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# High Birth Weight, Early UV Exposure, and Melanoma Risk in Children, Adolescents and Young Adults

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## Abstract

**Background:** Melanoma, the deadliest form of skin cancer, is the second most common cancer diagnosed before age 30. Little is known about potentially modifiable or intervenable risk factors specific to developing melanoma at a young age. The objective was to determine if high birth weight or higher early life ultraviolet (UV) radiation exposure would be associated with increased risk of melanoma in young patients.

**Methods:** Population-based, case–control study of 1,396 cases of melanoma diagnosed before age 30 in 1988-2013 and 27,920 controls, obtained by linking cancer registry data to birth records in California.

**Results:** High birth weight (>4000g) was associated with 19% higher risk of melanoma (OR: 1.19; 95% CI: 1.02, 1.39), while low birth weight (<2500g) was associated with 41% lower risk (OR:0.59; 95% CI: 0.43, 0.82), compared to normal birth weight (2500-4000g); dose–response per

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**Data and Computing Code:** This study involves data from both the California Cancer Registry and the State of California's confidential birth file. In accordance with state and federal laws to ensure that confidentiality and privacy of the data is maintained, these sources of data are not publicly accessible; access may be provided only after qualified researchers have undergone a rigorous review process to ensure patients' rights are protected and that the research justified. The computing code for performing a logistic regression in SAS is publicly available in the user guide and documentation provided online at support.sas.com.

1000g increase was also evident (OR:1.24; 95% CI:1.13, 1.36). All quartiles of birthplace UV greater than the lowest quartile were associated with increased melanoma risk. The strongest relationship between birthplace UV and melanoma was for 15-19 years of age at diagnosis.

**Conclusions:** High birth weight and high early-life UV exposure may be important independent risk factors for melanoma diagnosis before age 30. The implication is that adopting skin-protective behaviors as early as infancy could be important for primary prevention of melanoma in younger people. However, research that accounts for early-life behavioral patterns of skin protection during infancy is needed to advance our understanding of how birth weight and early-life UV may influence development of early onset melanoma.

### Keywords

case-control studies; registries; records-based; skin cancer; skin neoplasms; pediatrics; birthweight; solar radiation

## INTRODUCTION

Melanoma, the deadliest form of skin cancer, is responsible for about 75% of all skin cancer deaths.[1] Although largely preventable, incidence of melanoma has been rising for several decades, affecting adults as well as young people in the United States (US), [2–4] where more than 76,000 new melanomas are diagnosed annually. [5]

Melanoma has become one of the most common cancers among people <30 years of age in the US.[6] Although more than 1,000 melanomas diagnosed in California each year will affect adolescents and young adults aged 15-39 years old at diagnosis, the majority of our knowledge of melanoma risk factors has been derived from studies of people over 50 years of age. However, melanoma trends at younger ages from the Surveillance, Epidemiology, and End Results (SEER) Program show females have higher incidence of melanoma than their male counterparts, while the reverse is true for persons age 50 and older,[7] suggesting that factors commonly associated with melanoma risk at older ages, such as a lifetime accumulation of sun exposure or differences in other health behaviors, might not explain melanoma risk at younger ages. There is one study in the literature that evaluated early life sun exposure and risk of melanoma before 40 years of age, wherein total hours of sun exposure in childhood was collected by self-report through interviews with subjects and their parents.[8] Cust et al report childhood sun exposure was positively associated with melanoma diagnosed between 18-29 years of age, but not in the overall sample (18-39 years of age). Those results suggest that exposure to UV early in life warrants closer examination as a potential risk factor for early development of a melanoma, and that a lifetime of accumulation sun damage may not be requisite for melanoma onset.

