STUDY

Validity of Beachgoers' Self-report of Their Sun Habits

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Objective: To examine the validity of beachgoers' self-reported sun protection and UV exposure using objective measures.

Design: Eighty-eight participants completed a brief survey when they arrived at the beach; their skin was swabbed for the presence of sunscreen, while an observer recorded their clothing worn to the beach and the presence of sunburn. On leaving the beach, an exit survey detailing activities and sun habits while on the beach was completed by the participants, follow-up sunscreen swabs were obtained, and sunburns were recorded. Clothing observations were made for a subgroup (n=25) of participants during their beach stay.

Results: Most participants (38 [44%]) reported spending 2 to 3 hours at the beach, which was consistent with researcher observations (Spearman rank correlation, $r=0.75$). Moderate to substantial agreement was achieved between reported use of sunscreen for the day and sunscreen swabs (κ, 0.54, 0.70, and 0.72 for the face, legs, and arms, respectively). Participants' self-report of clothing worn to the beach had substantial agreement with researcher observation: κ coefficients ranged from 0.63 for footwear to 0.77 for head wear. Agreement was variable for clothing worn while on the beach, with slight to fair agreement for sunglasses (κ, 0.11) and footwear (κ, 0.23) and substantial agreement for upper body clothing (κ, 0.79). Agreement between self-reported and observed sunburn was consistently lower (κ, 0.21, 0.33, and 0.39 for the face, legs, and arms, respectively), with participants reporting more sunburn on arrival than was observed.

Conclusions: Overall, self-report measures of time outside, sunscreen use, and clothing worn demonstrated good criterion validity when compared with observation and sunscreen swabbing. Sunscreen swabbing proved an effective procedure for detecting sunscreen at a beach setting.

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In the United States, the incidence of and mortality due to skin cancers, specifically cutaneous melanoma, have increased rapidly in the past few decades.[1,2] Behavioral recommendations for the prevention of skin cancer aim to reduce exposure to UV radiation by limiting time spent in the sun; seeking shade, particularly during periods of peak UV exposure; using a sunscreen with a sun protection factor of 15 or higher; wearing protective clothing (hat, shirt, and pants) and sunglasses; and making sun safety a regular habit.[3] The US health objectives for 2010 include these recommendations.[4]

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Measurement of behavioral outcomes is critical to the internal validity and utility of skin cancer control research. Measurement of sun protection behaviors typically involves self-report, parental report, and direct observation of behavior.[5] Most studies rely on self-report of habitual sun protection practices, and there is no "gold standard" criterion for evaluation.[6,7] Methods used to examine the validity of self-report sun habits among these studies have relied on either direct observation[8-10] or proxy reports.[11] In Australia, validity data on a solar protection diary have been published for elementary schoolchildren[8] and outdoor workers.[9] Comparisons between diary and observations were assessed during outdoor recess for the schoolchildren and during a 2-hour period for the outdoor workers. κ Coefficients for schoolchildren provided substantial agreement for reporting head wear (κ, 0.70), but only fair agreement was obtained for clothing worn on the legs (κ, 0.35) and the shoulders (κ, 0.34). For outdoor workers, substantial levels of agreement were obtained for clothing worn on the legs (κ, 0.89), head (κ, 0.71), and shoulders/arms (κ, 0.64); and a moderate level of agreement was obtained for the face (κ, 0.42).[9] Similarly, κ coefficients for a study[10] of US postal workers yielded substantial agreement for wearing long pants (κ, 0.83), a long-sleeved shirt (κ, 0.71), a wide-brimmed hat (κ, 0.62), and any hat (κ, 0.60), with moderate agreement for wearing sunglasses (κ, 0.51).

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While direct observation is an effective approach to assess the wearing of hats, shirts, and sunglasses, researchers have faced the challenge of objectively assessing sunscreen use. Proxy report has been used to validate self-report of sunscreen use but is prone to the same limitations and error as the instrument it is validating. A study that assessed the validity of children's sun habits, with parents as proxy responders, reported moderate agreement for the use of sunscreen on a sunny day (κ, 0.52). Fair agreement was obtained for questions related to use of sunscreen in outdoor places (κ, 0.36), frequency of sunscreen use at the beach (κ, 0.32), and frequency that the parent or child applies sunscreen to the back (κ, 0.27).[11] These examples highlight the need for a more objective assessment of sunscreen use in validation studies.

