Skin Cancer Education and Early Detection at the Beach: A Randomized Trial of Dermatologist Examination and Biometric Feedback

Karen M. Emmons[1,2] PhD
Alan C. Geller[2,3] MPH, RN
Elaine Puleo[5] PhD
Sanghamitra S. Savadatti[1], MPH
Stephanie W. Hu[6]
Sue Gorham[4]
Andrew E. Werchniak[6] MD
For the Dana Farber Skin Cancer Screening Group

[1] Dana-Farber Cancer Institute, 44 Binney St. Boston MA 02115
[2] Harvard School of Public Health, 677 Huntington Ave, Boston MA 02115
[3] Boston University School of Medicine, 720 Harrison Ave, Boston MA 02118
[4] SHADE Foundation of America, North Valley Medical Plaza, 3811 E. Bell Rd #106, Phoenix, AZ 85032
[5] UMASS Amherst, Amherst, MA 01003
[6] Harvard Medical School, 25 Shattuck St, Boston MA 02115

Address communications and reprint requests to: Karen M. Emmons, Ph.D., Harvard School of Public Health and Dana-Farber Cancer Institute, Center for Community-Based Research, 44 Binney Street, Boston, MA 02115; phone: (617) 632-2188; fax: (617) 632-5690; electronic mail: Karen_M_Emmons @dfci.harvard.edu

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Abstract

Background/Objectives: There are limited data on the effectiveness of skin cancer prevention education and early detection programs at beaches, where sun exposure is typically high. We evaluate four strategies for addressing this need

Methods: This was a cluster-randomized design, conducted at four beaches in Massachusetts. . Follow-up was conducted on average 85 days post-intervention.

There were 4 intervention conditions: (1) education only; or education plus (2) biometric feedback; (3) dermatologist skin examination; or (4) biometric feedback and dermatologist skin examination. Main outcomes included sun protection behaviors, sunburns, and skin self-exams.

Results: Compared with other conditions, education plus biometric feedback led to a significant increase in hat wearing, sunscreen use, and a reduction in sunburns (Odds ratios compared to control group are 1.97, 1.94, 1.07 respectively). It also led to greater improvements in knowing what to look for in skin-self examinations (OR=1.13), but there were no differences between conditions in frequency of self-examinations. Skin examinations plus biometric feedback led to greater reductions in sunburns. The dermatologist exams identified atypical moles in 28% of participants.

Conclusions: Education and biometric feedback is more effective than education alone for impacting sun protective attitudes and behaviors in beach-going, high-risk populations. Dermatologist skin exams did not further increase sun protective behavior, although identification of abnormal skin lesions and referral did provide those participants with the opportunity for further assessment and treatment if needed.

Key Words: skin cancer prevention; skin examinations; sun protection

Capsule Summary

- This study evaluated 4 strategies for providing skin cancer prevention education in beach settings.
- Education and biometric feedback was more effective than education alone for impacting sun protective attitudes and behaviors in beach-going, high-risk populations.
- Dermatologist skin exams did not further increase sun protective behavior, although identification of abnormal skin lesions and referral did provide those participants with the opportunity for further assessment and treatment if needed.

Skin Cancer Education and Early Detection at the Beach: A Randomized Trial of Dermatologist Examination and Biometric Feedback

Skin cancer is the most common form of cancer in the United States, with more than one million new cases diagnosed each year.[1] Melanoma is the only preventable cancer which continues to rise while screening rates and preventive practices show little improvement[2] Chronic unprotected exposure to the sun's ultraviolet light and/or intermittent but intense exposures such as those that occur on beaches are thought to be a primary cause of skin cancer.[3] Every year over 180 million people make more than 2 billion visits to beaches in the US alone.[4] However, there have been few intervention studies conducted with beachgoers. Weinstock[5, 6] conducted an intervention matched to stage of readiness to change that included personalized sun safety assessments and biometric feedback. Significant improvements were found in self-reported sun protection behaviors. A smaller study found that a stage-matched intervention improved sun protection but not reduction of sun exposure.[7]

