Research Article

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Prevalence and Predictors of Recent Skin Examination in a Population-Based Twin Cohort

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Abstract

Background: The incidence of melanoma is increasing worldwide. Guidelines for clinical skin exam for improving early diagnosis of melanoma remain inconsistent, and current data on factors associated with regular skin screening on a population basis are limited.

Methods: We used self-reported data from 50,044 members of the California Twin Program, a population-based cohort of twins born in California between 1908 and 1982, to identify prevalence and determinants of recent clinical screening for skin cancer.

Results: Prevalence of skin examination was higher than national estimates, with 32% of respondents of all ages reporting ever having skin examination. Sociodemographic and constitutional risk factors including white race, educational attainment, marital status, and number of large moles were strongly associated with recent screening, as were individual and family history of skin cancer. Lower socioeconomic status, racial/ethnic minority status, and paradoxically, frequent UV-related risk behaviors in adulthood were associated with a lower likelihood of recent screening.

Conclusions: As the evidence concerning the efficacy of skin examination continues to evolve, attention should be paid to motivators and barriers of screening, particularly in high-risk subgroups where lack of screening may contribute to disparate rates of thicker melanomas and lower survival.

Impact: Our results demonstrate the need for prevention strategies targeted to specific at-risk groups to increase earlier detection leading to improved outcomes. *Cancer Epidemiol Biomarkers Prev; 24(8); 1190–8. ©2015 AACR.*

Introduction

Rates of melanoma have risen worldwide over the past three decades (1, 2). In the United States, incidence rates are increasing among non-Hispanic whites (NHW) across all age groups and categories of tumor thickness, with an estimated annual increase of 3.1% per year in males and 3.4% in females (3, 4). This trend is also evident across ethnic groups, particularly in Hispanic populations in the United States where rates of thick tumors have increased sharply over the past 20 years (5).

Recognizing the increased disease burden of melanoma, public health agencies have prioritized educational initiatives to reduce rates of both melanoma and nonmelanoma skin cancer (NMSC), emphasizing primary prevention through reduction of exposure to UV radiation as well as secondary prevention achieved by clinical skin examination and skin self-examination (6–8). However, scientific evidence remains inconsistent about the efficacy of secondary prevention to reduce skin cancer-related morbidity and mortality and prospective trials have not been feasible to test the efficacy of population-based skin examination (9).

Despite the lack of consensus, numerous observational studies have found that physician-based whole body screening is associated with decreased incidence of thicker melanomas at diagnosis and reduced mortality (10–15). However, it remains unclear to what extent at-risk individuals are accessing skin examination; thus, further research is needed about prevalence and predictors of screening. Such information may aid in targeted approaches to high-risk individuals and contribute to an understanding of the differential impact of the disease across at-risk subgroups (e.g., higher disease rates and poorer outcomes in older males, rising incidence, and lower survival in Hispanic populations; refs. 5, 16).

In prior studies, factors associated with physician-based skin examination included older age, white race, fair skin, higher level of education, usual source of health care, and personal and family history of skin cancer (17–20). Studies have differed with regard to gender, with some finding greater likelihood and higher prevalence of screening among females (21, 22); others finding higher rates among males (23); and others still observing no differences (24). Prevalence rates for ever having physician skin examination have been uniformly low, ranging from 14% to 21% of adults in the United States (24, 25) with one study estimating that only 24% of individuals considered high-risk for melanoma have ever screened (25). Prevalence of recent skin exam measured within past year was lower, around 8% to 11% for average risk populations (24).

To date, most population-based studies of skin screening have used the National Health Information Survey (NHIS) as a primary data source (19, 22–25). Although such studies have the benefits of a large sample yielding nationally representative estimates, they have not included melanoma risk factors such as nevi and

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childhood UV exposure. To elucidate determinants of skin cancer screening in the context of key melanoma risk factors, we investigated recent skin examination by physician in a sample of more than 50,000 California-born twins. The overall aim of the study was to evaluate determinants of skin examination in a population-based sample in a region with high rates of UV radiation and high incidence of melanoma (26). This unique dataset has the benefit of including several risk factors for melanoma not included in previous population-based studies such as number of large nevi, sun protection behaviors in childhood and early adulthood, and family cancer history beyond melanoma and NMSC.