Rates of melanoma in California are among the highest in the world (34.7 per 100,000 for non-Hispanic whites in 2012, nearly doubling from 18.1 per 100,000 since 1990).[9] Historically, rates among Hispanic persons have been relatively low (4.2 per 100,000 in 2012), but an increasing burden of thicker and later stage tumors was observed among California's Hispanic or Latino population,[10–12] who reflect nearly 40% of this state's inhabitants. Later detection of melanoma within these individuals is worrisome given that

poorer survival outcomes and greater economic burdens from treatment are associated with advanced melanomas. Later detection could also reflect the low awareness or suspicion of melanoma that has been observed among Hispanic or Latino individuals, as well as healthcare providers.[13] Nearly 9,000 new melanomas occur annually in California and heightened screening efforts do not explain the trends in this state.[14]

Experimental studies suggest how early-life ultraviolet (UV) exposure might affect melanoma occurrence at a young age, particularly reports that neonatal tissue could become more susceptible to invasive melanoma after a UV insult.[15,16] Underlying biology of melanoma in younger patients is also quite different, with childhood melanomas commonly presenting as amelanotic lesions.[17,18] Obesity is a major risk factor for adult cancer[19] and higher birth weight is associated with pediatric, adolescent, and adult obesity.[20,21] Increased risk of certain childhood cancers (primarily leukemia/lymphoma) has been observed with higher birth weight,[22,23] which has also been linked to adult melanoma in Danish and Swedish cohorts,[24,25] but remains less well examined at younger ages. Potentiating mechanisms for a link between obesity and melanoma include greater body surface area available for sun exposure or melanoma development,[26] increased leptin levels to support tumor growth via angiogenesis,[27] and activation of BRAF mutations.[28] Studies of risk factors for pediatric and AYA melanomas remain sparse.

We conducted a large, population-based, case–control study among California-born Hispanic and non-Hispanic persons aged <30 years to investigate the association between birth weight, early-life ambient UV and a diagnosis of melanoma.

## MATERIALS & METHODS

### Population & Data Sources

Cases of histologically confirmed cutaneous malignant melanoma (ICD-O-3 sites C440-449 and histology 8720-8780) were identified from the California Cancer Registry. Cases (n=1,396) had a primary melanoma diagnosis at 0-29 years of age in 1988-2013 and controls (n=27,920) were identified from California Birth records.

### Birth record linkage and selection of control subjects

Cases were linked to the birth record using date of birth, sex, first and last name, mother's residential address and/or zip, and mother's surname at birth, as described previously.[29] Controls were randomly selected (20 per case) in the same time period from California Birth records and frequency matched by year of birth.

### Ultraviolet Radiation (UV) occurring at Place of Birth

Birthplace UV (as a proxy for early life UV exposure) was measured in average daily watt-hours/$m^2$ and assigned based on mother's home address at the time of the subject's birth as described previously.[30,31] Quartiles of UV exposure were determined from the distribution observed among controls.

### Birth Weight

Birth weight, in grams (g), was obtained from the birth record (79 total missing: 4 cases, 75 controls). Birth weights of <1,000g (n=136; observed only among controls) or >5,250g (n=15; observed only among controls) were considered extreme and excluded from analysis, as survival is limited with birth weight <1,000g and values >5,250g reflected <1% of our data (no appreciable impact was observed from their inclusion during sensitivity analysis). We defined low birth weight (LBW) for ≥1,000 to <2,500g, normal birth weight for 2,500 to 4,000g, and high birth weight (HBW) for >4,000g to 5,250g.[32] Birth weight in 1,000g intervals (i.e. 1,000-1,999g, 2,000-2,999g, 3,000-3,999g, etc.) was treated as a continuous variable for trend analysis.

### Covariates

We determined quintiles of census tract socioeconomic status (SES) from mother's residential address on the birth record.[33] We used age at diagnosis in the cases to represent age for cases and their controls. We also obtained maternal age, race (white, black, Asian, or other), and ethnicity (Hispanic or non-Hispanic) from the birth record, along with information on sex and gestational age (weeks) for cases and controls.

### Statistical Analysis

We used means and frequencies to describe sample characteristics. Because we used frequency matching,[34] unconditional logistic regression was an appropriate analytic method[35,36] to estimate relative risks as odds ratios (OR) with 95% confidence intervals (CI) for melanoma. We examined the main effect of birth weight by comparing high and low birth weight to the normal birth weight category and the main effect of UV by comparing each quartile to the lowest quartile. We examined confounders by *a priori* criteria of >10% change in the unadjusted beta estimate. We evaluated effect measure modification by age at diagnosis and sex with stratified analysis. As a sensitivity analysis, we stratified models on ethnicity. All analyses were conducted with SAS version 9.4 (SAS Institute, Inc., Cary, North Carolina). Since this was a records-based study, we did not seek informed consent from individual subjects. The University of Southern California Health Science Institutional Review Board (USC-HSIRB) and the California State Committee for the Protection of Human Subjects (CPHS) approved the study.