The Extended Parallel Process Model (EPPM) provides important insights as to why feedback from imaging photographs might be useful as an intervention tool.[8] In essence, biometric feedback can be framed as fear appeals, in the form of images highlighting damaged skin. EPPM posits that such fear appeals, when provided together with messages emphasizing self-efficacy to take action, should increase protective behavior. Stephenson and Witte found support for this relationship related to sun protection.[9]

We examined different educational strategies to increase sun protection and reduce skin damage, and to increase early detection. Although the efficacy of large-scale community-based skin cancer screenings has not yet been demonstrated related to skin cancer mortality,[10] the

American Academy of Dermatology's (AAD) free screening programs have been shown to lead to the detection of thinner, more curable melanoma, compared with SEER data.[11] Intensive education and screening led to reduced melanoma mortality [12, 13] and a randomized trial in Queensland showed promising results in its initial randomization of 18 communities.[12, 13]

We tested four approaches for skin cancer education at beaches: 1) education alone; 2) education plus biometric feedback using a Dermascan machine and UV camera that illustrates skin damage due to sun exposure; 3) education plus dermatologist or dermatology nurse practitioner skin examination; and 4) education, skin examination, plus biometric feedback. We hypothesized that combining education, biometric feedback, and skin examination would maximize practices for sun protection, self-screening, and early detection.

METHODS

Four popular and crowded beaches in low to middle income communities in the Boston area participated in this study, each randomized to receive one of the 4 different education programs delivered on a Community Education Van.

Eligibility criteria included being: 1) 18 years and older; 2) able to understand, speak and read English; and 3) able to give informed consent. Analyses were restricted to Caucasians due to the few African- Americans and Hispanics at the beaches and their appreciably lower risks of skin cancer.[14-16]

Settings and Procedures

The Van visited each beach on 3-4 designated days in the summer of 2007. The intervention was offered on the same number of weekends vs. weekdays, with specific days assigned randomly in advance by the study methodologist. Alternative days for weather cancellation were scheduled in advance by day type. This was an evaluation of an existing program, and thus we used existing program procedures. Signage and the van itself drew people to the setting, and active recruitment also occurred on the beaches. Two percent of those approached to participate refused.

Pre-tests were completed on the van, and follow-up surveys completed by mail at the end of the summer (M = 85 days post-intervention). At baseline, participants received a coupon worth $6 to a food establishment near the beach, and a $10 grocery store gift card at follow-up.

Study Conditions

Skin Cancer Prevention Education: The educational intervention was delivered by a health educator and covered basic skin cancer knowledge, sun protection information, and signs and symptoms of common skin cancers. Participants completed a short quiz, which the health educator 'scored' and used as the basis of discussion during the session. Participants were given American Cancer Society educational brochures on the benefits of prevention and screening. Messages highlighted risk associated with unprotected exposure and the effectiveness of protective measures (response efficacy), as well as self-efficacy. The importance of dermatologist skin examination was also emphasized. The AAD's "Find a Dermatologist" card was provided to those who did not have a physician. The educational intervention took about 15 minutes.

Education Plus Biometric Feedback: In addition to the educational intervention, those in the Biometric Feedback condition received information on their personal skin damage caused by ultraviolet exposure using a Dermascan Analyzer and UltraViolet (UV) Reflectance Photography of their face and head. The Dermascan Skin Analyzer uses a "black" ultraviolet light with a UVA lamp, which enhances visibility of skin texture, markings, or lesions and is commonly used as an educational tool. The analyzer highlights the sun damage on participants' skin as dark purple blotches. The health educator explained that uneven and patchy dark areas show melanin clumping, caused by too much exposure to the sun. This represents U-V damage to the skin. Exposing skin to the sun without protection leads to the breakdown of melanin and decreases the amount of natural protection skin has. They then advised participants about using sunscreen, and recommended other ways to protect oneself against sun damage. Participants applied sunscreen and saw the impact on their skin's exposure. A UV photograph was provided as a take-home image of skin damage. The Education plus Feedback intervention took about 20-25 minutes to administer.