Sunscreen swabbing has been proposed as a quick, reliable, and objective method for determining whether sunscreen has been applied to the skin.[12] This procedure is based on the fact that organic sunscreens are soluble in a range of organic solvents, which are specifically designed to absorb radiation in the UV spectrum.[12] Sunscreen swabbing has proved successful within laboratory[12] and office[13] settings and on a small sample of children aged 2 to 4 years at a child care center.[12] It is portable, rapid, and easy to perform, and swabs can be stored and analyzed in batches days or weeks later. This procedure seems to be an appropriate procedure to be used in conjunction with other objective measures of sun protection to obtain a more complete picture of an individual's sun protection practices. Therefore, this study aims to assess the validity of self-report measures of sun habits using recognized objective approaches in addition to innovative biological procedures.

METHODS

SETTING

The setting for this study was a beach in Honolulu, popular for swimming and snorkeling, which attracts approximately 2500 visitors a day. This setting was chosen for the study because the entrance and exit for the beach were limited to one location, providing an ideal opportunity to recruit participants and reduce attrition.

INSTRUMENTS

Self-report Instruments

The *Sun Habits Survey* consisted of a range of items related to UV exposure and sun protection practices. Items included demographic information, such as sex, date of birth, level of education, ethnicity, and place of residence. Participants were asked to report on their use of sunscreen, such as whether it was applied before coming to the beach, how long before it was applied, and where on the body it was applied. Participants were also asked to report on the color of their skin (no color change, tanned, pink, or red) as a result of being in the sun for the past 48 hours.

The *Sun Habits Exit Survey* required participants to report on their sun habits during their time at the beach. Items included time spent at the beach, in the shade, and in the water; use of shade; type of clothing worn on the upper and lower body; type of footwear and head wear; and use of sunglasses and sunscreen. Participants were asked to report the color of their skin (no color change, tanned, pink, or red) as a result of being in the sun at the beach all day.

Objective Instruments

The *Sun Habits Audit* was completed by research staff (A.D.S. and others) to record date, time of arrival and departure, and presence of sunburn on the face, arms, and legs at arrival and again at departure. Information was also collected on the clothing the participant wore to the beach (head wear, upper body, lower body, and footwear). Interrater reliability for assessing clothing ranged from 0.77 for sunglasses to 0.88 for upper body clothing.[14]

A *Sun Habits Midstudy Observation* was conducted throughout the day to record the type of clothing participants wore while on the beach. Researchers attempted to locate each participant involved in the study and unobtrusively record what they were wearing on the head, upper body, lower body, and feet.

The *Sunscreen Swabbing* procedure provides an objective measure of sunscreen use.[12,13] We used 70% isopropyl alcohol swabs (BD Alcohol Swabs; BD, Franklin Lakes, NJ) because they are individually wrapped and small (approximately 2.5 cm^2) and have been used previously.[13] Participants' skin was swabbed at 4 anatomical sites: 1 baseline site (underarm) to provide a skin swab with no sunscreen and 3 potential sunscreen sites (forearm, cheek, and thigh). Staff (K.B.L. and others) wore polyurethane gloves while swabbing subjects. The alcohol swab was wiped over a 2.5×4-cm area at the specific site. Swabs were then placed in a vial that contained 4 mL of 100% ethanol. Eluted washings (0.5 mL) were transferred to a UV-rated cuvette (UVB ultra micro, 70-880 μL; BrandTech, Essex, Conn), and absorbance was determined using a UV-visible spectrophotometer (DU-530; Beckman, Fullerton, Calif) at 5-nm intervals over the wavelength of 280 to 400 nm (the UVA and UVB spectrum). Absorbance is defined as a logarithmic function of the percentage transmission of light through sample and respective reference solution. A swab placed directly into ethanol was used as a reference standard (control swab) for all other swabs, thereby limiting potential light-absorbing properties of the swab itself. Because of coding of samples, laboratory staff were blinded to specific information relating to individual swabs. Sunscreen absorbance readings obtained from swab samples were assessed at 320 nm because this wavelength has been previously reported as a reliable indicator of sunscreen use.[12,13] A cutoff at an absorbance of 0.147 has been used within a controlled environment (office setting), where sunscreen was applied at a recommended dose, to classify a swab as either sunscreen positive or sunscreen negative, with a sensitivity of 99.7% and a specificity of 96.7%.[13] It was hypothesized that in an outdoor environment, the cutoff at a wavelength of 320 nm may need to be adjusted to account for self-application of sunscreen, water, and sand abrasion.[13] Based on participant self-report with full disclosure of the swabbing procedure, agreement between swabs taken from this beach population and participant self-report was also highest in the same range (0.140-0.147). As a result, any adjustment seemed unwarranted.

