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Identifying Risk Factors Using a Skin Cancer Screening Program

Jeremy Robert Etzkorn, MD, Rajiv Prakash Parikh, Suroosh S. Marzban, MS, Kimberly Law, Ashley H. Davis, MS, Bhupendra Rawal, MS, Michael J. Schell, PhD, Vernon K. Sondak, MD, Jane L. Messina, MD, Lois E. Rendina, Jonathan S. Zager, MD, and Mary H. Lien, MD

University of South Florida, College of Medicine (JRE, RPP, KL, AHD, JLM, MHL) and the Department of Cutaneous Oncology (SSM, VKS, LER, JSZ) and Department of Biostatistics (BR, MJS) at the H. Lee Moffitt Cancer Center & Research Institute, Tampa, Florida.

Abstract

Background—The incidence of melanoma and nonmelanoma skin cancer continues to increase. To detect lesions at an earlier phase in their progression, skin cancer screening programs have been advocated by some. However, the effectiveness of skin cancer screening and the ideal population that these screenings should target have yet to be firmly established. This study details the relationship of a group of well-known risk factors with presumptive diagnoses in a large series of individuals self-referred for free skin cancer screening.

Methods—Data obtained during 2007 to 2010 from a descriptive cross-sectional study skin cancer screening program are presented. Participant history was recorded using standardized medical history forms prior to skin examination. Screeners conducted a skin examination varying from whole-body to limited areas (per participant preference) and recorded diagnoses. Diagnoses were assigned to the nonmelanoma cancer (NMC) or suspicious pigmented lesion group for analysis.

Results—A presumptive diagnosis of NMC was associated with male sex, age ≥ 50 years, personal history of skin cancer, lower skin phototype, increased sunscreen use, and increased chronic sun exposure (all P values $\leq .0001$). After controlling for skin phototype, increased sunscreen use was not associated with a presumptive diagnosis of NMC ($P = .96$). Presumptive diagnosis of a suspicious pigmented lesion was associated with a reported history of “changing mole” ($P < .0001$) and negatively associated with age ≥ 50 years ($P < .0001$) and a personal history of skin cancer ($P = .0119$).

Conclusions—Several known risk factors for nonmelanoma skin cancer correlated with a presumptive diagnosis of NMC. The yield of presumptive atypical pigmented lesions was increased in participants aged < 50 years, supporting the notion that this population may benefit from screening.

Address correspondence to Mary H. Lien, MD, University of South Florida, College of Medicine, Department of Dermatology and Cutaneous Surgery, 12901 Bruce B. Downs Blvd, MDC 79, Tampa, FL 33612. mlen@health.usf.edu.

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Introduction

In the United States, the overall incidence and mortality rate of melanoma has increased in recent decades. Cutaneous melanoma currently ranks fifth for men and seventh for women in incidence of all new cancers diagnosed, and an estimated 76,690 new cases will be diagnosed in the United States in 2013.¹ Nonmelanoma skin cancers, basal cell carcinoma (BCC), and squamous cell carcinoma (SCC) continue to be the most commonly diagnosed cancers in the United States, and more than 3.5 million cases were diagnosed in 2006.² These neoplasms significantly impact the public health burden by contributing to medical cost, morbidity, and mortality.

Prevention

Prevention and early detection of skin cancer have been emphasized. Free skin cancer screenings consisting of whole-body visual skin examinations performed by cutaneous oncology specialists are advocated by both the American Academy of Dermatology (AAD) and the American Cancer Society. However, the US Preventive Services Task Force concluded that sufficient evidence does not exist to recommend for or against routine screening for skin cancer using total-body skin examination.^{3,4} Concerns cited by critics of routine screening include low cost effectiveness and lack of conclusive evidence demonstrating that routine screening improves clinical outcomes by reducing morbidity and mortality.^{4,5} Advocates of screening have noted reductions in the frequency of thick melanomas in association with skin cancer screening programs, and results from a large-scale, systematic, skin cancer screening program in Germany reported a reduction in mortality associated with melanoma.⁶ Utilizing AAD screening data, Geller et al⁷ reported a lower frequency of melanomas thicker than 1.50 mm (2%) compared with the National Cancer Institute's Surveillance, Epidemiology, and End Results registry (10%). Aitken et al⁸ reported results from a population-based, case-control study that examined whether a whole-body clinical skin examination within the preceding 3 years was associated with a change in the thickness of subsequently diagnosed melanomas. Their results showed that a recent whole-body clinical skin examination was associated with a 14% reduction in the risk of thick melanomas (> 0.75 mm). Because of the strong relationship between melanoma thickness and mortality, they postulated that screening may decrease mortality rates from melanoma.