<u>Education plus Dermatologist/Dermatology Nurse Practitioner (DNP) Skin Examinations:</u> Skin examinations were provided on the van by board-certified dermatologists or a DNP in the van's private examination rooms. The dermatologist/DNP provided a presumptive diagnosis to the participant and made appropriate recommendations/referrals for follow- up. Participants were required to complete an "AAD Skin Cancer Screening Registration and Report form", which provided a record of the screening details for use in follow-up with their personal physician. All of the providers were trained to give brief sun protection education messages, following those used by the health educators. The providers also emphasized the importance of SSE and physician screening, and reminded participants that this session was not meant to be a substitute for a dermatologist office visit. Here forward this group is called the "Derm Exam" group. This intervention took about 25 minutes to deliver.

<u>Education, Biometric Feedback, and Dermatologist Skin Examinations</u>: Participants in the combined condition (referred to as "Feedback plus Derm Exam") received all of the components described above for each condition. This intervention took about 30-35 minutes.

Measures

Primary outcomes included sunburning (frequency in the previous month) and sun protection practices, and skin self-examinations. *Sun protection practices* were assessed in terms of behaviors when outside on a sunny day during the past month for at least 15 minutes during 10AM to 4PM (use of a wide-brimmed hat, regular use of sunscreen with SPF 15+, limiting time in the sun; assessed with a 5-point scale ranging from never to always). The measure of sun protection practices has been widely used in the literature, and has been found to have an acceptable Cronbach's alpha coefficient of reliability (.70). [17] In a recent study of sun protection at 16 US swimming pools, self-reports specifically of sunscreen use were comparable with objective measures such as assessment of swabbed skin.[18] Skin screening practices (careful SSE during the past month, intentions to perform SSE in the next month, and ever having a full skin cancer examination from a dermatologist) were also assessed. Aitken[13] found high agreement (93%) between self-reports and clinical records. Self-efficacy for SSE and self-reported risk of skin cancer (below average, average, or above average; Cronbach alpha = 0.74) were assessed with measures used in previous studies.[19,20] Secondary outcomes included skin cancer beliefs, perceived skin damage, and knowing what to look for when examining moles; Rodrique found a Cronbach alpha = 0.74 for measurement of perceived risk of skin cancer.[19] At pre-test, participants were also asked for their age, gender, and highest grade or year of school completed. *History of personal and familial skin cancer* was assessed, as were *risk factors* (color of untanned skin, presence of moles, damage to the skin from lifetime sun exposure, skin burning easily in the sun).

At the end of summer follow-up assessment, all baseline measures of risk, self-exam, and sun protection practices were repeated, and participants were asked about their attendance at any of the four beaches, subsequent receipt of a physician skin examination, and dermatologic procedures (e.g. biopsy, etc).

Data Analysis Plan

Data analysis began with testing for demographic differences between participants at the different beach sites using chi-square tests for categorical variables and t-tests for continuous variables. Significant baseline differences were found in education, gender, and age and all further analyses controlled for these variables. Our outcome variables were dichotomized to simplify presentation and be able to display meaningful differences (e.g. sun protection variables were dichotomized as 0= never, rarely, sometimes; 1= often, always responses). This decision was made based on understanding of the topic and consideration of frequency tables. This allowed us to use dichotomous logistic regression procedures vs. polytomous logistic regression procedures which are more difficult to interpret. Generalized linear models for dichotomous outcomes using repeated measures on 2 time points tested for time, condition, and time by condition interactions while controlling for education, gender and age. These procedures provide similar results to using an analysis of covariance approach on post-test outcome variables with pretest variables as covariate. Final models were tested for significant effects of whether a participant was enrolled on a weekend or weekday. Since this variable was not an effect modifier or mediator, it was not retained in the final models. To obtain a measure of effect size, logistic regression models of follow-up measures regressed on all significant variables stated above along with baseline values were created. These models reflected similar results to the repeated measures analyses. Significant differences were further explored using kappa tests of agreement between the time points. Intention to treat was used (carrying all baseline values forward) in our analyses. All repeated measures analyses were conducted using SAS GLIMMIX and all analyses used SAS Version 9.1.

