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Development and reliability of a brief skin cancer risk assessment tool

Karen Glanz, PhD, MPH [a,*], Elinor Schoenfeld, PhD [b], Martin A. Weinstock, MD, PhD [c], Gabriela Layi, MA [a], Jeanne Kidd, MA [b], Dorothy M. Shigaki, MS [a]

[a] *Cancer Research Center of Hawaii, University of Hawaii, 1960 East-West Road, Biomed C-105, Honolulu, HI 96822, USA*
[b] *School of Medicine, SUNY Stony Brook, New York, NY, USA*
[c] *Brown University School of Medicine, Providence, RI, USA*

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Abstract

This study aimed to develop and pilot test a brief skin cancer risk assessment tool (BRAT), a self-administered instrument that can be reliably used to assess skin cancer risk. To develop the BRAT, we critically reviewed published literature on risk factors; formulated a draft questionnaire; pilot tested the questionnaire; and retested 1 month later. The BRAT items address the key risk factors for melanoma and other keratinocyte skin cancers: ethnicity, personal and family history of skin cancer, mole count, freckles, childhood residence, sunburn history, and sun sensitivity factors (skin color, natural hair color, ease of sunburning and tanning). One hundred sixty-five persons completed the initial BRAT pilot study, and 52 additional people at moderate- or high-risk completed a second BRAT pilot study. Results were as follows: using a dichotomous risk measure, about 90% of subjects would be correctly classified at baseline and follow-up. Weighted κ for the total BRAT score (0.41–0.68) and for individual items (0.57–0.99) were fair to good, as were correlation coefficients. The BRAT has acceptable to good reproducibility. Reliability statistics compared favorably with those reported in the literature for similar measures.

Keywords: Skin cancer; Melanoma; Risk assessment; Cancer prevention

1. Introduction

Skin cancer is the most common form of cancer, and one of the most preventable [1,2]. Because skin cancer rates continue to rise with alarming speed [3], development of effective prevention strategies is a public health priority [4]. Behaviors recommended for preventing skin cancer and its sequelae include reducing sun exposure, using broad-spectrum sunscreen, skin self-examination, seeking shade, and wearing protective clothing and sunglasses [5,6]. However, a great challenge remains to inform, persuade, and motivate most people to routinely practice these habits, which are not consistently followed in the United States [7,8].

A promising approach to the use of limited health intervention resources is to identify persons at increased-risk and direct prevention efforts toward them. Risk factors for skin cancer include nevi, personal and family history, excess sun exposure, residing in a locale with high ultraviolet (UV) radiation, and physical characteristics that constitute sun sensitivity phenotype, and nevi for melanoma [9]. In the past, some tools for assessing melanoma risk [10] or its components [11] have been developed. However, they have either been incomplete assessments of risk or more suitable for clinical use than in population interventions [12,13]. For example, these assessments have relied on physical examinations such as a count of nevi by a nurse interviewer. Up to now there has not been a tool for efficiently assessing skin cancer risk in large populations, based on self-reports, so that prevention efforts can be focused.

The aim of this research, which is part of a randomized trial of skin cancer prevention strategies, was to develop and pilot test an epidemiologically based brief skin cancer risk assessment tool (BRAT), a short self-administered instrument that can be reliably used to assess skin cancer risk. The tool was designed primarily to evaluate the risk for melanoma, which accounts for most skin cancer deaths [1,3].

2. Methods

2.1. Context

This research was conducted as part of Project SCAPE (Skin Care Awareness, Prevention and Education), a

* Corresponding author. Tel.: +1-808-586-3076; fax: +1-808-586-3077.
E-mail address: kglanz@hawaii.edu (K. Glanz).

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randomized trial to evaluate the impact of a mailed, tailored intervention, compared to standard skin cancer education materials, on prevention and early detection of skin cancer in moderate- and high-risk adults. Project SCAPE also aims to evaluate the process and impact of a skin cancer prevention intervention in diverse ethnic groups and regions, and to refine skin cancer risk assessment methodologies.

The brief skin cancer risk assessment tool was developed to provide a short, self-administered instrument to reliably assess skin cancer risk. It would then be used both to determine trial eligibility and to provide tailored risk feedback in participants randomly assigned to receive tailored print materials.

2.2. Development of the brief skin cancer risk assessment tool (BRAT)

To develop the BRAT, we: (1) critically reviewed published literature on risk factors and their self-assessment; (2) formulated a draft questionnaire; (3) pilot tested the questionnaire on a convenience sample of persons at varying levels of risk; and (4) retested 1 month later. We then conducted a second pilot study with persons found to be at moderate- or high-risk of skin cancer (based on responses to the initial BRAT), as part of a measurement sub-study to the main Project SCAPE trial.