## RESULTS

Cases were more likely to be female, white (non-Hispanic), higher SES, and higher birth weight, but also tended to have lower mean UV exposure (Table 1). Final models for birth weight and birthplace UV were mutually adjusted and included SES, sex, age, mother's race/ethnicity, and mother's age; inclusion of gestational age had no impact, thus was not retained in our models.

Estimated effects of birth weight are shown in Table 2. After adjustment, melanoma odds among high birth weight infants were 19% higher than in normal birth weight infants (OR: 1.19, 95% CI: 1.02, 1.39). Among low birth weight infants, melanoma odds were 41% lower (OR: 0.59, 95% CI: 0.43, 0.82) than the normal birth weight group. There was evidence of

dose–response with melanoma odds increasing by 24% per 1000g increase in birth weight (OR: 1.24, 95% CI: 1.13, 1.36). After stratifying by sex, high birth weight remained associated with higher melanoma odds for males (OR: 1.40, 95%CI: 1.12, 1.73) but not females (OR: 1.01, 95%CI: 0.80, 1.27). Conversely, low birth weight remained associated with lower melanoma odds for females (OR: 0.46, 95%CI: 0.29-0.71) but was attenuated for males (OR: 0.87, 95%CI: 0.54, 1.39).

The effects of birth place UV are also shown in Table 2. Prior to adjustment, SES strongly confounded the relationship between birth place UV and melanoma. Compared to the lowest quartile of birth place UV, adjusted melanoma odds were 44% higher for the second-lowest quartile (OR: 1.44, 95% CI: 1.23, 1.69), 37% higher for the second-highest quartile (OR: 1.37, 95% CI: 1.18, 1.61), and 29% higher for the highest quartile (OR: 1.29, 95% CI: 1.09, 1.53); dose–response for birth place UV exposure was not evident. When stratifying by Hispanic ethnicity (presented for sensitivity analysis only), higher early life UV was most strongly associated with odds of melanoma among non-Hispanics, but not in Hispanic individuals (we may have been underpowered for Hispanics). After stratifying by sex, higher birth place UV was more strongly associated with odds of melanoma in males. In age-stratified analysis of birthplace UV (Table 3), estimated effects were strongest for melanomas diagnosed at 15-19 years of age.

## DISCUSSION

By investigating nearly 1,400 melanomas diagnosed among California-born persons <30 years of age compared to over 27,000 controls, we have identified high birth weight and birthplace residence in areas of high UV as important, independent risk factors for the development of early onset melanoma. Melanoma is an aggressive tumor with potentially devastating impact in terms of years of life lost for young people, especially with late stage disease. As incidence of melanoma in young people has risen globally in recent decades, identifying risk factors specific to this age group can facilitate primary prevention, while also highlighting aspects of early life development that warrant more exploration.

We estimated that, after adjustment, high birth weight increased odds of melanoma by 19%. This is consistent with some, but not all, existing studies of birth weight and other childhood cancers, which rarely included melanomas.[22,25,37] In the present study, low birthweight appeared to be a protective factor (up to 40% lower odds), which, to the best of our knowledge, has not been reported in the literature, and decreased skin surface area available for UV exposure might be suggested here as a possible explanation. An Irish study found that higher birth weight was associated with melanoma at 21-30 years of age;[37] however, examination at younger ages was not possible because no cases in the cohort occurred before age 21. An international, pooled case–control study of childhood cancers, including childhood melanomas diagnosed ≤14 years, reported a positive association between birth weight and melanoma in UK data (n=152; OR: 1.35, 95% CI: 1.12, 1.64), but found a null association in US data (n=114; OR: 1.02, 95% CI: 0.84, 1.22).[22] A Danish study found adult melanoma risk increased by 7% per 1000g increase in birth weight;[24] similarly, risk increased by 18% per 1000g among young people in Sweden.[25] We observed a stronger dose–response effect, i.e. a 24% increase in melanoma risk per 1000g birth weight.