RESULTS

Baseline Findings

Five hundred and ninety-six beachgoers were eligible for the study and enrolled (see Figure 1); 532 completed the final survey (89% response rate). Participants overall were middle-aged, and were at high risk for skin cancer as reflected by fair complexion and burning history (see Table 1); of note, almost 60% had received a sunburn in the previous month, and sun protection practices overall were relatively poor. There were significant baseline differences in demographic characteristics by condition including gender, education, and age. There were no significant differences at baseline in self-reported measures of risk (e.g. color of untanned skin; how easily skin burns, atypical mole history). There were baseline differences in some of the behavioral variables (always using sunscreen, previous sunburns, ever having a full skin examination) and perceived level of previous skin damage. Ninety-one percent of participants completed the follow-up survey at the end of the summer; non-responders tended to be male and slightly younger.

Outcomes at the End of Summer Follow-Up:

Skin Cancer Prevention Behaviors: There were significant differences in hat wearing by condition, with little change in the Education Only and Derm Exam conditions, and significant change in the Feedback and Feedback plus Derm Exam conditions (see Table 2). There were condition by time and time effects related to sunscreen use, with the greatest increases in the Feedback condition. There were also condition by time and time effects in reduction of sunburns, with lowest levels of improvement in the Education Only and Derm Exam conditions, and the greatest improvements in the two conditions feedback conditions (OR=1.85). Even in the education only condition, although 46% (n=63) of participants reported having none or one sunburn in the past month at baseline, that increased by 18 percentage points to 64% (n=88) at follow up (15 % percentage point increase in Derm exam group). There were no differences by condition in SSE at follow-up.

Mole Detection and Dermatologist/DNP Skin Examination: Among those who had a dermatologist/DNP examination, 45% (n=140) had some type of finding, including benign lesions; of these 63% (n=88) (or 28% of all those examined) were found to have atypical moles requiring follow-up. Among those requiring follow-up, 37% (n=34) had seen their own provider by the follow-up assessment.

Skin Cancer Beliefs*:* There was a significant condition by time interaction in perception of skin cancer risk, and a significant time main effect, with the greatest change in the Feedback Condition (Table 2). Of note, there was a decrease in perceived risk in all but the Feedback plus Derm Exam condition. There was a condition effect for perceptions of having skin damage, but no time effect, suggesting that the interventions did not impact on perceptions of damage. There were condition by time and time effects related to knowing what to look for when examining moles. There was the greatest improvement in the Feedback condition, followed by the Feedback plus Derm Exam condition; the Education Only condition had the least amount of improvement in knowledge about skin self-exam.

Satisfaction: Approximately two-thirds of those in the Education Only and Feedback conditions were very satisfied with the program, compared with over 80% (n=250) of those in the two Derm Exam conditions ($p<.0001$).

DISCUSSION

Two to fourfold risks of melanoma have been associated with intermittent sun exposure incurred at beaches.[21-23] In this study of beachgoers, interventions involving biometric feedback resulted in fewer sunburns, more sunscreen use and hat-wearing, and improvement in knowing what to look for when conducting a skin self-examination, compared with conditions not including biometric feedback. The Community Preventive Services Task Force [24] concluded that there is sufficient evidence for sun protection interventions in outdoor recreational or tourism settings. To date, interventions in these settings have largely included provision of information, activities designed to enhance the knowledge, attitudes, beliefs, and practices of children and adults, the use of modeling and demonstrations of sun protection practices, and some efforts to impact on environmental factors. [24-28]