PROCEDURE

Data collection was undertaken over 3 days during February/March 2004. Participants were recruited while waiting for admittance to the beach. To reach our quota of 90 participants, we recruited every fifth person (alternating between men and women) between 8 and 9 AM and 12 and 1 PM, while every third and ninth person was recruited between 9 and 11 AM and 1 and 2 PM. Only 1 person from each group or family was eligible to be involved. Inclusion criteria included being at least 18 years old and having the ability to understand English.

Once consent was obtained, participants completed the Sun Habits Survey, which took approximately 5 minutes. Participants were given a fluorescent bracelet to wear on their wrist for easier identification for the midstudy observations. On entering the beach, participants were escorted to a designated area to have their skin swabbed (baseline) for the presence of sunscreen. During this time, another staff member (A.D.S.) completed a sun habits audit, recording clothing worn to the beach and the presence of sunburn (participants were unaware of this procedure). Sunscreen swabs were taken from 4 anatomical sites. Once these procedures were completed, participants went about their usual beach activities. Periodically, a researcher would conduct a midstudy observation (unknown to the participant) to observe the sun habits of participants while on the beach. On leaving the beach, participants completed an exit survey of their sun protection practices and participated in a follow-up sunscreen swab. Participants were given a small gift in appreciation for being involved. All procedures were approved by the Committee for Human Subjects at the University of Hawaii at Manoa.

DATA PREPARATION AND STATISTICAL ANALYSIS

Participant surveys were inspected for improper entries and were optically scanned, and a random sample of 15% was verified for accuracy. All statistical analyses were conducted using a commercially available software program (SPSS, version 13).[15]

First, descriptive statistics were examined for the participant surveys and researcher observation measures. Sunburn measures were collapsed to make self-reported and observed categories comparable. Self-reported sunscreen use was categorized from information provided in the Sun Habits Survey and Sun Habits Exit Survey into 4 categories: (1) no use of sunscreen, (2) only applied sunscreen before the beach, (3) only applied sunscreen while at the beach, and (4) applied sunscreen before and reapplied sunscreen at the beach. Similarly, clothing options having similar sun protection coverage were combined to improve the sample size within categories. Upper body was recoded from 6 categories (nothing, bikini top, 1-piece swimsuit, tank top, short-sleeved shirt, and long-sleeved shirt) to 3 categories (nothing/bikini top, 1-piece swimsuit/tank top, and sleeved shirt). Lower body was recoded from 5 categories (bikini bottom, men's swimming brief, shorts, skirt, and long pants) to 3 categories (bikini bottom/men's swimming brief, shorts/skirt, and long pants). Footwear was recoded from 4 categories (nothing, slippers, sandals, and shoes) to 3 categories (nothing, slippers/sandals, and shoes). For midstudy audits, footwear was dichotomized (yes or no) to account for the few people reporting the use of footwear while on the beach. Sunburn categories were collapsed to make self-reported and observed categories comparable. Reported sunburn was recoded from 3 categories (no sunburn, tan, and pink or red) to 2 categories (no sunburn and pink or red).