We ascertained prevalence rates and examined predictors of screening including constitutional, sociodemographic, sun exposure behaviors, and personal and family cancer history variables. On the basis of prior research, we hypothesized that recent skin examination would be associated with older age, white race, non-Hispanic ethnicity, fair skin, married status, higher level of education, health insurance coverage, and history of skin cancer (19, 23, 24). In addition, we hypothesized that recent screening would be associated with melanoma risk factors including many large moles, lighter hair color, lower sun protective behaviors, and family history of melanoma.

Materials and Methods

The study was conducted with data from the California Twin Program, a population-based cohort of California-born twins housed at the University of Southern California (Los Angeles, CA). For the purpose of this cross-sectional analysis, we disregarded twin status and considered respondents to be a population-based sample of California-born individuals as in prior research (27). In addition, we conducted analyses to account for the paired nature of the data. The large size of the cohort enabled sufficient statistical power to detect small associations, and the cohort has been found to be generally representative of the population from which it was drawn, with exceptions detailed below (28).

The recruitment process and representativeness of the respondents have been described elsewhere (28, 29). Briefly, from all twins born in California between the years of 1908 and 1982 ($n =$ 256,616), approximately 161,109 were identified as linked to a California address from the Department of Motor Vehicles (DMV). Of these individuals, questionnaires were mailed to 115,733 with valid addresses in three waves between 1991 and 2000. Responses were received from 52,267 individuals, comprising both members of 14,832 twin pairs and 22,603 single twin respondents. After estimating the number of questionnaires that would not have been received by intended recipients, the response rate was 45.2%, comparable with or exceeding rates of similar studies (30).

Study respondents were primarily NHWs; however, in comparison with census data, Hispanic respondents were slightly overrepresented (28). In addition, male respondents were more likely to be married in comparison with the census population, whereas older females were more likely to be unmarried. This latter difference was likely a result of incomplete maiden name linkage between the California Department of Vital Statistics and the Department of Motor Vehicle due to DMV procedures pre-1960s resulting in an inability to locate older, married females (13, 30). In addition, due to differing response rates by age and gender, a greater number of younger females than males were represented.

To participate in the study, respondents returned a 16-page questionnaire comprising questions about demographic characteristics, medical history including diagnosis of cancer in themselves and family members, and behaviors such as tobacco and alcohol use, physical exercise, dietary preferences, and sun exposure practices.

Measures

Frequency of recent skin examination

Respondents were asked, "How recently have you had a skin exam for cancer?" among questions about other cancer screening procedures. For the skin cancer examination question, five responses were possible: in past year; 1–2 years ago; 3–5 years ago; 6 or more years ago; never. For the current study, the outcome variable "recent skin exam" was dichotomized into "within 2 years" versus "3 or more years/never." Because guidelines are inconsistent for screening, no strict definition of adherence was possible. Thus, we considered "within 2 years" an acceptable timeframe for achieving prevention objectives as frequency of skin examination (within 1–3 years) has been associated with thinner tumors at diagnosis and improved prognosis (10, 15).

Constitutional and sociodemographic variables

Respondents reported their gender, relationship status, and level of education. Age was calculated from birth date and recorded at date of questionnaire completion. Natural hair color was reported, as was color of untanned skin, ranging from 1 (milk white) to 7 (dark black). Skin reaction to sun was reported by having respondents rate their reaction to 30 minutes in the sun at noon, ranging from 1 (painful, blistering sunburn) to 7 (no sign of sunburn). Respondents were asked to estimate the number of moles the size of a pencil eraser that they had on their body for as long as they could remember.

Sun exposure behavior variables

Respondents were asked, "How often have you gotten a painful sunburn that blistered/peeled in strips?" both before and after the age of 25 years, with responses comprising "never," "1–2 times," "3–5 times," "6–10 times" and "11 or more times." To measure sun protective practices at ages 10, 18, and current age, respondents were asked "When out in the sun, how much preparation have you taken at various ages to protect yourself?" with responses ranging from 1 (no protection at all) to 7 (full protection including covered arms, legs, and head and use of sunscreen).