The BRAT items address the key common risk factors for melanoma and basal cell and squamous cell carcinomas: personal and family history of skin cancer, total body mole count ($\geq$1/4 in.), freckles, childhood residence, sunburn history, ethnicity, and sun sensitivity factors (skin color, natural hair color, ease of sunburning and tanning) [9,11,14–16]. A scoring system was developed, based on the relative risk of melanoma for each risk factor, because melanoma is the cause of most skin cancer deaths (see Table 1). The actual BRAT instrument was designed as a scannable form, that fit on one side of a letter-size page. (Copies of the BRAT instrument and scoring details are available from the senior author on request.) The back of the page included questions about demographic factors (age, gender, and education level). We required the scores of each item to be additive for ease in calculating the overall score. This constraint required that the relative risks not be used directly for the score, though the weighting of each item was based on the relative risk. We took account of the correlation among multiple factors, particularly those indicative of sun sensitivity. We also evaluated the overall reasonableness of the classification results in a variety of individual cases to confirm the validity of the final score, though this procedure did not result in any changes to the scoring algorithm.

2.3. Procedures

Data collection for the initial BRAT pilot study took place in the waiting rooms of primary care practices (HMO's and group practices) in Honolulu, Hawaii, and on Long Island, New York, in March 1999. These two sites were used to include participants from various ethnic groups and geographic/climatic regions: the majority of residents in Hawaii are non-Caucasians and the climate is tropical, while in New York most people are Caucasian but the latitude is further north of the Equator.

Table 1
Brief skin cancer risk assessment tool: variables, risk ratios, and scoring

Risk variable	Risk ratio	Scoring
Key common risk factors		
(1) Ethnicity	Caucasian = 10–1 compared to non-Caucasians	Unscored (due to correlation with sun sensitivity)
(2) Prior skin cancer	Automatically in high-risk category, exclusion if still in treatment (ineligible)	Yes, 30; no, 0
(3) Moles	10-fold risk for high number of moles $\geq$1/4 in.	None, 0; 1–2, 5; 3–5, 10; 6–10, 20; >10, 30
(4) Sun sensitivity (skin color, hair color, ability to tan, ease of burning)	4–5-fold risk	*Skin color*: 0, dk br/black; 2, med brn; 4, lt brn; 16, olive; 18, fair; 20, very fair *Hair color*: 0, black; 1, dk brn; 2, lt brn; 3, blonde; 4, red *Burn easily in sun*: 0, no; 3, yes *Ability to tan*: 0, dark; 1, medium; 2, light; 3, none
(5) Childhood residence (sun exposure/latitude)	2–3-fold risk for southern/tropical latitude	Northern latitude, 0; southern US, 5; Hawaii/Australia/tropics, 10
(6) Sunburn history	2–3-fold risk for many vs. none	0, none; 1–2, 1; 3–5, 2; 6–10, 3; >10, 4
(7) Freckles	2–3-fold risk for many vs. none	None, 0; few, 2; many, 4
(8) Family history	Confers risk, but unreliable response	Unscored risk item [30]
Other demographics—no direct, significant risk factor role		
(9) Gender		
(10) Age	Increases through life, melanoma is #1 cancer in 25–35 years age group; prior history affects how much risk "remains", and squamous CC is uncommon in people <age 65 years; no simple risk equation	
(11) Where born		
(12) Length of time lived in Hawaii/Long Island		
(13) Education level		

Research staff posted a sign and brochures to inform patients about the study, and approached those waiting for their doctor's appointments to invite them to participate. Those under age 20 or over age 65, and anyone currently being treated for skin cancer, were excluded. After an explanation of the study procedures and an informed consent process, those who were willing to participate were given a BRAT form on a clipboard. A part of the consent procedures involved asking if they would allow us to call them back 1 month later. A month later, an interviewer re-contacted subjects by telephone and administered the BRAT instrument verbatim.

Subjects for the second pilot study were recruited at the beginning of recruitment for the main trial (from April to May 1999). We were able to include these individuals in this analysis, because the instrument remained the same as originally designed. The only difference was that this group included only persons found to be at moderate- or high-risk of skin cancer upon completion of the BRAT. They were recruited in the same setting as the first pilot study, and agreed to be part of a measurement sub-study for the Project SCAPE trial. These subjects received a mailed packet including a questionnaire (Sun Habits Survey) and a 4-day Sun Exposure Diary. They were asked to complete and return the survey first, and then complete the Sun Exposure Diary over 4 days, including 2 weekend days [17]. A second mailed packet was sent out about 4 weeks later, and the second survey included a re-administration of the BRAT items. The second surveys were returned to the study office 6–8 weeks after the first BRAT assessment.