Targeted Screening Programs

Identifying and subsequently targeting high-risk populations with screening programs may improve the yield and cost effectiveness of screening.^{9,10} Several phenotypical and environmental risk factors may be associated with an increased risk of nonmelanoma skin cancer^{11,12} and melanoma.^{13–40} The risk conferred by each of these factors and the benefit of efforts, such as applying sunscreen, to prevent the development of nonmelanoma skin cancer and melanoma remain areas of inquiry.

Methods

Study Design

A descriptive, cross-sectional study was conducted from unidentified data obtained from participants screened by the Mole Patrol™ (Moffitt Cancer Center, Tampa, FL) from 2007 to 2010. Institutional review board approval was granted for this study. The Mole Patrol is a free skin cancer screening program initially developed in 1994. Screeners at these events primarily consisted of volunteer physicians (dermatologists, surgical oncologists, and dermatopathologists) but also included nurse practitioners and physician assistants who worked in dermatology or cutaneous oncology practices.

Venues

Screening was provided to participants at numerous public events across Florida and Puerto Rico, including sporting events (Steinbrenner Field), popular beaches (Clearwater and St. Petersburg), skin cancer screening training events (Skin Screening Training), military-associated events (MacDill AirFest), and community fairs and outdoor festivals in Florida (AAA Tampa, Conga Caliente, Ft. Myers, Gulf Harbour Marina, Largo, Leesburg, Kennedy Space Center, Men's Health Forum USF, Miles for Moffitt, Ocala, and Titusville) and Puerto Rico.

Baseline Characteristics

Prior to being screened, participants provided a focused medical history by completing a standardized form, which was a modified version of the standardized AAD screening form used in previous studies from the AAD National Melanoma/Skin Cancer Screening Program.¹³ Participants self-reported the frequency of their sunscreen use (always, sometimes, rarely, never). Skin phototype was self-reported by participants as follows: I (always burn, never tan), II (usually burn, rarely tan), III (sometimes burn, sometimes/always tan), IV (rarely burn, usually tan), or V (never burn, always tan). The participants' race and ethnicity were not recorded. In addition to the information requested on the standardized AAD screening form, screeners recorded their assessment of each participant's degree of chronic sun exposure (minimal, moderate, or severe).

Findings on Skin Examination

Participants underwent visual skin examinations, which ranged from examination of limited areas, such as sun-exposed skin, to whole-body examinations, based on the privacy level of the venue and patient preference. Presumptive diagnoses, both benign (solar lentigo, seborrheic keratosis, hemangioma) and potentially malignant or malignant (actinic keratosis [AK], BCC, SCC, atypical mole, melanoma, other), were recorded by using a checklist and free-text entry. Subsets of the presumptive diagnoses recorded at the time of screening were further assigned to one of two categories: the nonmelanoma cancer (NMC) group and the suspicious pigmented lesion group. Lesions with a presumptive diagnosis of AK, BCC, or SCC were included in the NMC group, and lesions with a presumptive diagnosis of atypical mole or melanoma were included in the suspicious pigmented lesion group.

All patients with a finding in either of these suspicious categories were urged to receive prompt evaluation by a dermatologist or other qualified provider, and lists of local providers were made available at each screening venue. However, biopsies were not performed as part of the Mole Patrol, and no post-screening follow-up was conducted to determine whether suspicious findings were further evaluated or histologically confirmed.

Statistical Analyses

Descriptive statistics are presented using frequencies and percentages. The Mantel-Haenszel Chi-square test and Cochran-Mantel-Haenszel statistics together were used to assess trends of association and an overall significance among various categorical disease characteristics (sex, age ≥ 50 years, skin phototype, history of skin cancer, sunscreen use, history of a “changing mole,” and degree of chronic sun exposure) by different disease groups (NMC and suspicious pigmented lesion groups) and for assessing the association between sunscreen use and the NMC group while separately controlling for other risk factors. For 2×2 tables, Barnard’s unconditional test was used to assess potential associations. A two-sided P value of $.05$ was considered statistically significant. All statistical analyses were performed using SAS (version 9.2, SAS Institute Inc, Cary, NC) and StatXact (version 8, Cytel Inc, Cambridge, MA).