Personal and family cancer history

Respondents were asked to report their own diagnostic history about both melanoma and NMSC as well as that of their twin. They were also asked whether their children, siblings, parents, or spouse/partner had ever been diagnosed with melanoma or NMSC. Personal and family history of any cancer type was also obtained.

Health insurance

Study respondents in two latter waves of recruitment were queried as to their health insurance status ($n = 26{,}718$). Respondents were asked whether and what type of insurance coverage they had. Responses included PPO, HMO, federal programs

(including veteran's health benefits, Medicare, and Medicaid), or not currently insured. A separate subanalysis was conducted with these respondents to examine the association between insurance status and recent skin examination with insurance dichotomized as "insured" versus "noninsured".

Statistical Analysis

Descriptive frequencies and means were used to describe the population. A Pearson χ^2 test was used to ascertain significant differences between responders and nonresponders to the outcome question (skin examination within 2 years). Logistic regression was conducted according to the method prescribed by Hosmer and Lemeshow (31). In the first step of the analysis, univariate analyses were conducted with variables selected for their theoretical significance to the outcome; a *P* value of less than (<) 0.25 was the criteria for entry into the multivariable model. In the second step, significant variables were entered into multivariate regressions models for each set of predictors (sociodemographic and constitutional variables, sun exposure behaviors, and cancer history).

To examine the dependency of twin data, all analyses were repeated with all single-respondent twins as well as one twin randomly chosen from pairs ($n = 35{,}801$) to see whether estimates were affected by the correlated nature of the data. To further explore potential issues arising from paired data, interaction terms were entered in the model to determine whether main effect estimates were influenced by single versus double respondent status.

All analyses were conducted in STATA version 12 (32). Approval for the study was obtained by the University of Southern California Institutional Review Board.

Results

Population description and prevalence

Respondents who did not complete the question about skin examination were excluded from analysis ($n = 2{,}223$). Therefore, the analytic dataset for this study retained 50,044 individuals comprising both members from 14,243 twin pairs (28,486 individuals) and 1 member from 43,116 twin pairs (21,558 individuals). Table 1 presents the sociodemographic characteristics of the sample.

Figure 1 presents prevalence estimates of skin screening in the sample for those respondents who reported ever having a skin examination and those who reported never screening. Thirty-two percent of the entire sample reported ever having a skin examination. For respondents over 40, this figure increased to 44%.

χ^2 analyses revealed significant differences between respondents and nonrespondents to the question about skin examination (1, 12). Nonresponders to the skin exam question had a greater pattern of missing data for all questionnaire items compared with item responders. Those who did not respond to the question about skin exam were significantly more likely to be older, male, married, and have fewer years of schooling. With regard to sun exposure, nonresponders were significantly less likely to report "never" having severe sunburn before or after the age of 25 years; and to report practicing no sun protection at current age. For cancer history variables, nonresponders were less likely to report a personal or family history of melanoma or NMSC.

Results of analyses of correlated data

Analyses conducted on the sample of single-respondent twins plus one randomly chosen twin from twin pairs ($n = 35{,}801$) resulted in similar estimates with regard to magnitude and significance (1, 13–18). Results were qualitatively the same as the main analysis with the following exception: for the cancer history variables, because estimates differed with respect to direction and significance indicating confounding due to twin status, cancer history results were reported for the single-respondent plus one randomly chosen twin from twin pair sample ($n = 35{,}801$). Results were further classified by monozygotic (MZ) versus dizygotic (DZ) twin type for variables related to twin genetic relationship with regard to cancer history.

Relationship between recent skin exam and sociodemographic variables

The relationship between skin examination within 2 years and sociodemographic and constitutional variables is shown in Table 1. Respondents age 40 years and older were twice as likely to report recent skin examination as younger respondents after adjustment for all significant variables in the multivariate model. Female gender was associated with less likelihood of recent screening in both univariate and adjusted analyses. Stratum-specific results by birth decade revealed that women's relative risk of performing recent skin examination was lower in all decades save those between 1948 to 1972, where it was higher (significantly so only for those born between 1958–1967; unpublished raw data).