2.4. Statistical analysis

Only subjects with two completed BRAT's were included in data analyses. Descriptive analyses were completed to apply the scoring system to the baseline BRAT responses in the first pilot study. These data were used to establish cut-off points for risk tertiles (low, moderate, high). Next, we completed item analyses for each item by comparing baseline and follow-up responses, examining stability or change in both individuals' and grouped data by percent change, magnitude of change, κ statistics [18] and Spearman ρ correlations. To assess reproducibility of the BRAT in assigning risk categories to individuals, we used the κ statistic and Spearman ρ correlation on risk category scores. Weighted κ's and correlations were used for non-categorical items.

3. Results

3.1. Samples

For the first pilot test, 173 persons completed the initial BRAT and 165 (95.4%) completed the second administration. Characteristics of the samples are shown in Table 2. They were predominantly Caucasian (72.1%) and female (73.3%), with an average age of 39.9 years of age and nearly one-third being college graduates. In the second pilot test, 118 people were enrolled in the measurement sub-study and 62 of these (52.5%) completed the first set of surveys and diaries. Of those 62, 83.9% ($n = 52$) completed the second survey, diary, and BRAT assessment. These respondents were also predominantly Caucasian (76.9%), nearly all female (92.3%), and slightly older and more educated than subjects in the first pilot test (see Table 2).

Table 2
Characteristics of samples

	Pilot test #1	Pilot test #2
N	165	52
Hawaii	57 (34.5%)	26 (50.0%)
New York	108 (65.5%)	26 (50.0%)
Caucasian (%)	72.1	76.9
Female (%)	73.3	92.3
Mean age	39.9 years (±11.5)	44.3 years (±12.0)
≥College graduates (%)	32.1	53.8

3.2. Cut-points for risk categories

Scores on the initial BRAT ranged from 0 to 89. We determined that ethnicity should not be assigned a separate score because its contribution was adequately reflected by the items indicative of sun sensitivity. Data from both study sites were used to determine the lower, middle, and high tertile of risk scores. The data were distributed relatively evenly across the range of possible scores, and visual inspection showed that distinct groupings in three categories would result in suitable clusters of scores. As a result, individuals scoring 26 or below were placed in the low-risk category; scores of 27–35 were considered moderate-risk; and scores of 36 and higher were classified as high-risk. Because of their higher contribution to melanoma risk, the items accounting for the greatest proportion of risk scores were: personal history of skin cancer, number of moles larger than 1/4 in., skin color, sunburn history, and childhood residence (see Table 1).

For example, someone with medium brown skin; no moles, skin cancer history, or history of sunburn; and who grew up in New York would have a risk score of "7" and be classified as low-risk. Someone with fair skin, 3–5 moles, 1–2 blistering sunburns as a child, and who grew up in California would have a risk score of 33 and be deemed moderate-risk. Lastly, an individual with very fair skin who grew up in Hawaii, has 6–10 large moles, more than six severe sunburns in childhood, and was previously treated for skin cancer, would have a score of 87 and be in the high-risk category.

3.3. Test–retest reliability

Table 3 shows the test–retest reliability (reproducibility) findings for the BRAT scoring system for the first pilot

Table 3
Reliability findings: risk categories—pilot test #1 ($n = 165$)

Risk category at baseline	Risk category at follow-up[a]			Total (%)
	Low (%)	Moderate (%)	High (%)	
Low	**84.7** ($n = 50$)	15.3 ($n = 9$)		100
Moderate	20.0 ($n = 15$)	**69.3** ($n = 52$)	10.7 ($n = 8$)	100
High		29.0 ($n = 9$)	**71.0** ($n = 22$)	100

Note: Weighted $\kappa = 0.68$ ($P < 0.001$), Spearman ρ correlation $= 0.76$ ($P < 0.001$).

[a] Overall, 75.2% of respondents did not change risk categories (124/165; diagonal/bold values); 10.3% changed to a higher category (low to moderate/moderate to high; 17/165); and 14.5% changed to a lower category (high to moderate/moderate to low; 24/165).

test. As shown within the rows, the proportion of subjects who did not change categories was 84.7, 69.3, and 71.0 for low-, moderate-, and high-risk categories at baseline. Overall, 75.2% of respondents did not change risk categories between the first and second risk assessment, while 14.5% changed to a lower category and 10.3% changed to a higher category. Eighty-six percent would still be classified as moderate- or high-risk using a dichotomous risk measure. The weighted κ was 0.68 and the Spearman ρ correlation was 0.76, both highly statistically significant and moderate in magnitude.

In the second pilot test, which only included persons rated at moderate- or high-risk at baseline, 75.0% of those in the moderate-risk category and 62.5% in the high-risk category did not change (Table 4). 71.2% were in the same risk category at the second assessment (37 out of 52, based on bolded values). The κ was 0.41 and the Spearman ρ correlation was 0.44, both highly significant.