Results

Between 2007 and 2010, the Mole Patrol screened 5,169 people. The demographics of the screening population are presented in Table 1. The largest age group of people screened were between 51 to 60 years (23.2%), followed by 61 to 70 years (22.4%).

Nonmelanoma Skin Cancer Group

The percentages of participants with presumptive diagnoses of AK, SCC, and BCC were 16%, 3%, and 6%, respectively. When the frequencies were all grouped together as the NMC group, the overall frequency of these diagnoses was 21%. Table 2 documents the frequencies and percentages of the presumptive diagnoses in the NMC group when participants were stratified by age.

Table 3 outlines the relationship between variables obtained from the screening questionnaires and from the examiners’ assessments as well as presumptive diagnoses of findings in the NMC group. Statistically significant positive associations were noted for male sex, age 50 years or older, lower skin phototype, a personal history of skin cancer, increased sunscreen use, and increased chronic sun exposure. As noted in Table 3, increased sunscreen use was associated with NMC ($P < .0001$) on univariate analysis. However, increased sunscreen use was also associated with a personal history of skin cancer ($P < .0001$) as well as lower skin phototype ($P < .0001$).

Table 4 shows the association between increased sunscreen use and NMC after separately controlling for age 50 years or older, personal history of skin cancer, lower skin phototype, and increased chronic sun exposure. When controlling for lower skin phototype, the association between increased sunscreen use and NMC findings was not statistically significant ($P = .96$).

Suspicious Pigmented Lesion Group

The frequencies of a presumptive diagnosis of atypical mole and melanoma were 11% and 0.7%, respectively. When grouped into the suspicious pigmented lesion group, the frequency of findings was 11.6%.

Table 5 outlines the relationship between variables obtained from the screening questionnaires and from examiners' assessment as well as presumptive diagnoses of findings in the suspicious pigmented lesion group. Statistically significant associations with the presence of a suspicious pigmented lesion finding included a positive association with a history of a "changing mole" and a negative association with age 50 years or older and a personal history of skin cancer.

Table 6 presents the frequencies and percentages of the suspicious pigmented lesion group findings stratified by age. For participants screened who had a presumptive diagnosis of a suspicious pigmented lesion group finding, 38% were older than 50 years of age.

Discussion

Recommendations for or against routine screening for skin cancer have several limitations, chief among them being the paucity of evidence regarding the positive effect of screening on morbidity or mortality.⁴ It may be more feasible to demonstrate an effect on health outcome end points from skin cancer screening if it is targeted to high-risk populations.⁹ Identifying factors that define high-risk populations is an important step in improving and rationalizing targeted screenings for nonmelanoma skin cancer and melanoma.¹³

Common suggested risk factors for the development of nonmelanoma skin cancer include ultraviolet light exposure, pigmentary traits (eg, hair and eye color), skin phototype, prior history of nonmelanoma skin cancer, and increasing age.^{11,12} This study found similar risk factors for the presence of NMC group findings on screening clinical skin examination; male sex, age 50 years or older, a personal history of skin cancer, lower skin phototype, and more chronic sun exposure were all associated with an increased frequency of NMC findings (all P values < .0001).

We initially noted an association between the NMC group findings and the use of sunscreen ($P = .0001$). However, in this study, persons with lower skin phototype reported more frequent applications of sunscreen than those with higher (ie, more pigmented) skin phototype, and persons with lower skin phototype were also more likely to have NMC group findings than those with a higher skin phototype. When controlling for skin phototype, the association between sunscreen use and frequency of NMC findings failed to maintain statistical significance ($P = .96$). Other variables, including personal history of skin cancer, age, and degree of chronic sun exposure, were also examined but did not alter the statistically significant relationship between increased sunscreen use and frequency of NMC.

The use of sunscreen to prevent skin cancer is a common recommendation in the practice of dermatology. However, few clinical trials have been conducted to assess the efficacy of sunscreen use, either in high-risk populations or the general populace. In patients who

underwent organ transplant, one case-control study demonstrated that sunscreen use resulted in a significantly decreased incidence of SCC and AK but not BCC.⁴¹ In randomly assigned patients, results from a study conducted in Nambour, Australia, suggest that regularly applying sunscreen may prevent melanoma⁴² and SCC^{43,44} in the general population. The same trial failed to show a protective effect for BCC. From this trial it is reasonable to conclude that light-skinned, middle-aged and older people living in sunny areas may benefit from generously applying sunscreen, and the regular use of sunscreen may be cost effective in the setting studied by the Nambour trial.⁴⁵ However, generalizing the results of the Nambour trial to other patient populations and locations may not be reasonable.⁴⁶ In addition, recommending sunscreen application may have unintended consequences, including allowing users to prolong their sun exposure times.^{47–49} Some researchers have suggested that sunscreen use in intentional sun exposure situations may increase the risk of skin cancer, particularly melanoma.^{50–53} When making recommendations regarding sunscreen use, it may be prudent to emphasize that the potential benefits of sunscreen use may be negated if that use leads to increased exposure to the sun.

