity for comparability. Latitudes are average national latitudes taken from the CIA Factbook (https://www.cia.gov/library/publications/the-world-factbook/).

Statistical Analysis

Statistical analyses were conducted in SPSS/PASW Statistics Version 18 (SPSS, Inc., 2014). The t tests were used to explore differences between male and female melanoma incidences and also between melanoma incidences in Western Europe and Central and Eastern Europe. Linear regressions were used to explore bivariate relationships between melanoma incidences and the independent variables—historical sunscreen sales, income, urbanization, population aging, and latitude. Only those variables that were significantly associated, or nearly significantly associated (95% confidence interval [CI]), with melanoma incidences were selected for the final multivariate regression model.

Results

Bivariate Analyses

A paired-samples t test revealed that melanoma incidences were higher in 2012 (10.92 ± 5.27) than they were in 2008 (9.89 ± 5.27), $t(22) = -5.182$, $p < .001$. Independent-samples t tests showed that there was no statistically significant difference in melanoma rates between males and females ($p > .05$). We chose to use only combined-sex melanoma incidence data in our subsequent analyses. Independent-samples t tests did, however, reveal that melanoma incidences in countries in Western Europe were significantly higher than in countries in Central and Eastern Europe, $t(22) = 4.78$, $p < .001$.

Bivariate regression analysis showed that there was a statistically significant relationship between mean sunscreen sales (1997-1999) and mean melanoma incidences (2008, 2012), $\beta = 0.183$, $t(22) = 5.207$, $p < .001$. However, contrary to our hypothesis, higher sunscreen sales were associated with higher melanoma incidences. Melanoma incidences were also significantly associated with income, $\beta = 0.0003$, $t(22) = 7.406$, $p < .001$; urbanization, $\beta = 0.196$, $t(22) = 1.953$, $p = .064$; and aging, $\beta = 1.377$, $t(22) = 5.207$, $p = .043$. Melanoma incidences were generally higher in countries with higher income, greater urbanization and a larger proportion of the population aged 65 and older. Thus, these variables were included in the final regression model.

As noted above, by selecting only those European countries with average latitude above 45°N, the potential effect of

Table 2. Summary of Multivariate Regression Analysis.

Variable	*B*	*SE*(*B*)	β	*t*
Sunscreen sales	.001	.066	0.002	0.009
Income	.0003	.0001	0.865	3.104***
Urbanization	.006	.092	0.012	0.065
Population aging	−.175	.615	−0.053	−0.284

Note. B = unstandardized coefficients; *SE*(*B*) = standard error of the unstandardized coefficients; β = standardized coefficients.
***$p < .001$.

domestic/everyday UV exposure had already been accounted for (not including lower latitude/high-UV countries). However, an additional analysis was performed to see whether variances in average latitude above 45°N were associated with melanoma incidences. A linear regression showed that there was no significant association between the latitude and melanoma incidences in the countries selected in this study ($p > .05$). Thus, latitude was not included as a variable in the final regression model.

Linear regression analysis also showed that there was no significant relationship between the estimated fraction of melanoma cases attributed to sunbed use and melanoma incidences ($p > .05$), although it is important to note the small sample size ($n = 12$). The absence of complete data and of significance in the subset meant that sunbed use was not included in the multivariate regression model.

Multivariate Regression Analysis

Although our final multivariate regression model (Table 2) was statistically significant, $F(4, 19) = 11.93$, $p < .001$, sunscreen sales, urbanization and population aging no longer significantly predicted melanoma incidence. Income remained significantly positively associated with melanoma incidence, $\beta = 0.0003$, $t(19) = 3.104$, $p < .006$. When organized hierarchically, income significantly increased the model's predictive capacity, accounting for 14.9% of the total model's predictive capacity of 65.5%. Adjusted R^2 were used to account for the relatively small sample size.