Why high birth weight might be associated with early onset melanoma occurrence remains unclear, but might involve differences in skin surface area, propensity for obesity and tumorigenesis, and behaviors impacting infant sun exposure. Increased skin surface area is a likely feature of children born with higher birth weight that may simply reflect a greater opportunity for sun exposure, highlighting the importance of adopting skin protective behaviors as early as infancy for primary prevention of early onset melanoma, or greater chance for nevi presence (number of nevi is one of the strongest predictors of melanoma).[38,39] It may also be that larger (normal or high birth weight) infants are taken outdoors more often in early infancy than their smaller (low birth weight) counterparts. This would support the notion that greater surface area could offer a partial, plausible explanation for the increased risk of early onset melanoma with higher birth weight (and the reduced risk among those with low birth weight).

Obesity later in life has been associated with higher birth weight,[40] and obesity itself is an important risk factor for cancers, including melanoma,[26] through a variety of mechanisms, including an underlying propensity for tumor growth via angiogenesis, which represents the body's ability to support rapid expansion of capillary networks that are crucial for tumor development.[19,41] Obesity remains prevalent in the US population, which may accelerate melanoma growth via increased leptin levels.[27] Maternal overweight or obesity status before pregnancy, and excessive weight gain during pregnancy, are modifiable factors linked to larger offspring size, higher birth weight,[42,43] and unfavorable cardiovascular characteristics in childhood, including elevated leptin.[44] Intervention upon excess maternal weight before and during pregnancy may reduce the potential for high offspring birth weight, perhaps modifying the risk of early onset melanoma. Our results suggest the link between birth weight and melanoma in childhood, adolescence, and young adulthood should be more closely examined.

We observed that residence in areas with high UV exposure at birth was an important risk factor for melanoma in younger patients, particularly for adolescents and young adults 15-19 years of age at diagnosis. UV exposure occurring early in life may be sufficient to increase risk for early onset melanoma, possibly because of increased susceptibility to UV damage in infant skin, which is still developing through the first two years of life.[45] In the present study, higher levels of UV (second lowest through highest, compared to the lowest and referent quartile) were associated with increased risk of melanoma, but evidence of dose–response was not observed, as the increases in risk were not linear with increasing quartile. Characterizing the frequency and intensity of UV exposure occurring around infancy could help explain how early life UV is linked to development of melanoma before age 30, as sun exposure behavior among infants has not been investigated to date and it remains unclear if any differences may occur by birth weight.

SES was an important confounder of the effect of early life UV on early onset melanoma, which is consistent with existing adult literature, where the highest SES levels are associated with the greatest melanoma risk.[46] High SES may reflect a variety of behaviors that influence diagnosis, including more knowledge about melanoma risk and greater access to clinical skin screenings, which can increase the chance of a patient bringing a suspicious growth to the attention of a health care provider and getting detected early, if it is melanoma.

There may also be different social norms related to sunbathing, as well as sun exposure from participation in recreational or leisure-related activities that increase one's UV exposure, which could increase the risk of developing melanoma.

From the ethnicity-stratified models, which were completed and presented for sensitivity analyses only, high SES was also the most important risk factor among Hispanic persons, who may be "acquiring" increased melanoma risk by adopting behavioral risk factors from their non-Hispanic counterparts alongside greater acculturation, similar to phenomena described for obesity risk acquisition upon moving to the US.[47] This is concerning given reports of intentional tanning behaviors and low skin-protective behaviors in Hispanic children and minority youth.[48,49] While greater knowledge about melanoma risk and greater access to health care should be present with higher levels of SES, this might not be true for persons of Hispanic or Latino heritage, since prevention campaigns tend to focus on non-Hispanic white populations. Studies of melanoma and preventive interventions routinely exclude persons of color, including those of Hispanic heritage, despite the benefits that increased awareness of melanoma and greater use of skin protection and skin self-checks might provide.