Common suggested risk factors for melanoma include skin phototype or ethnicity,^{14–16,18–20} freckling tendency,^{16–18,20,21} many moles and/or atypical moles,^{15,16,18–22,24,25} light eye color,²⁰ blonde or red hair,^{16–20,22,25} middle-aged and older men,^{13,14,26} new or changing moles,^{13,18,26,27} family history of melanoma,^{15,28,29} personal history of melanoma,^{13,30} history of nonmelanoma skin cancer,^{22,28,31–35} sunburn history,^{21–23,39,40} and artificial ultraviolet light exposure (including tanning beds).^{25,36–38} Goldberg et al¹³ analyzed data from 362,804 patients screened via the AAD National Melanoma/Skin Cancer Screening Program and identified five risk factors for a presumptive diagnoses of melanoma in skin cancer screening: history of previous melanoma, age above 50 years, lack of a regular dermatologist, mole changes, and male sex.

Of the risk factors examined in this study, a history of a “changing mole” was significantly associated with the presence of a suspicious pigmented lesion group finding on the clinical skin examination, a result that must be viewed in the context of a screener providing a clinical diagnosis after being informed that a lesion has changed. Age of 50 years or older ($P < .0001$) and a history of skin cancer ($P = .0119$) were negatively associated with a suspicious pigmented lesion group finding on screening examination. The finding that an age of 50 years or older was negatively associated with the presence of a suspicious pigmented lesion group finding on screening examination contrasts with results obtained from the analysis conducted by Goldberg et al¹³ on the AAD National Melanoma/Skin Cancer Screening Program data. However, it is important to note the differences between this study and the Goldberg analysis. We grouped the presumptive diagnoses of atypical mole and melanoma, whereas the Goldberg study did not. Also, our study was confined to a limited geographical region characterized by high levels of chronic sun exposure, thereby making this study population likely to be significantly different from the population analyzed in the Goldberg study in terms of the characteristics of sun exposure experienced by screening participants. Our study does not align with other published data that demonstrate a positive association between melanoma and a personal history of melanoma^{13,30} or a personal history of nonmelanoma skin cancer.^{22,28,31–35} However, our

study did not distinguish between a personal history of melanoma or other types of skin cancer.

Studies of the relationship between various measures of sun exposure and melanoma development have had conflicting results. Some have failed to identify such an association,^{18,54} while others have noted varied associations between sun exposure and melanoma development: increased risk when spending less than 10 hours each week outdoors in the summer between the ages of 10 and 24 years,²⁸ increased risk with childhood residence in a high ambient ultraviolet light exposure environment,⁵⁵ increased risk with history of severe sunburns,^{22,23,40} increased risk with history of childhood sunburn,^{19,20,25,40} and decreased risk with more occupational sun exposure.¹⁹ The present study did not identify an association between chronic sun exposure level, as assessed by the screeners, and suspicious pigmented lesion group findings. The study questionnaire also did not specifically ask about sunburn history, recreational vs occupational sun exposure, or sun exposure characteristics at different age intervals.

Demonstrating a benefit from population-based screening is difficult secondary to the large number of participants who would be required to achieve sufficient power in such a study.⁵ Aitken et al⁵⁶ attempted to implement a population-based screening program in Australia to address this question, but the authors could not accrue a sufficient number of patients for data analysis, partially secondary to funding considerations. However, even if population-based screening initiatives lack benefit, screening populations with identifiable risk factors may still prove fruitful.

Limitations

This study had several limitations. Cross-sectional studies may delineate associations, but we were unable to ascertain causation between the variables examined. Screening occurred over a limited geographical area (ie, Florida, Puerto Rico). Volunteers at various community events participated in the screening program, so the results obtained in this study may not be applicable to other screening populations. Histopathological verifications of the presumptive clinical diagnoses initially made at the time of screening were not performed. Prior studies with dermatologists and primary care physicians demonstrated adequate rates of sensitivity and specificity when comparing presumptive diagnoses from visual skin screening examinations to follow-up histopathological diagnoses, particularly for diagnoses of SCC and BCC.^{57–59} However, the participants in this study were usually screened by nurse practitioners and physician assistants whose diagnostic accuracies of skin cancer are unknown.