Discussion

Regional- and national-level studies have shown that the risk of melanoma is higher among higher income populations within a country (Bentham & Aase, 1996; Haider et al., 2007; Kerkpatrick et al., 1990; Singh et al., 2011; van der Aa et al., 2011). This is to our knowledge the first multi-national comparative study to explore show the relationship between mean disposable income and melanoma rates. After adjusting for sunscreen sales, urbanization and population aging, income was strongly associated with melanoma incidence, with high-income countries having higher melanoma incidences. In higher income countries, people have more money to spend on activities that might entail intermittent high UV exposure, such as vacationing in lower latitude countries, a known risk factor (Elwood, 1992). Like most commodities, sunscreen is generally more affordable in countries with higher disposable income per capita, which helps to explain why sales were higher in higher income countries.

Although the association between sunscreen sales and melanoma incidences lost significance in our final model, we nonetheless observed that melanoma incidences were generally higher in countries with higher historical sunscreen sales. This is an important observation that adds to existing knowledge on the relationship between sunscreen use and melanoma risk. Best-available evidence suggests that sunscreen, when applied optimally, can be effective at the individual level (Green et al., 2011). However, our findings suggest that *in practice*, sunscreen as a public health measure has not historically succeeded in protecting against increased risk of melanoma *at the ecological or population level.* Sunscreen sales are a proxy for the amount of time spent in high-UV areas. However, our findings may also relate to previous research which has found that the availability of sunscreen may actually have increased population-wide UV exposure, because of the false sense of protection it confers when used improperly (Weinstock, 2001). There is a distinction to be made between how successfully sunscreen has been marketed in high-income countries (as revealed by high per capita sales), and the relative lack of success that these countries have had in the prevention of melanoma (as revealed by high melanoma incidences). Our findings can be understood in relation to historical evidence, which suggests that during the late 1990s, even though some sunscreens were chemically effective when applied optimally (Green et al., 2011), in practice, they were not being applied correctly by sunbathers during periods of high UV exposure (Robinson & Rademaker, 1998; Wartha Wright et al., 2001). In short, our results show that increased sunscreen sales did not mitigate against the increased risk that high-income populations experience as a result of income-related activities like vacations to lower latitude countries.

Limitations

To reiterate, one of the well-known limitations of ecological studies is that they can only show an association between variables and cannot prove causation. Using population-level data offered the potential for ecological fallacies. Our data were not able to speak to individual-level behaviors. Per capita data divide the total volume of sunscreen purchased in a country by the total population. For instance, per capita data are unable to tell us whether a small proportion of the population are buying large volumes of sunscreen, or whether a large proportion of the population are buying small volumes of sunscreen. Also, data as to who is buying sunscreen and how it is being used are not included in this study. As such, it does not tell us the extent to which men are using sunscreen relative to women, and younger people are using sunscreen relative to older people, although this is found elsewhere in the literature (Thieden, Philipsen, Sandby-Møller, & Wulf, 2005).

Another limitation of this study is that it was not able to adjust for differences in indoor tanning (sunbed) use between countries. As discussed above, we did not find a significant association between the estimated fraction of melanoma cases attributed to sunbed use and melanoma incidences for 12 countries included in this study. However, these data pertained to a limited number of countries (*n* = 12) and we were unfortunately unable to find any comparable and consistent cross-national data on indoor tanning (sunbed) use, despite extensive searching. Recent data from the "Euromelanoma" (van der Leest et al., 2011) project suggests that sunbed use varies between countries, with approximately 25% of those screened in Belgium reported having used sunbeds compared with less than 10% of those screened in the Ukraine. Although insufficient for the purposes of this article, the growing Euromelanoma project may provide valuable and comparable data on sunbed use across European countries, which could be used for future studies exploring these trends at the population level.

It is also worth noting that most of the existing literature on melanoma and sunscreen use concerns studies conducted before 1990, when sunscreens with little UVA protection were available. More recent sunscreens have started to include ingredients (e.g., avobenzone) that offer some UVA protection. With UVA being linked to melanoma development (Wang et al., 2001) and with newer sunscreens offering UVA protection, future ecological studies might show a different relationship between sunscreen use and melanoma rates.

One other consideration is the role of public awareness campaigns. Again, comparable and quantifiable data on melanoma prevention campaigns were not available across all the countries in our sample. As with sunbed use, the "Euromelanoma" campaign offers potential for future cross-national studies to explore associations between recent large-scale prevention initiatives (e.g., disseminating information about skin cancer and offering skin examinations to the general public on "Melanoma Day"; van der Leest et al., 2011).