Non-Hispanic white respondents were approximately 75% more likely to report recent skin exam than Hispanic respondents after adjustment. In univariate analysis, African-Americans and other races had significantly greater odds of having a recent skin examination compared with Hispanics; however, this finding was not significant after adjustment.

Respondents who reported being married or partnered were significantly more likely to report recent skin exam in both univariate and multivariate analysis. Years of schooling was strongly associated with recent skin exam in univariate and multivariate analyses, with a dose–response relationship between increasing levels of education and higher likelihood to report recent screening.

Both fairer skin and skin's sunburn response were associated with recent skin exam in univariate analyses, with a dose–response relationship between fairer and more sun-sensitive skin and likelihood of screening. With the addition of race in the multivariate model, these associations were attenuated and no longer significant. Lighter hair color was significantly associated with recent skin exam in univariate analysis; after adjustment, only blonde and red hair remained significant.

Having large nevi was strongly associated across analyses, with a dose response between increasing number of large moles and recent skin examination. Respondents with 10 or more moles were nearly two and a half times as likely to report recent screening as those with no moles after adjustment.

Relationship between recent skin exam and sun exposure behaviors

The relationship between recent skin examination and sun exposure behaviors is shown in Table 2. In univariate analyses, frequency of severe sunburn before the age of 25 years was associated with recent skin exam. In adjusted analyses, a

Table 1. Predictors of recent skin examination among a population-based sample of California-born twins by constitutional variables ($N = 50,044$)

Variable	Study sample, *N* (%)	Unadjusted OR (CI 95%)	Adjusted OR (CI 95%)[a]
Age			
<40	29,080 (58.1)	1	1
≥ 40	20,964 (41.9)	2.68 (2.56–2.80)[b]	2.07 (1.96–2.19)[b]
Missing	0		
Gender			
Male	21,965 (43.9)	1	1
Female	28,079 (56.1)	0.73 (0.70–0.76)[b]	0.83 (0.79–0.88)[b]
Missing	0		
Race			
Hispanic	5,163 (10.3)	1	1
African-American/Other	4,103 (8.2)	1.20 (1.05–1.38)[b]	1.12 (0.94–1.32)
White	38,973 (77.9)	3.19 (2.89–3.52)[b]	1.77 (1.56–2.02)[b]
Missing	1,805 (3.6)		
Relationship status			
Not married	19,404 (38.8)	1	1
Married/with partner	29,949 (59.9)	1.61 (1.53–1.68)[b]	1.21 (1.14–1.28)[b]
Missing	691 (1.4)		
Average years of school			
<12	7,969 (15.9)	1	1
12	13,816 (27.6)	0.96 (0.90–1.03)	1.13 (1.04–1.23)[b]
13–15	12,577 (25.1)	0.85 (0.79–0.92)[b]	1.26 (1.15–1.38)[b]
16+	12,872 (30.2)	1.32 (1.23–1.41)[b]	1.64 (1.51–1.79)[b]
Missing	560 (1.1)		
Color of untanned skin			
Dark to very dark (6–7)	839 (1.7)	1	1
Medium to olive (4–5)	17,562 (35.1)	1.48 (1.21–1.82)[b]	0.95 (0.73–1.25)
Fair to medium fair (3)	15,304 (30.6)	1.84 (1.50–2.26)[b]	0.93 (0.71–1.22)
Very fair (1–2)	15,754 (31.5)	2.11 (1.72–2.59)[b]	0.88 (0.67–1.16)
Missing	585 (1.2)		
Hair color			
Dark brown/black	12,636 (25.3)	1	1
Light to medium brown	16,827 (33.6)	1.47 (1.38–1.56)[b]	1.08 (0.99–1.17)
Light blonde, blonde, light brown (blonde as child)	16,088 (32.2)	1.90 (1.79–2.02)[b]	1.21 (1.12–1.32)[b]
Red/strawberry/auburn	3,778 (7.6)	1.84 (1.68–2.01)[b]	1.14 (1.02–1.28)[b]
Missing	715 (1.4)		
Sunburn response			
Never peels (7)	9,014 (18.0)	1	1
Rarely peels (5–6)	19,195 (38.4)	1.36 (1.24–1.48)[b]	1.03 (0.93–1.15)
Sometimes peels (3–4)	16,204 (32.4)	1.64 (1.51–1.79)[b]	1.09 (0.97–1.21)
Always/usually peels (1–2)	4,921 (9.8)	1.84 (1.68–2.02)[b]	1.08 (0.96–1.22)
Missing	710 (1.4)		
Large nevi			
None	26,452 (52.9)	1	1
1–2	15,558 (31.1)	1.29 (1.23–1.36)[b]	1.20 (1.13–1.27)[b]
3–9	6,025 (12.0)	2.00 (1.88–2.13)[b]	1.71 (1.59–1.85)[b]
10 or more	1,204 (2.4)	2.92 (2.59–3.30)[b]	2.40 (2.07–2.79)[b]
Missing	805 (1.6)		