Self-report measures of sunburn on arrival and departure, clothing worn to and on the beach, and sunscreen use were compared with researcher observation measures using simple κ values. Interpretation of κ coefficients was based on guidelines proposed by Landis and Koch,[16] which are considered conservative.[17] κ Coefficients will be categorized on a 6-point ordinal scale: poor (κ, <0.0), slight (κ, 0.0-0.2), fair (κ, 0.2-0.4), moderate (κ, 0.4-0.6), substantial (κ, 0.6-0.8), and almost perfect (κ, 0.8-1.0).[16] McNemar tests were examined when agreement was not substantial to assess for systematic bias. Similarly, self-reported time spent on the beach was compared with observed time using a Spearman rank correlation.

An analysis of variance was conducted to detect differences in absorbance readings between various sunscreen practices. Goodness-of-fit χ^2 statistics were used to determine how well the sun behavior frequency distributions of the subsample undergoing midstudy observations fit the distributions of a larger sample of participants and the general beach population.

RESULTS

PARTICIPANT CHARACTERISTICS

A total of 128 people were approached to be involved in this study, and 90 participants consented (recruitment rate, 70.3%). A complete set of data (survey, exit survey, and sunscreen swab: baseline and follow-up) was obtained from 88 (98%) of the 90 participants recruited. Participants were evenly distributed between men (45 [51%]) and women (43 [49%]). The mean age was 40 years (SD, 13.9 years; range, 19-74 years), 70 (80%) were white, and many (41 [47%]) reported having a college degree or higher. Of the participants, 77 (86%) reported being on vacation. Most participants (38 [44%]) reported spending between 2 and 3 hours at the beach, followed by 1 to 2 hours (18 [21%]), 3 to 4 hours (17 [18%]), 4 to 5 hours (10 [11%]), and 0 to 1 hour (5 [6%]). These results had a good level of agreement with data recorded by researchers (Spearman rank correlation, $r=0.75$).

SUNSCREEN USE

Moderate to substantial agreement was obtained between reported use of sunscreen and the swabbing procedure (**Table 1**). For the baseline swab before arrival at the beach, agreement was highest for the face, followed by the arm and leg. The swabbing procedure's ability to detect sunscreen applied while at the beach resulted in moderate agreement with self-report application (κ, 0.42-0.57). Participants who applied sunscreen before coming to the beach, but did not apply sunscreen on the beach, confounded this agreement. Therefore, the follow-up swab was used to validate any sunscreen use that day, for which moderate to substantial agreement for the arm, leg, and face was obtained. McNemar tests revealed no biases toward overreporting at baseline or follow-up.

The **Figure** illustrates the absorbance readings (at a wavelength of 320 nm) for all sunscreen swabs at follow-up (n=264) for the various types of sunscreen application reported by participants. Outliers in this figure highlight inconsistencies between self-report and the swabbing procedure. For example, of those reporting that they never used sunscreen, 8 swabs obtained absorbance readings above 0.147, indicating the presence of sunscreen. Outliers below 0.147 for participants who reported applying sunscreen (at follow-up only or applied and reapplied) indicate that sunscreen was not detected.

An analysis of variance revealed a significant difference in absorbance readings at a wavelength of 320 nm ($F_1=219.5$, $P<.001$) between participants who reported sunscreen use (mean, 0.06; 95% confidence interval [CI],

Table 1. Agreement Between Reported Use of Sunscreen and the Sunscreen Swab for 88 Participants

Participants' Reported Use of Sunscreen	Swabbing Assessment of Sunscreen Use* No	Swabbing Assessment of Sunscreen Use* Yes	κ Value, Mean (95% Confidence Interval)
Sunscreen applied before the beach (baseline)			
Face			
No (n = 45)	40 (89)	5 (11)	0.77 (0.64-0.90)
Yes (n = 43)	5 (12)	38 (88)	
Arm			
No (n = 52)	48 (92)	4 (8)	0.66 (0.50-0.82)
Yes (n = 36)	10 (28)	26 (72)	
Leg			
No (n = 62)	49 (79)	13 (21)	0.49 (0.30-0.68)
Yes (n = 19)	5 (27)	14 (73)	
Sunscreen applied at the beach			
Face			
No (n = 39)	24 (62)	15 (38)	0.42 (0.23-0.61)
Yes (n = 49)	10 (20)	39 (80)	
Arm			
No (n = 37)	25 (68)	12 (32)	0.55 (0.37-0.73)
Yes (n = 51)	7 (14)	44 (86)	
Leg			
No (n = 45)	33 (73)	12 (27)	0.57 (0.40-0.79)
Yes (n = 43)	7 (16)	36 (84)	
Sunscreen use for the day (follow-up)			
Face			
No (n = 22)	19 (86)	3 (14)	0.54 (0.34-0.72)
Yes (n = 66)	15 (23)	51 (77)	
Arm			
No (n = 25)	23 (92)	2 (8)	0.72 (0.56-0.87)
Yes (n = 63)	9 (14)	54 (86)	
Leg			
No (n = 33)	30 (91)	3 (9)	0.70 (0.55-0.85)
Yes (n = 55)	10 (18)	45 (82)	