The present study suggests that biometric feedback improves skin cancer prevention practices and raises awareness of suspect moles. Biometric feedback has effectively been utilized as a strategy for a wide range of other behavior change efforts [29-31] and treatment of clinical disorders.[32] The Extended Parallel Process Model (EPPM) helps to understand the impact of intervention approaches like this that might be considered "fear appeals". Witte and colleagues have shown that fear appeals are most effective when they include both a threat component emphasizing severity and susceptibility, and messages about recommended actions that emphasize both response efficacy (e.g. sunscreen will reduce the risk of further sun damage and cancer) and self-efficacy (e.g. this is something you can easily do).[9, 33-35] The Dermascan and UV camera provide an immediate, easily-comprehensible measure of personal risk and an individual assessment of sun-induced skin damage that would otherwise remain invisible to the naked eye. Response efficacy was illustrated by providing feedback before and after applying sunscreen, and self-efficacy was highlighted in all messages. Further, delivering this feedback at the beach may impact on behavioral patterns at a choice point of behavior execution, which may have more impact than information about a future behavior. The Dermascan allows the individual to become a direct observer of the consequences of excessive sun exposure and an active participant in halting the process.

There are more than 40 major skin cancer foundations in the United States and nearly all of these provide point-of-service education to large numbers of people at similar outdoor settings, such as golf clubs, swimming pools, and beaches, often with non-professional volunteers. Training in use of biometric feedback equipment is available on-line. With a minimal cost of renting or buying the analyzer and the cost of film, coupled with brief training, many of these organizations are currently outfitted to provide personalized interventions across the country.

The dermatologist's skin examination did not appear to add to the effects of biometric feedback in terms of reduction of risk behaviors, with the exception of sun burns. For many people, the exam did not identify suspicious lesions, and may not have provided a threat component. For those that did need follow-up, they may have seen the threat as "isolated" to one location on their skin, rather than as systemically affecting their body, as illustrated by biometric feedback. Notably, satisfaction scores were highest in the two skin examination conditions, perhaps due to greater credibility and more "complete care" attributed to a program staffed with dermatologists/DNPs. Almost one-third of participants who had a screening exam were found to have a suspicious mole requiring follow-up. This suggests that the beach setting is an important channel for early detection.

The current study builds on earlier studies utilizing biometric feedback for skin cancer prevention. In a small trial of college students, Mahler et al [36] found that a UV facial photograph and a brief video describing the causes and consequences of photo-aging led to greater perceptions of susceptibility to skin damage, stronger beliefs in the effectiveness of sunscreen, and more confidence in being able to use sunscreen regularly at a one-month follow-up. Gibbons et al have also successfully used UV light photographs to discourage tanning booth use among college students. [37] Weinstock et al's feedback intervention among Rhode Island beachgoers yielded improvements that were twice as great in the intervention group at 24 months. [6]

Study limitations should be noted. Randomization was performed by beach. We evaluated an intervention that was already being conducted by a non-profit, which provided an opportunity to conduct real-world research that would inform the design of this and other programs nationally, at significant economy of scale. However, we were constrained by the van's availability and distance of additional beaches from its home base. Participants did have access to any of the four beaches. intraclass correlations for different variables tested were in the area of $\rho = .10$. Although the design represented the most rigorous compromise possible, it does have the potential to bias towards Type 1 error. These data are self-reported and there is always the possibility of socially desirable responses, despite use of valid and reliable measures. The four intervention conditions were all brief, but of different lengths. The lack of a no-education control group made it difficult to determine the summertime secular effects. That said, the Feedback interventions did outperform standard education. We controlled for differences between groups, but we cannot determine if similar effects would have been found with a more homogenous population, or if the findings would generalize to an older or younger population.

Strengths of the study include use of a randomized trial to test 4 different interventions, focus on a group that is very susceptible to skin cancer, high response rates, post-tests surveys completed close to the end of summer, and measurement of both sun protection and early detection practices. We also included careful procedures to randomize intervention delivery across weekends and weekdays. Although 39% of the participants reported visiting at least one of the other beaches over the course of the summer, we had procedures in place to flag return visits by participants. No participants attempted to participate in the van program at multiple beaches.

This study illustrates the added value of biometric feedback over skin cancer education for beach-based intervention programs. It also demonstrates that a beach-based screening program does provide an opportunity to identify a substantial number of people who could benefit from early detection, although it is not necessary for successful skin cancer prevention education. The fact that an additional 25% of participants in all four conditions performed SSE after the intervention is noteworthy. These findings may be helpful to guide best practices in recreational settings such as beaches. The results of this randomized study also provide additional support for the beach as an important site for reaching and intervening with individuals who are at increased risk for skin cancer.