Conclusion

Melanoma incidences were higher in high-income countries where sales of sunscreen were higher. In short, our results show that, at the population level, income was significantly associated with melanoma incidences, and that increased sunscreen sales has not prevented higher income populations from being at higher risk of melanoma. From a public health perspective, our results correspond with existing advice that sunscreen should be applied according to optimal recommendations (i.e., one teaspoon should be applied to per body part, prior to sun exposure and should be reapplied regularly and after activities such as swimming) and alternative methods of sun protection should be considered (e.g., wearing clothes and wide-brimmed hats; Robinson & Bigby, 2011).

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Notes

1. More details about Euromonitor's data collection methodology can be found online at http://www.euromonitor.com/research-methodology
2. Latitudes were taken from the CIA Factbook (https://www.cia.gov/library/publications/the-world-factbook/).
3. Latitude varies across individual countries (i.e., the difference in latitude in much difference there is between the north and south of the country). However, the average latitudes given serve broadly as an ecological control for latitude (and thus as a proxy for a country's general national ultraviolet [UV] exposure).
4. Southern European populations (at lower latitudes) have darker skin types that are less sensitive to UV radiation; thus, making comparisons across populations of different skin types would be more difficult.

References

Autier, P. (2001). What is the role of currently available sunscreens in the prevention of melanoma? *Photodermatology, Photoimmunology & Photomedicine*, *17*, 239-241.

Bentham, G., & Aase, A. (1996). Incidence of malignant melanoma of the skin in Norway, 1955-1989: Associations with solar ultraviolet radiation, income and holidays abroad. *International Journal of Epidemiology*, *25*, 1132-1138.

Boniol, M., Autier, P., Boyle, P., & Gandini, S. (2012). Cutaneous melanoma attributable to sunbed use: A systematic review and meta-analysis. *BMJ*, *345*, Article e4757.

Burnett, M., & Wang, S. (2011). Current sunscreen controversies: A critical review. *Photodermatology, Photoimmunology & Photomedicine*, *27*, 58-67.

Chang, Y., Barrett, J., Bishop, D., Armstrong, B., Bataille, V., Bergman, W., . . .Newton-Bishop, J. A. (2009). Sun exposure and melanoma risk at different latitudes: A pooled analysis of 5700 cases and 7216 controls. *International Journal of Epidemiology*, *38*, 814-830.

Crombie, I. (1979). Variation of melanoma incidence with latitude in North America and Europe. *British Journal of Cancer*, *40*, 774-781.

Dennis, L., Beane Freeman, L., & VanBeek, M. (2003). Sunscreen use and the risk for melanoma: A quantitative review. *Annals of Internal Medicine*, *139*, 966-978.

Elwood, M. (1992). Melanoma and sun exposure: Contrasts between intermittent and chronic exposure. *World Journal of Surgery*, *16*, 157-165.

Elwood, J., Lee, J., Walter, S., Mo, T., & Green, E. (1974) Relationship of malanoma and other skin cancer mortality to latitude and ultraviolet radiation in the United States and Canada. *International Journal of Epidemiology*, *3*, 325-332.

Erdmann, F., Lorte Tieulent, J., Schuz, J., Zeeb, H., Greinert, R., Breitbart, E., & Bray, F. (2013). International trends in the incidence of malignant melanoma 1953-2008—Are recent generations at higher or lower risk? *International Journal of Cancer*, *132*, 385-400.

Euromonitor International. (2012). *Statistics: Sun protection*. Available from http://www.euromonitor.com

Green, A., Williams, G., Logan, V., & Strutton, G. (2011). Reduced melanoma after regular sunscreen use: Randomized trial follow-up. *Journal of Clinical Oncology*, *29*, 257-263.

Haider, A., Mamdani, M., & Shear, N. (2007). Socioeconomic status and the prevalence of melanoma in Ontario, Canada. *Journal of Cutaneous Medicine and Surgery*, *11*, 1-3.

IARC (2014). GLOBOCAN: Estimated cancer incidence and prevalence worldwide. Retrieved from http://globocan.iarc.fr/Default.aspx

Kerkpatrick, C., Lee, J., & White, E. (1990). Melanoma risk by age and socio-economic status. *International Journal of Cancer*, *46*, 1-4.