The questionnaire used in the present study did not specifically query history of sunburn, recreational vs occupational sun exposure, sun exposure characteristics at different age intervals, or recreational exposure to tanning beds, nor did the questionnaire delineate between personal history of melanoma or other skin cancer types. This may have affected the ability to detect an association between a personal history of skin cancer (specifically a personal history of melanoma) and the frequency of a suspicious pigmented lesion group finding on examination. Not all screening questionnaires were completed in their entirety;

however, given the size of the study population, this was an expected limitation and was consistent with other large population screening studies.

Conclusions

Analysis of the Mole Patrol data identified several risk factors for a presumptive clinical diagnosis of nonmelanoma cancer and suspicious pigmented lesion group findings. For nonmelanoma cancer findings, male sex, age of 50 years or older, personal history of skin cancer, lower skin phototype, and a higher degree of chronic sun exposure helped to identify participants at increased risk, while a history of a “changing mole” significantly correlated with the presence of a suspicious pigmented lesion group finding.

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Table 1

Demographics of the Screening Population (N = 5,169)

Demographic	No. of Participants (%)
Age (yrs)	
Average	50.7
Median	53
Range	1–91
Sex (n = 3,684)	
Male	1,706 (46.3)
Female	1,978 (53.7)
Age ≥ 50 yrs (n = 5,155)	
No	2,177 (42.2)
Yes	2,978 (57.8)
Frequency of sunscreen use (n = 3,508)	
Never	292 (8.3)
Rarely	502 (14.3)
Sometimes	1,842 (52.5)
Always	872 (24.9)
Frequency of skin phototype (n = 992)	
Always burn, never tan (I)	89 (9.0)
Usually burn, rarely tan (II)	184 (18.6)
Sometimes burn, sometimes/always tan (III)	307 (30.9)
Rarely burn, usually tan (IV)	283 (28.5)
Never burn, always tan (V)	129 (13.0)
History of skin cancer (n = 3,437)	
Yes	531 (15.4)
No	2,906 (84.6)
Frequency of chronic sun exposure level (n = 888)	
Minimal	275 (31.0)
Moderate	499 (56.2)
Severe	114 (12.8)

Table 2

Frequency of Nonmelanoma Cancer Findings Stratified by Age

Age (yrs)	No. of Participants	Frequency (%)
0–9	69	0 (0)
10–19	219	1 (0.5)
20–29	394	7 (1.8)
30–39	550	33 (6.0)
40–49	945	135 (14.3)
50–59	1,188	266 (22.4)
60–69	1,202	372 (30.9)
70–79	501	220 (43.9)
80	87	43 (49.4)

Table 3

Selected Risk Factors in the Nonmelanoma Cancer Group

Risk Factor	P Value
Male sex	< .0001 *
Age ≥ 50 yrs	< .0001 *
Lower skin phototype	< .0001 *
History of skin cancer	< .0001 *
Increased sunscreen use	.0001 *
Changing mole reported	.7159
Increased chronic sun exposure	< .0001 *

* Positive association between risk factors.

Table 4Relationship Between Increased Sunscreen Use and Nonmelanoma Cancer Findings^a

Risk Factor	P Value
Age ≥ 50 yrs	< .0001
History of skin cancer	.0047
Lower skin phototype	.9435
Increased chronic sun exposure	.0298

^a After correcting for other risk factors.

Table 5

Selected Risk Factors and Suspicious Pigmented Lesion Findings

Risk Factor	P Value
Male sex	.6390
Age ≥ 50 yrs	< .0001 ^a
Lower skin phototype	.1131
History of skin cancer	.0119 ^a
Increased sunscreen use	.1876
Changing mole reported	< .0001 ^b
Increased chronic sun exposure	.6230

^a Negative association with risk factor.^b Positive association with risk factor.

Table 6

Frequency of Suspicious Pigmented Lesion Findings Stratified by Age

Age (yrs)	No. of Participants	Frequency (%)
0–9	69	4 (5.8)
10–19	219	25 (11.4)
20–29	394	81 (20.6)
30–39	550	115 (20.9)
40–49	945	136 (14.4)
50–59	1,188	111 (9.3)
60–69	1,202	93 (7.7)
70–79	501	30 (6.0)
80	87	3 (3.4)