*Data are given as number (percentage) of each group. Percentages are based on row totals.

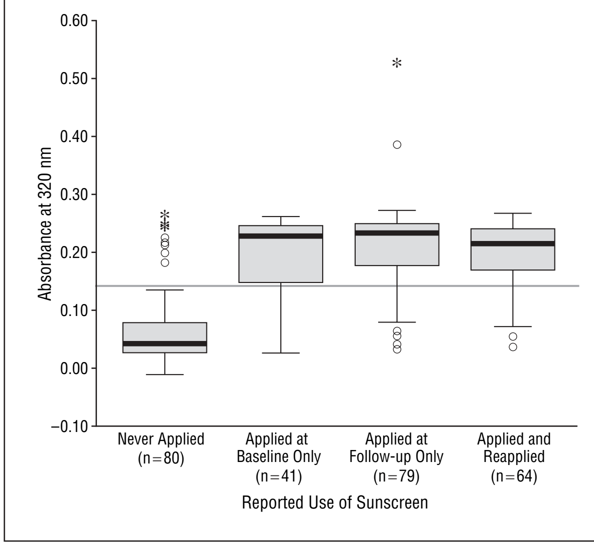

Figure. Absorbance readings of sunscreen swabs at 320 nm (including the cutoff for the presence of sunscreen at 0.147 nm) for various types of sunscreen application. o indicates outliers greater than 1.5 box lengths and less than 3 box lengths away from the edge of the box; asterisks, outliers that are 3 or more box lengths from the edge of the box; boxes, interquartile range and contains 50% of observations or cases; bold horizontal lines in the boxes, median value; and whiskers, smallest and largest value.

0.05-0.08) and those who reported no sunscreen use (mean, 0.20; 95% CI, 0.19-0.21). Among participants who reported using sunscreen, there were no significant differences in absorption (F_2=1.17, *P*=.31) between participants who applied sunscreen before the beach (mean, 0.19; 95% CI, 0.17-0.22), those who applied sunscreen at the beach only (mean, 0.22; 95% CI, 0.19-0.23), and those who applied sunscreen before the beach and reapplied sunscreen while at the beach (mean, 0.20; 95% CI, 0.18-0.21).

SUN-PROTECTIVE CLOTHING

In terms of clothing worn to the beach, substantial agreement was obtained for all types of clothing, with the highest agreement for head wear, followed by sunglasses, upper body, lower body, and footwear (**Table 2**). Midstudy observations were undertaken on 25 (28%) of 88 participants to observe sun protection practices while on the beach. Substantial levels of agreement with self-report measures were obtained for upper body, lower body, and head wear, while use of sunglasses and footwear on the beach was only slight to fair. The McNemar test for sunglasses, using the conservative exact significance value, showed that participants were more likely to report the use of sunglasses compared with observation (*P*=.02). The κ coefficient for footwear was only fair, and the McNemar test showed no difference in the pattern of disagreement.

There were no significant differences between participants who were involved in the midstudy observation (n=25) and participants who were not observed while on the beach (n=63) in terms of the clothing researchers observed them wearing to the beach on their upper body (χ^2_2=4.9, *P*=.09), lower body (χ^2_2=0.08, *P*=.70), feet (χ^2_2=1.4, *P*=.50), and head (χ^2_2=3.2, *P*=.40) and in terms of their use of sunglasses (χ^2_1=1.2, *P*=.30).