Table 5 gives the reliability of individual items comprising the skin cancer risk score, arranged from most to least reproducible. All associations showed relatively high correlations over time, ranging from 0.57 to 0.97. The most reliable item was childhood residence, followed by natural hair color; and the least reliable were the number of large moles, tendency to sunburn, and skin color. The two pilot studies yielded similar reliabilities on most items; however, prior skin cancer was more reproducible in the second study and freckles, skin color, and tendency to burn were somewhat less reliable in the second pilot study.

Table 4
Reliability findings: risk categories—pilot test #2 ($n = 52$)

Risk category at baseline	Risk category at follow-up		Total (%)
	Moderate (%)	High (%)	
Moderate	**75.0** ($n = 27$)	25.0 ($n = 9$)	100
High	37.5 ($n = 6$)	**62.5** ($n = 10$)	100

Note: Weighted $\kappa = 0.41$ ($P < 0.001$; κ used without weighting due to only two levels), Spearman ρ correlation $= 0.44$ ($P < 0.001$).

Table 5
Reliability of individual items***

Item	Pilot test #1 ($N = 165$)		Pilot test #2 ($N = 52$)	
	κ[a]	Spearman ρ	κ[a]	Spearman ρ
Childhood residence	0.97	0.97	0.90	0.89
Hair color	0.84	0.88	0.80	0.86
Freckles	0.83	0.86	0.69	0.74
Sunburn history	0.77	0.83	0.62	0.90
Prior skin cancer	0.74	0.77	0.91	0.92
Ability to tan	0.72	0.80	0.64	0.75
Skin color	0.71	0.77	0.69	0.73
Tendency to burn	0.70	0.70	0.57	0.58
Large moles	0.61	0.65	[b]	0.69

*** $P < 0.001$ for all associations.

[a] Weighted κ used for non-categorical items.

[b] Could not calculate due to uneven cell sizes.

4. Discussion

The brief skin cancer risk assessment tool for adults was found to have acceptable to good reproducibility in two separate pilot studies, including subjects from two different locations. The κ's in the range of 0.40–0.65 are generally considered "acceptable," and those above 0.65 are considered "good" [19,20]. Reproducibility was slightly lower with a longer interval between administrations, but was still significant and yielded no change in risk category in nearly three-quarters of respondents.

The reliability statistics found in this study compared favorably with those reported in the literature for similar measures, although only one other study reports on the reproducibility of a self-administered questionnaire to assess melanoma risk, among residents in Sweden. In their report, Westerdahl and others repeated the survey 1–3 years later, and found κ's for classification between 0.52 and 0.83, and somewhat lower for raised nevi (0.40) [14].

Several other studies have examined reliability in terms of inter-observer agreement between self-assessments and dermatologists' assessments. Jackson et al. found κ's of 0.67 for freckles, 0.60 for moles, and 0.43 for atypical nevi [21]; Melia et al. found somewhat lower associations between self- and dermatologist assessments: 0.67 for hair color, 0.34–0.36 for skin type, and 0.13–0.19 for freckling [22]. Many other investigations have concentrated on using physician examinations or physical measures to validate measures of sun sensitivity [11,23] and nevus counts [16,24–29]. Depending on the specific test and study methods, associations among these variables have varied widely: from 0.14 to 0.96 for repeated counts, all versus large nevi, and physician versus self-count.

For the purposes of cancer prevention education in a primary care or preventive oncology clinic, the brief skin cancer risk assessment tool appears to have sufficient reproducibility to both classify and provide patients and consumers with information and tools to promote skin cancer protection practices among at-risk individuals. Its reproducibility

among adults appears to meet general standards in the literature, based on other available data. Validation with clinical exams may further support the usefulness of this measure.

There are noteworthy limitations resulting from the use of this particular study population, as opposed of a random sample of the general population. We were unable to characterize non-respondents in the patient population. Reliability data from the two pilot tests suggest that the BRAT instrument is not clearly problematic in less well-educated subjects than in those who have more formal education.

In addition, this approach does not include a score related to family history as a risk factor due to the unreliability of self-report. Nor does it include clinical or direct dermatologic measures of nevi and dysplastic nevi, which might be further limitations to the accuracy of the BRAT score. These flow directly from the need for a self-administered instrument, and cannot be readily avoided.

Another limitation of this tool is that it does not attempt to measure risk factors for some of the many other types of skin cancers, which are much more rare [3].

The risk assessment developed in this study was meant to identify individuals for preventive interventions, rather than for skin cancer detection or screening. To our knowledge, this is the first brief skin cancer risk assessment tool that has been developed primarily for use in such public health-oriented prevention efforts. It builds on the epidemiological literature to date, most of which focuses on risk assessment for the purpose of understanding disease etiology. In view of the pressing need to reverse the rise in skin cancer across the United States [4], the BRAT has great potential to help better target preventive interventions to those who might benefit the most.

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