### Strengths and Limitations

This population-based case–control study was conducted in a large, diverse population of California with a wide range of UV exposures, over a long time span (1988-2013). Linkage to birth records facilitated the study of birth weight, as well as the identification of birth residence to link objectively to early UV exposure, which is free from bias associated with self-reported measures of UV,[50] and no participant contact was necessary, reducing or eliminating selection bias. There is still potential for misclassification of sun exposure in early life, despite our use of an objective measure, which represents potential UV exposure via ambient UV at the birthplace residence in early life. Because we had no information on sun exposure behavior and could not assess how long a person had lived at their birthplace address, misclassification of a subject's true sun exposure during infancy and early life may be present. However, migration patterns out of California over the time period studied appeared to be low,[51] so it is more likely that misclassification arises from lack of behavior information. For example, it is possible that during peak UV hours, greater sun-protective behaviors were used by mothers to protect their infants, i.e. seeking shade while outdoors, using protective clothing/hats and stroller shades, etc. This may have reduced our ability to detect a dose–response relationship for higher UV exposure in early life, which may be more thoroughly addressed by using a combination of individual-based objective UV dosimetry with collection of sun exposure behaviors. This study was likely underpowered to detect effects among Hispanic persons or test for interaction between birth weight and early life UV exposure. We also had no information on genetic variants or family history of melanoma.

## CONCLUSION

The epidemic of melanoma among young people in the US remains an important public health concern. High birth weight and high early life UV exposures may be important risk

factors for early onset melanoma. Knowledge of risk factors may help clinicians identify high-risk persons and prioritize them for screening. While literature on adults suggests that intense, intermittent UV or lifelong accumulation of chronic UV exposure is related to developing a melanoma after age 50, the present study suggests that early exposure to high levels of early life UV may be associated with increased risk of melanoma before age 30.

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**Table 1.**

Characteristics of a case–control study of melanomas diagnosed at ages 0-29 in California (1988-2013). In this population-based study, cases were identified from California Cancer Registry records and controls were identified from California birth records.

| | Melanoma | |
|---|---|---|
| | **Cases (n=1,396)** | **Controls (n=27,920)** |
| Age in years, mean ± SD | 19 ± 6 | 19 ± 6 |
| Average Daily Ambient Ultraviolet Radiation (UV; watt hours/$m^2$), mean ± SD | 5,007 ± 187 | 5,019 ± 189 |
| Age Category (years) | | |
| <5 | 52(4) | 1,040(4) |
| 5-9 | 57(4) | 1,140(4) |
| 10-14 | 137(10) | 2,740(10) |
| 15-19 | 391(28) | 7,820(28) |
| 20-24 | 557(40) | 11,140(40) |
| 25-29 | 202(14) | 4,040(14) |
| Sex, No. (%) | | |
| Female | 862 (62) | 13,492(48) |
| Male | 534 (38) | 14,429(52) |
| Socioeconomic status quintiles, No. (%) | | |
| Lowest | 183(13) | 6,408(23) |
| Lower Middle | 265(19) | 6,695(24) |
| Middle | 341(24) | 7,074(25) |
| Upper Middle | 283(20) | 4,248(15) |
| Highest | 323(23) | 3,426(12) |
| Missing | 1 | 70 |
| Race (Mother), No. (%) | | |
| White | 1,350(97) | 22,534(81) |
| Black | 8(1) | 2383(9) |
| Asian/Pacific Islander | 27(2) | 2623(9) |
| Other | 11(1) | 380(1) |
| Hispanicity (Mother), No. (%) | | |
| No | 1,276(91) | 17,846(64) |
| Yes | 102(7) | 9,790(35) |
| Unknown | 15(1) | 225(1) |
| Missing | 3 | 60 |
| Maternal Age (years), No. (%) | | |
| <20 | 62 (4) | 3,118(11) |
| 20-34 | 1,146(82) | 22,024(79) |
| ≥35 | 184(13) | 2,704(10) |
| Missing | 4 | 75 |
| Gestational Age (weeks), No. (%) | | |
| <33 | 11(1) | 547(2) |