SUNBURN

Fair levels of agreement for sunburn on arrival to the beach were observed for the arms, legs, and face (**Table 3**). The McNemar test revealed that participants were significantly more likely to report sunburn on their arms (χ^2_1=4.0, *P*=.05) and legs (χ^2_1=4.3, *P*=.04) than what the researcher observed, with a similar but nonsignificant trend for the face (χ^2_1=1.3, *P*=.30). Self-report and researcher observation had poor levels of agreement for sunburn as a result of being at the beach that day, with researchers significantly more likely to observe the presence of sunburn on participants' skin when they were leaving the beach (χ^2_1=4.2, *P*=.04). To understand this finding, we examined the impact of participants who came to the beach already with a sunburn (per self-report). When these participants were removed from the analysis, the level of agreement improved, and while researchers were still likely to report more sunburn, this trend was not significant (χ^2_1=1.9, *P*=.20).

Table 2. Agreement Between Self-report and Objective Measures of Sun-Protective Clothing

Self-report Sun Habit	Observed Sun Habit*			κ Value, Mean (95% Confidence Interval)
Clothing worn to the beach				
Head wear (n = 85)	Nothing	Cap	Brimmed hat	NA
Nothing (n = 47)	43 (91)	2 (4)	2 (4)	0.77 (0.65 to 0.89)
Cap (n = 26)	1 (4)	25 (96)	0	
Brimmed hat (n = 12)	4 (33)	2 (17)	6 (50)	
Sunglasses (n = 79)	No	Yes	NA	NA
No (n = 21)	20 (95)	1 (5)	NA	0.76 (0.61 to 0.92)
Yes (n = 58)	7 (12)	51 (88)	NA	
Upper body (n = 88)	Nothing or bikini top	1-Piece swimsuit or tank top	Sleeved shirt	NA
Nothing or bikini top (n = 9)	4 (44)	1 (11)	4 (44)	0.65 (0.51 to 0.77)
1-Piece swimsuit or tank top (n = 32)	2 (6)	25 (78)	5 (16)	
Sleeved shirt (n = 47)	0	5 (11)	42 (89)	
Lower body (n = 86)	Bikini bottom or men's swimming brief	Shorts or skirt	Long pants	NA
Bikini bottom or men's swimming brief (n = 6)	0	6 (100)	0	0.64 (0.39 to 0.90)
Shorts or skirt (n = 74)	0	74 (100)	0	
Long pants (n = 6)	0	0	6 (100)	
Footwear (n = 85)	Nothing	Slippers or sandals	Shoes	NA
Nothing (n = 5)	1 (20)	0	4 (80)	0.63 (0.47 to 0.78)
Slippers or sandals (n = 64)	5 (8)	56 (88)	3 (5)	
Shoes (n = 16)	1 (6)	1 (6)	14 (88)	
Clothing worn on the beach				
Head wear (n = 25)	Nothing	Cap	Brimmed hat	NA
Nothing (n = 15)	13 (87)	1 (7)	1 (7)	0.65 (0.34 to 0.92)
Cap (n = 5)	2 (40)	3 (60)	0	
Brimmed hat (n = 5)	0	1 (20)	4 (80)	
Sunglasses (n = 18)	No	Yes	NA	NA
No (n = 7)	6 (86)	1 (14)	NA	0.11 (−0.21 to 0.43)
Yes (n = 11)	8 (73)	3 (27)	NA	
Upper body (n = 24)	Nothing or bikini top	1-Piece swimsuit or tank top	Sleeved shirt	NA
Nothing or bikini top (n = 13)	12 (92)	0	1 (8)	0.79 (0.58 to 1.00)
1-Piece swimsuit or tank top (n = 6)	0	5 (83)	1 (17)	
Sleeved shirt (n = 5)	1 (20)	0	4 (80)	
Lower body (n = 23)	Bikini bottom or men's swimming brief	Shorts or skirt	Long pants	NA
Bikini bottom or men's swimming brief (n = 12)	10 (83)	2 (17)	0	0.65 (0.34 to 0.96)
Shorts or skirt (n = 11)	2 (18)	9 (82)	0	
Long pants (n = 0)	0	0	0	
Footwear (n = 23)	No	Yes	NA	NA
No (n = 18)	15 (83)	3 (17)	NA	0.23 (−0.22 to 0.67)
Yes (n = 5)	3 (60)	2 (40)	NA	

Abbreviation: NA, data not applicable.
*Data are given as number (percentage) of each group. Percentages are based on row totals and may not total 100 because of rounding.