[a]Adjusted for all variables (Tables 1–3) statistically significant in univariate analysis at $P < 0.25$.
[b]$P < 0.05$

significant association was observed for only those with 6 or more episodes of severe sunburn, who were 20% more likely to report recent skin exam. Severe sunburn after the age of 25 years was significantly associated with increased odds of recent exam in univariate analyses. However, after adjustment with the entry of sunburn before the age of 25 years, those with increasing number of sunburn episodes were significantly less likely to report recent screening.

Although sun protective practices at the age of 10 years were significantly associated with screening in univariate analyses, this relationship was attenuated after adjustment. Respondents who practiced no sun protection at the age of 18 years were 18% more likely to have recently screened than those who used complete sun protection in multivariate analyses. At current age, those reporting moderate or no sun protection were significantly less likely to report recent skin exam compared with those using high levels of sun protection across analyses.

Relationship between recent skin exam and cancer history

The relationship between recent skin exam and cancer history is shown in Table 3. Personal history of melanoma was strongly associated with recent skin examination with those reporting melanoma occurrence seven times as likely to report screening after adjustment. Twin history of melanoma was also strongly associated with screening, with respondents twice as likely to report recent skin exam if their twin had melanoma after adjustment, particularly among MZ twins. History of melanoma in an immediate family member as well as spousal history

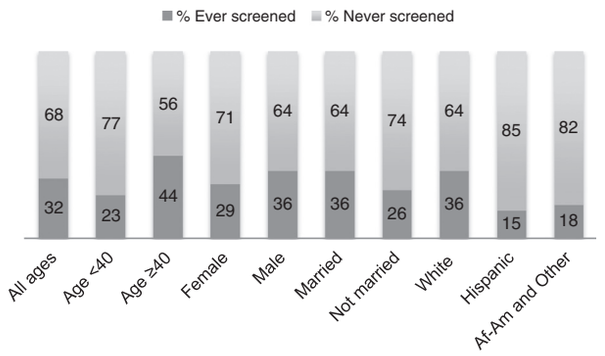

Figure 1.
Prevalence of skin exam among a population-based sample of California-born twins.

were also significantly associated with greater odds of recent screening.

Personal history of NMSC was strongly associated with recent skin exam, with respondents reporting NMSC nearly nine times as likely to report recent screening. History of NMSC in one's twin (with stronger and significant effects for MZ vs. DZ twins), immediate family history, and spousal history were all significantly associated with recent skin exam across analyses.

A personal history of occurrence of cancer other than melanoma or NMSC, and cancer history in one's twin, family, or spouse were significantly associated with recent skin exam. Only history of other cancer among DZ twins and in a family member was not significantly associated with recent skin screening after adjustment.

Relationship between recent skin examination and health insurance

The relationship between recent skin exam and health insurance status was analyzed in a subsample of respondents for which data were available. In both univariate and multivariate analysis, any type of health insurance versus no insurance was strongly associated with recent skin exam (OR, 2.59; 95% CI, 2.24–3.00; AOR, 2.03; 95% CI, 1.69–2.43). Category of insurance (private, HMO, or government) versus no insurance was also examined; type of insurance did not affect estimates (unpublished raw data).

Discussion

In this large, population-based cohort of 50,044 California-born twins, we sought to identify prevalence and predictors of recent skin examination to understand the determinants of physician-based skin examination for skin cancer. Currently, consensus does not exist regarding the efficacy or interval of skin screening for early detection of melanoma. However, studies have shown benefits for regular physician skin screening leading to earlier detection of disease and subsequent reduction of mortality (14, 15).