LeBoit, P., Burg, G., Weedon, D., & Sarasin, A. (Eds.). (2006). *World Health Organization classification of tumours: Pathology and genetics of skin tumours*. Lyon, France: International Agency for Research on Cancer Press.

Liu, T., & Soong, S. (1996). Epidemiology of malignant melanoma. *Surgical Clinics of North America*, *76*, 1205-1222.

Marks, R. (2001). Epidemiology of melanoma. *Clinical and Experimental Dermatology*, *25*, 459-463.

Mulliken, J., Russak, J., & Rigel, D. (2012). The effect of sunscreen on melanoma risk. *Dermatologic Clinics*, *30*, 369-376.

Perez-Gomez, B., Aragones, N., Gustavsson, P., Lope, V., Lopez-Abente, G., & Pollan, M. (2008). Socio-economic class, rurality and risk of cutaneous melanoma by site and gender in Sweden. *BMC Public Health*, *8*, 33.

Planta, M. (2011). Sunscreen and melanoma: Is our prevention message correct? *Journal of the American Board of Family Medicine*, *24*, 735-739.

Robinson, J., & Bigby, M. (2011). Prevention of melanoma with regular sunscreen use. *Journal of the American Medical Association*, *306*, 302-303.

Robinson, J., & Rademaker, A. (1998). Sun protection by families at the beach. *Archives of Pediatrics & Adolescent Medicine*, *152*, 466-470.

Singh, S., Ajani, U., Johnson, C., Roland, K., Eide, M., Jemal, A., . . .Ekwueme, D. U. (2011). Association of cutaneous melanoma incidence with area-based socioeconomic indicators—United States, 2004-2006. *Journal of the American Academy of Dermatology*, *65*, S58-S68.

SPSS, Inc. (2014). SPSS Version 18. Available from www.spss.com

Thieden, E., Philipsen, P., Sandby-Møller, E., & Wulf, H. (2005). Sunscreen use related to UV exposure, age, sex, and occupation based on personal dosimeter readings and sun-exposure behavior diaries. *Archives of Dermatology*, *141*, 967-973.

van der Aa, M. A., de Vries, E., Hoekstra, H. J., Coebergh, J. W., & Siesling, S. (2011). Sociodemographic factors and incidence of melanoma in the Netherlands, 1994-2005. *European Journal of Cancer*, *47*, 1056-1060.

van der Leest, R., de Vries, E., Bulliard, J., Paoli, J., Peris, K., Stratigos, A. J., . . . del Marmol, V. (2011). The Euromelanoma skin cancer prevention campaign in Europe: Characteristics and results of 2009 and 2010. *Journal of the European Academy of Dermatology and Venereology*, *25*, 1455-1465.

Wang, S., Setlow, R., Berwick, M., Polsky, M., Marghoob, A. A., Kopf, A. W., & Bart, R. S. (2001). Ultraviolet A and melanoma: A review. *Journal of the American Academy of Dermatology*, *44*, 837-846.

Wartha Wright, M., Wright, S., & Wagner, R. (2001). Mechanisms of sunscreen failure. *Journal of the American Academy of Dermatology*, *44*, 781-784.

Weinstock, M. (2001). Sunscreen use can reduce melanoma risk. *Photodermatology, Photoimmunology & Photomedicine*, *17*, 234-236.

Westerdahl, J., Ingvar, C., Masback, A., & Olsson, H. (2000). Sunscreen use and malignant melanoma. *International Journal of Cancer*, *87*, 145-150.

Williams, S. (2012). A tax on indoor tanning would reduce demand in Europe. *BMJ*, *345*, Article 6550.

Wolf, P., Quehenberger, F., Mullegger, R., Stranz, B., & Kerl, H. (1998). Phenotypic markers, sunlight-related factors and sunscreen use in patients with cutaneous melanoma: an Austrian case-control study. *Melanoma Research*, *8*, 370-378.

World Bank (2014). World development indicators. Retrieved from http://databank.worldbank.org/data/views/variableSelection/selectvariables.aspx?source=world-development-indicators.

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