COMMENT

This study has incorporated innovative and recognized objective procedures to assess the validity of conventional data collection approaches toward sun protection measurement. Overall, self-report measures of time outside, sunscreen use, and clothing worn demonstrated good criterion validity when compared with direct observation and sunscreen swabbing. Sunscreen swabbing, previously tested in a controlled environment, proved to be an effective procedure for detecting sunscreen at a beach setting.

To our knowledge, this is the first study to incorporate sunscreen swabbing into an assessment of self-report measures of sun habits. This procedure proved to be a rapid noninvasive approach to assess the presence of sunscreen that was easily integrated with other objective assessments to obtain a comprehensive picture of sun habits of beachgoers. Good to substantial agreement (κ, 0.49-0.77) was obtained between self-report and the swabbing procedure. This procedure can effectively detect the presence of sunscreen not only within a controlled environment, where sunscreen was applied at a recommended dose (2 mg/cm^2),[18] but also in a beach setting, where the level of protection afforded by sunscreen may be compromised by inadequate application,[19-21] water resistance, and abrasion from clothing and/or sand.[22,23] It was previously suggested that these factors may also necessitate an adjustment of the absorbance cutoff for detecting the presence of sunscreen (absorbance of 0.147 at a wavelength of 320 nm) in an uncontrolled setting.[13] While the examination of various absorbance cutoffs at 320 nm confirmed that 0.147 was the appropriate absorbency for differentiating sunscreen-positive and sunscreen-negative swabs for this study, more data need to be collected in a range of settings to confirm the appropriateness of this cutoff. Different cutoffs may also be required depending on the type of spectrophotometer, swabs, and cuvettes used, because these factors may also affect the absorbance readings of the eluted sunscreen samples.

Sunscreen swabbing was not able to differentiate between application and reapplication of sunscreen among beachgoers. There were no significant differences in the absorbance readings of swabs from individuals who had applied sunscreen at baseline only, had applied sunscreen at follow-up only, or had applied sunscreen at baseline and follow-up. Although this finding confirms those reported previously among office workers,[12,13] it was unexpected because we estimated that abrasion and inappropriate application of sunscreen before arrival would result in lower absorbance readings at follow-up. A possible explanation may be that the swab reaches a threshold in its ability to remove sunscreen from the skin. This procedure is not able to assess the effectiveness by which sunscreen has been applied to the skin or the effectiveness of the UV protection of sunscreen. Some variation in the absorbance of sunscreen-positive swabs seems correlated with the sun protection factor, but more research needs to be conducted to conclude if this technique can reliably confirm the sun protection factor of sunscreen.

On several occasions, the swabbing procedure detected the presence of sunscreen when participants reported not applying sunscreen. It is possible that swabbing may detect the presence of sunscreen used on the previous day because absorbance readings did not decrease over a 6-hour period in a controlled setting[13] and, therefore, it is likely tourists wore sunscreen during prior activities. Furthermore, cosmetic products with sunscreen ingredients may have been used but not reported; the survey and exit survey questions asked specifically about sunscreen use. Screening questions will be included in future surveys to account for this potential oversight.

Our study assessed the types of clothing worn by individuals at 2 points (on arrival to the beach and while at the beach). Observations for clothing worn to the beach were all comparable with data in previous studies[9,10] that compared self-report data with researcher observation among adult populations, with κ coefficients providing substantial levels of agreement (κ, 0.63-0.77). In relation to clothing worn on the beach, κ coefficients were comparable to previous research demonstrating substantial agreement (κ, 0.64-0.79) for head wear, upper body, and lower body only. However, poor to fair agreement was obtained for sunglasses (κ, 0.11) and footwear (κ, 0.25). This disparity may be more a product of comparing self-report assessment that asked participants to reflect on the clothing they wore during their time at the beach with a "point-in-time" observation. For example, participants may have worn sunglasses while on the beach, but when the observation was conducted, they may have just returned from the water and were not wearing their sunglasses. Although locating participants on a crowded beach is labor intensive and difficult, improved agreement between the 2 measures may be achieved if multiple observations were undertaken of the participants while on the beach.