We observed high prevalence rates for recent skin examination among the sample (32% of California twins reported ever screening compared with 21% in recent national estimates; ref. 25). Because of the relative rarity of melanoma, this proportion of individuals screening may be sufficient if those who screen are at highest risk of disease. Our findings indicate that individuals with greater constitutional and demographic risk factors were more likely to screen, for example, non-Hispanic whites, of older age, of higher socioeconomic status (SES), with large/many nevi, and history of melanoma or NMSC in one's self or twin (with stronger effects for MZ twins). Nevertheless, despite greater likelihood of

Table 2. Predictors of recent skin examination among a population-based sample of California-born twins by indicators of UV exposure ($N = 50,044$)

Variable	Study sample, *N* (%)	Unadjusted OR (CI 95%)	Adjusted OR (CI 95%)[a]
Frequency of severe, peeling sunburn BEFORE age 25			
Never/1–2 times	22,887 (45.7)	1	1
3–5 times	12,719 (25.4)	1.38 (1.31–1.46)[b]	1.04 (0.98–1.12)
>6 times	13,528 (27.0)	1.82 (1.73–1.91)[b]	1.21 (1.12–1.31)[b]
Missing	910 (1.8)		
Frequency of severe, peeling sunburn AFTER age 25			
Never/1–2 times	33,419 (66.8)	1	1
3–5 times	6,618 (13.2)	1.20 (1.13–1.28)[b]	0.90 (0.84–0.98)[b]
>6 times	3,233 (6.5)	1.32 (1.22–1.44)[b]	0.81 (0.73–0.91)[b]
Missing	6,774 (13.5)		
At age 10: Sun protection measures taken			
Complete protection (5–7)	6,001 (12.0)	1	1
Moderate protection (3–4)	13,204 (26.4)	1.15 (1.06–1.25)[b]	0.93 (0.84–1.03)
No protection (1–2)	29,185 (58.3)	1.37 (1.28–1.48)[b]	0.92 (0.83–1.02)
Missing	1,654 (3.3)		
At age 18: Sun protection measures taken			
Complete protection (5–7)	6,729 (13.5)	1	1
Moderate protection (3–4)	18,447 (36.9)	1.11 (1.03–1.19)[b]	0.98 (0.89–1.08)
No protection (1–2)	23,438 (46.8)	1.24 (1.15–1.32)[b]	1.18 (1.07–1.31)[b]
Missing	1,430 (2.9)		
At current age: Sun protection measures taken			
Complete protection (5–7)	26,753 (53.5)	1	1
Moderate protection (3–4)	13,315 (26.6)	0.60 (0.57–0.63)[b]	0.71 (0.66–0.76)[b]
No protection (1–2)	8,948 (17.9)	0.44 (0.41–0.47)[b]	0.54 (0.49–0.58)[b]
Missing	1,028 (2.1)		

[a]Adjusted for all variables (Tables 1–3) statistically significant in univariate analysis at $P < 0.25$.
[b]$P < 0.05$.

Table 3. Predictors of recent skin examination among a population-based sample of California-born twins by cancer history ($N = 35,801$)