Figure 1. Trial Profile/Consort Diagram

Beachgoers invited to participate
n = 668

Education Only Condition	Feedback Condition	Derm Skin Exam Condition	Feedback plus Derm Skin Exam Condition
n=164	n=172	n=177	n=155

↓

Eligible Participants
n=614

Education Only Condition	Feedback Condition	Derm Skin Exam Condition	Feedback plus Derm Skin Exam Condition
n=155	n=147	n=159	n=153

↓

Enrolled participants
n=593

Education Only Condition	Feedback Condition	Derm Skin Exam Condition	Feedback plus Derm Skin Exam Condition
n=155	n=142	n=145	n=151

↓

Post-Test Completed
n=575

Education Only Condition	Feedback Condition	Derm Skin Exam Condition	Feedback plus Derm Skin Exam Condition
n=153	n=141	n=135	n=146

↓

Final Survey Completed
n=532

Education Only Condition	Feedback Condition	Derm Skin Exam Condition	Feedback plus Derm Skin Exam Condition
n=128	n=124	n=142	n=138

Table 1. Demographic Characteristics and Risk Factors by Study Condition

	Education Only Condition (n=138)	Feedback Condition (n=146)	Derm Skin Exam Condition (n=159)	Feedback plus Derm Skin Exam Condition (n=153)	Total (n=596)	P value
Demographics						
Gender (% F)	60%	50%	45%	67%	55%	.001
Education						.01
≤ HS	39%	20%	41%	30%	33%	
Some College	29%	35%	31%	27%	30%	
College +	32%	45%	28%	43%	37%	
Age (median)	51	34	54	51	49	.001
Skin Cancer Risk Factors						
Previous skin cancer	14%	8%	10%	12%	11%	NS
Atypical moles	18%	21%	14%	14%	17%	NS
Fair/very fair complexion	67%	80%	56%	62%	66%	NS
Burn easily	47%	58%	47%	49%	50%	NS

Table 2. Condition Effects on Sun Protection Attitudes and Behaviors, from Baseline (BL) to Follow-Up (FU)

Variable	Education Only Condition		Feedback Condition		Derm Skin Exam Condition		Feedback & Derm Skin Exam Condition		P-value
	BL (%)	FU (%)	BL (%)	FU (%)	BL (%)	FU (%)	BL (%)	FU (%)	
Sun Protection Behaviors									
Wear hat (always/often) Odds ratios*	30	33	29	42 1.97	28	31	34	40 1.43	Cond* x Time p=.0321 Time p<.0001 Cond p=.0120
Wear sunscreen (always/often) Odds ratios*	38	40	33	48 1.94	30	42 1.41	42	53 1.64	Cond x Time p=.0178 Time p<.0001 Cond p=.3859
Sunburn past month (0 or 1) Odds ratios*	46	64	32	55 1.07	51	66	41	68 1.85	Cond x Time p=.0051 Time p<.0001 Cond p=.5122
Skin self-exam (past month)	36	59	29	60	34	59	28	63	Cond x Time p=.2913 Time p<.0001 Cond p=.8339
Limit time in the sun (past month)	29	30	24	31	25	28	19	28	Cond x Time p=.4505 Time p=.0057 Cond p=.1716
Beliefs									
Perceived skin cancer risk (higher than average) Odds ratios*	24	20	34	24 0.53	23	21 1.20	23	25 1.59	Cond x Time p<.0001 Time p=.0005 Cond p=.9556
Perceived skin damage (moderate/a lot)Odds ratios*	50	48	52	61 1.55	52	46	63	67 1.89	Cond x Time p=.1507 Time p=.8086 Cond p=.0135
Know what to look for when examining moles (somewhat/ strongly agree) Odds ratios*	38	59	28	62 1.13	32	61 1.19	28	60 0.69	Cond x Time p<.0001 Time p<.0001 Cond p=.0865

* Pertinent odds ratios from logistic regression models of follow-up regressed on baseline values.

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