| | Melanoma | |
|---|---|---|
| | **Cases (n=1,396)** | **Controls (n=27,920)** |
| 33-36 | 75(6) | 2,078(8) |
| 37-42 | 1,169(88) | 22,204(85) |
| >42 | 72(5) | 1,431(5) |
| Missing | 69 | 1,661 |
| Birth Weight Category (grams, g), No. (%) | | |
| Low Birth Weight (LBW; <2500g) | 41(3) | 1,676(6) |
| Normal Birth Weight (2500-4000g) | 1,141(82) | 23,014(82) |
| High Birth Weight (HBW; >4000g) | 210(15) | 3,156(11) |
| Missing | 4 | 75 |
| Quartiles of UV, No. (%) | | |
| Q1 (UV = 3912-4946) | 349(25) | 6,967(25) |
| Q2 (UV > 4946 - 5036) | 348(25) | 7,015(25) |
| Q3 (UV > 5036 - 5121) | 364(26) | 6,953(25) |
| Q4 (UV = 5121-5752) | 334(24) | 6,921(25) |
| Missing | 1 | 65 |

**Table 2.**

Early Life Risk Factors for Melanoma Diagnosed at ages 0-29 in California (1988-2013)

| | Unadjusted | Adjusted[a] | By Sex[b] | | By Mother's Ethnicity[c] | |
|---|---|---|---|---|---|---|
| | **All** | **All** | **Females** | **Males** | **Hispanic** | **Non-Hispanic** |
| *Cases (n)* | *1,377* | *1,377* | *849* | *528* | *102* | *1,275* |
| *Controls (n)* | *27,406* | *27,389* | *13,233* | *14,156* | *9,713* | *17,676* |
| | **OR (95%CI)** | **OR (95%CI)** | **OR (95%CI)** | **OR (95%CI)** | **OR (95%CI)** | **OR (95%CI)** |
| Birth Weight (grams, g) | | | | | | |
| LBW (1000 to <2500g) | 0.53 (0.39, 0.73) | 0.59 (0.43, 0.82) | 0.46 (0.29, 0.71) | 0.87 (0.54, 1.39) | 1.03 (0.42, 2.59) | 0.48 (0.34, 0.67) |
| Normal (2500 to 4000g) | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| HBW (>4000 to 5250g) | 1.35 (1.16, 1.57) | 1.19 (1.02, 1.39) | 1.01 (0.80, 1.27) | 1.40 (1.12, 1.73) | 1.16 (0.63, 2.14) | 1.39 (1.18, 1.63) |
| Per 1000g increase | 1.45 (1.28, 1.65) | 1.24 (1.13, 1.36) | 1.28 (1.13, 1.45) | 1.19 (1.03, 1.38) | 1.19 (0.84, 1.68) | 1.85 (1.64, 2.08) |
| UV Quartiles [d] | | | | | | |
| Q1 (UV = 3912-4946) | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Q2 (UV > 4946-5036) | 1.01 (0.86, 1.17) | 1.44 (1.23, 1.69) | 1.23 (1.00, 1.51) | 1.83 (1.41, 2.36) | 0.76 (0.39, 1.49) | 1.46 (1.24, 1.72) |
| Q3 (UV > 5036-5121) | 1.06 (0.91, 1.24) | 1.37 (1.18, 1.61) | 1.25 (1.02, 1.52) | 1.61 (1.25, 2.08) | 1.06 (0.58, 1.93) | 1.46 (1.24, 1.72) |
| Q4 (UV = 5121-5752) | 0.97 (0.83, 1.13) | 1.29 (1.09, 1.53) | 1.22 (0.98, 1.50) | 1.44 (1.09, 1.89) | 1.46 (0.80, 2.68) | 1.42 (1.19, 1.69) |
| Maternal Age (years) | | | | | | |
| <20 | 0.37 (0.29, 0.49) | 0.52 (0.40, 0.68) | 0.50 (0.36, 0.71) | 0.55 (0.36, 0.83) | 0.77 (0.42, 1.43) | 0.44 (0.33, 0.60) |
| 20-34 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| ≥35 | 1.31 (1.12, 1.54) | 1.21 (1.02, 1.43) | 1.31 (1.05, 1.62) | 1.07 (0.81, 1.41) | 1.37 (0.74, 2.56) | 1.15 (0.97, 1.37) |
| SES Quintiles | | | | | | |
| Lowest | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Lower Middle | 1.37 (1.13, 1.67) | 0.94 (0.77, 1.15) | 0.99 (0.77, 1.28) | 0.86 (0.63, 1.18) | 1.24 (0.75, 2.07) | 1.09 (0.88, 1.35) |
| Middle | 1.67 (1.39, 2.01) | 0.95 (0.78, 1.15) | 1.03 (0.81, 1.31) | 0.84 (0.61, 1.14) | 0.76 (0.40, 1.41) | 1.22 (1.00, 1.49) |
| Upper Middle | 2.33 (1.93, 2.82) | 1.22 (1.00, 1.49) | 1.18 (0.91, 1.53) | 1.26 (0.92, 1.72) | 1.57 (0.82, 3.01) | 1.62 (1.31, 2.00) |
| Highest | 3.29 (2.73, 3.96) | 1.53 (1.25, 1.87) | 1.56 (1.20, 2.02) | 1.47 (1.07, 2.02) | 2.70 (1.34, 5.45) | 2.07 (1.68, 2.55) |
| Per quintile increase | 1.34 (1.29, 1.40) | 1.13 (1.08, 1.18) | 1.12 (1.06, 1.19) | 1.14 (1.13, 1.74) | 1.18 (1.00, 1.38) | 1.21 (1.16, 1.27) |