Variable[a]	Study sample, *N* (%)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)[b]
Personal history of melanoma			
No	35,506 (99.2)	1	1
Yes	295 (0.8)	13.98 (10.51–18.61)[c]	7.14 (5.01–10.19)[c]
Twin history of melanoma			
No	35,622 (99.5)	1	1
Yes	179 (0.5)	4.30 (3.21–5.77)[c]	2.14 (1.49–3.09)[c]
For DZ twins			
No	23,528 (99.5)	1	1
Yes	117 (0.5)	3.51 (2.42–5.09)[c]	1.73 (1.10–2.73)[c]
For MZ twins			
No	10,949 (99.4)	1	1
Yes	61 (0.6)	5.62 (3.43–9.20)[c]	3.38 (1.73–6.63)[c]
Immediate family history of melanoma (other than twin)			
No	34,470 (96.3)	1	1
Yes	1,311 (3.7)	1.83 (1.63–2.06)[c]	1.42 (1.23–1.64)[c]
Spousal history of melanoma			
No	35,632 (99.5)	1	1
Yes	169 (0.5)	2.84 (2.09–3.86)[c]	1.65 (1.21–1.87)[c]
Personal history of NMSC			
No	34,417 (96.1)	1	1
Yes	1,384 (3.9)	15.65 (13.75–17.81)[c]	8.62 (7.41–10.03)[c]
Twin history of NMSC			
No	35,184 (98.4)	1	1
Yes	617 (1.6)	4.61 (3.90–5.45)[c]	1.27 (1.02–1.59)[c]
For DZ twins			
No	23,262 (98.5)	1	1
Yes	383 (1.5)	3.93 (3.19–4.84)[c]	1.24 (0.94–1.65)
For MZ twins			
No	10,793 (98.3)	1	1
Yes	217 (1.7)	6.02 (4.50–8.07)[c]	1.38 (1.01–2.04)[c]
Immediate family history of NMSC (other than twin)			
No	31,936 (89.2)	1	1
Yes	3,865 (10.8)	1.89 (1.75–2.03)[c]	1.21 (1.10–1.32)[c]
Spousal history of NMSC			
No	35,293 (98.6)	1	1
Yes	508 (1.42)	2.80 (2.34–3.34)[c]	1.49 (1.21–1.87)[c]
Personal history of other cancer			
No	34,095 (95.2)	1	1
Yes	1,706 (4.8)	1.72 (1.54–1.91)[c]	1.62 (1.41–1.86)[c]
Twin history of other cancer			
No	34,291 (95.8)	1	1
Yes	1,510 (4.2)	1.47 (1.31–1.66)[c]	1.22 (1.06–1.41)[c]
For DZ twins			
No	22,650 (95.78)	1	1
Yes	995 (4.22)	1.77 (1.44–2.17)[c]	1.07 (0.89–1.28)
For MZ twins			
No	10,539 (95.66)	1	1
Yes	471 (4.34)	1.34 (1.16–1.55)[c]	1.58 (1.23–2.07)[c]
Immediate family history of other cancer			
No	24,619 (68.8)	1	1
Yes	11,182 (31.2)	1.30 (1.23–1.37)[c]	1.03 (0.97–1.10)
Spousal history of other cancer			
No	34,861 (97.4)	1	1
Yes	940 (2.6)	1.74 (1.51–2.01)[c]	1.26 (1.05–1.50)[c]

[a]Missing not available; "yes" response only provided.
[b]Adjusted for all variables (Tables 1–3) statistically significant in univariate analysis at $P < 0.25$.
[c]$P < 0.05$.

screening among these respondents, absolute rates may be suboptimal as the majority of respondents within risk categories reported never screening.

Given that melanoma risk increases with age, for example, a greater proportion of older adults should screen; while we found that respondents over the age of 40 years had greater odds of recent skin examination, absolute screening rates were low, with nearly 70% reporting never screening. The prevalence of screening for older males (over age 40), who have highest incidence of disease, was also low (66% never screening). In addition, while

individuals with large and many nevi, one of the most important risk factors for melanoma (33, 34), were more likely to screen than those with no large moles, only 38% of respondents with more than 10 large moles reported recent skin exam.

Consistent with recent studies, we found that higher SES individuals (e.g., higher educational attainment) are more likely to screen than lower SES individuals (35). Because low SES status is associated with advanced melanoma at diagnosis (35), strategies are required to improve the uptake of skin examination among these individuals. One critical factor that may influence future screening rates among low SES individuals is the expansion of insurance coverage and in particular, the projected substantial increases in Medicaid enrollment under health care reform (36). Because our findings suggest that any type of health insurance may double the rate of skin screenings (with an attributable risk for recent screening of more than 50% for those with insurance), future public health strategies might harness such changes to promote skin examination among lower SES populations who are at risk of poor outcomes.

In addition, we observed lower rates and likelihood of screening for minorities as well as confounding between race/ethnicity and skin phototype and sunburn response, with attenuation of the association between these constitutional variables and skin examination. These findings are of concern, as ethnic minorities such as Hispanics have a diverse range of skin phototype, including fair skin, and high rates of sunburn (37, 38). Such disparities in screening may be an important factor influencing the delayed diagnosis and poorer melanoma prognosis among minority groups (39, 40). Thus, targeted efforts are needed to increase skin examination among ethnic and racial minority populations.

Despite high levels of UV in the state, California twins who reported a greater history of sunburns and less sun protective practices in early adolescence did not report higher likelihood to screen. An exception was for respondents reporting less sun-protective behaviors before the age of 25 years, suggesting that higher exposures in early adulthood, possibly related to tanning practices, may increase skin cancer awareness motivating more regular screening. However, for respondents who reported little or no sun protection at current age, these risk behaviors did not appear to influence regular screening in this sample. These findings raise interesting hypotheses for future longitudinal and qualitative studies of the psychosocial factors motivating sun protection practices and skin cancer screening at critical ages.

There were limitations to this study. The cross-sectional nature of the design limits causal inference, and generalizability is confined to the California-born population. An attrition analysis of item nonresponse found significant differences across constitutional, sociodemographic, UV, and cancer variables between those who responded and those who did not respond to the question about skin examination. Although overall prevalence rates and estimates were not likely to be affected given that only 4% did not respond, those who did not respond to the skin examination question possessed some characteristics associated with lower odds of performing screening.

Our measures were not previously validated; however, they were adapted from those used widely in prior research (41). The study outcome, skin examination, was a single-item measure, and did not include the concept of skin self-examination. Thus we were only able to examine factors associated with clinical skin examination. In addition, we were neither able to distinguish setting for clinical exam (dermatologic or general practice), nor whether respondents had undergone full-body as opposed to partial skin examination. Furthermore, because these data were collected between 1991 and 2000 and recent evidence shows increases in skin examination rates from 2000 to 2010, current rates may be higher than those represented here (25).

In addition, the sample had a greater proportion of unmarried females in older birth decades, younger females, and an overrepresentation of Hispanic females. Thus our finding that males were more likely to report recent screening than females even after adjustment for age could have resulted from selection bias as these factors were associated with less likelihood of screening in our study. If so, it remains unclear to what extent older males, who have higher rates of disease and overall poorer melanoma outcomes, are likely to screen.

Finally, we included a large number of variables with known importance to skin examination our study, which may have resulted in overfitting of the model with the consequence that the standard errors of the estimated examination rates would be too small. However, predictors of screening identified by the analysis would include the most important ones, and our overall findings are very likely to be representative of the California population.

Strengths of the study include a large sample of more than 50,000 respondents that has previously been found to be representative of California native residents enabling robust, population-based estimates. Furthermore, the cohort has been well characterized in comparison to the population from which it was drawn, allowing the identification of potential sources of selection bias.

In conclusion, although the lack of consensus about skin examination to screen for skin cancer poses challenges in interpreting adherence, certain sociodemographic and constitutional factors associated with higher melanoma risk were found to motivate recent skin examination in the present study. However, with an estimated 68% of all individuals in the sample as well as high rates of individuals with critical risk factors reporting "never" screening, disease prevention objectives may not be achieved, as early detection is dependent upon regularity of screening. Our findings suggest a need to focus attention on the specific barriers to screening among those with known risk factors for melanoma, as well as among subgroups such as ethnic minority and lower SES individuals who may benefit from early detection leading to improved outcomes.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

Authors' Contributions

Conception and design: K.A. Miller, T.M. Mack, M.G. Cockburn
Development of methodology: K.A. Miller, M.G. Cockburn
Acquisition of data (provided animals, acquired and managed patients, provided facilities, etc.): A.S. Hamilton, T.M. Mack, M.G. Cockburn
Analysis and interpretation of data (e.g., statistical analysis, biostatistics, computational analysis): K.A. Miller, B.M. Langholz, M.G. Cockburn
Writing, review, and/or revision of the manuscript: K.A. Miller, B.M. Langholz, A.S. Hamilton, M.G. Cockburn
Administrative, technical, or material support (i.e., reporting or organizing data, constructing databases): J. Zadnick, M.G. Cockburn
Study supervision: M.G. Cockburn

Other (participation in development of the screening questionnaire and maintenance of the cohort): W. Cozen

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