[a]Model includes Birth Weight, UV quartile, Socioeconomic status (SES), Sex, Age, and Maternal Characteristics (Age, Race, and Ethnicity)

[b] Model includes Birth Weight, UV quartile, SES, Age, and Maternal Characteristics (Age, Race, and Ethnicity)

[c] Model includes Birth Weight, UV quartile, SES, Sex, Age, and Maternal Characteristics (Age)

[d] Quartiles determined by distribution in controls; represents average daily ambient UV in watts/m2 based on mother's residential address on the birth record.

**Table 3.**

Age-Stratified Association of Early Life Ambient Ultraviolet (UV) Radiation and Melanoma Diagnosed at ages 0-29 in California (1988-2013)

| | By Age Category[a] | | | | | |
|---|---|---|---|---|---|---|
| | **0-4 y** | **5-9y** | **10-14y** | **15-19y** | **20-24y** | **25-29y** |
| *Cases (n)* | *48* | *56* | *136* | *386* | *549* | *202* |
| *Controls (n)* | *961* | *1,120* | *2,711* | *7,698* | *10,939* | *3,960* |
| | **OR (95%CI)** | **OR (95%CI)** | **OR (95%CI)** | **OR (95%CI)** | **OR (95%CI)** | **OR (95%CI)** |
| UV Quartiles[b] | | | | | | |
| Q1 (UV = 3912-4946) | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Q2 (UV > 4946 -5036) | 1.67 (0.68, 4.16) | 0.90 (0.42, 1.93) | 1.14 (0.66, 1.96) | 1.81 (1.32, 2.47) | 1.42 (1.11, 1.81) | 1.25 (0.82, 1.90) |
| Q3 (UV > 5036-5121) | 1.68 (0.70, 4.05) | 1.14 (0.54, 2.39) | 1.36 (0.83, 2.22) | 1.85 (1.37, 2.50) | 1.17 (0.91, 1.51) | 1.32 (0.88, 1.96) |
| Q4 (UV = 5121-5752) | 1.73 (0.68, 4.39) | 0.72 (0.30, 1.72) | 1.40 (0.83, 2.36) | 1.65 (1.19, 2.30) | 1.08 (0.83, 1.41) | 1.36 (0.89, 2.09) |

[a]Model includes UV quartile, SES, Birth Weight, Sex, and Maternal Characteristics (Age, Race, and Ethnicity)

[b]Quartiles determined by distribution in controls; represents average daily ambient UV in watts/$m^2$ based on mother's residential address on the birth record