Agreement between self-report and visual inspection of sunburns was slight to fair. This study found that while participants were more likely than observers to report the presence of sunburn on arrival to the beach, researcher observations were more likely to report the presence of sunburn on departure from the beach. Assessing sunburn in this manner is confounded by assessment error associated with researcher observation and participant report. On entry to the beach, participants may have been aware that they had received a sunburn within the past 48 hours and had already experienced some fading in their erythema, thus explaining the underreport of sunburn by observers. On the other hand, warm temperatures and physical activity may make participants look flushed or display signs of erythema without much pain (individu-

Table 3. Agreement Between Self-report and Observed Sunburn

Self-reported Sunburn Data	Observed Sunburn*: No Sunburn	Observed Sunburn*: Pink or Red	κ Value, Mean (95% Confidence Interval)
Sunburn on arrival to the beach (n = 85)			
Face			
No sunburn or tan (n = 57)†	46 (81)	11 (19)	0.21 (−0.01 to 0.42)
Pink or red (n = 28)	17 (61)	11 (39)	
Arms			
No sunburn or tan (n = 65)†	61 (94)	4 (6)	0.39 (0.16 to 0.63)
Pink or red (n = 20)	12 (60)	8 (40)	
Legs			
No sunburn or tan (n = 63)†	58 (92)	5 (8)	0.33 (0.10 to 0.56)
Pink or red (n = 22)	14 (64)	8 (36)	
Sunburn while at the beach			
Overall (n = 81)			
No sunburn (n = 55)	32 (58)	23 (42)	0.14 (−0.10 to 0.35)
Pink or red (n = 26)	11 (42)	15 (58)	
No reported sunburn before entering the beach (n = 49)			
No sunburn (n = 36)	26 (72)	10 (28)	0.30 (0.03 to 0.58)
Pink or red (n = 13)	5 (38)	8 (62)	
Reported sunburn on entering the beach (n = 32)			
No sunburn (n = 19)	6 (32)	13 (68)	−0.13 (−0.45 to 0.18)
Pink or red (n = 13)	6 (46)	7 (54)	

*Data are given as number (percentage) of each group. Percentages are based on row totals.

†Participants had the option to choose if they believed that they had tanned as a result of the sun.

als may not consider themselves sunburned until it hurts) when they are leaving the beach, resulting in overreporting of sunburn through visual inspection. While one advantage of visual inspection was that assessment can be conducted quickly,[5] researchers lacked a standard by which to effectively determine sunburn on an individual. As a result of these inconsistencies, an alternative method to objectively assess sunburn in a noninvasive manner should be adopted. Spectrophotometers and colorimeters have been used to quantify skin color[5] and have been shown to have high interrater reliability.[24-26] Colorimeters, in particular, seem to be an effective instrument for objectively quantifying sunburn because they have been reported to be highly correlated with visual inspection (*r*, 0.72-0.97).[5] A couple of limitations of these instruments is that they are expensive and there is a degree of labor intensity associated with using them effectively.[5,6] Regardless, they may be more reliable and less prone to observer error than visual inspection, and efforts should be made to incorporate them into future validation studies.

Interpretation of the findings reported in this study should be tempered by the following limitations. Because of a small sample size, our findings may not be generalizable to all beachgoers. Furthermore, this study only compares beach habits of individuals for that day of assessment and may not be reflective of their general sun protection practices. Only 25 midstudy observations were obtained because this assessment was only conducted on individuals who were on the beach and excluded individuals who were in the vicinity of the beach (such as in the water, at the snack shop, or in the restrooms). There was, however, no significant difference between participants who were involved in midstudy observation and those who were not in terms of the clothing they were observed wearing to the beach. There was also no specific time after arrival to the beach that midstudy observations were undertaken. Greater effort will also be made in the future to ensure that all assessments are conducted within a specified amount of time after arrival to the beach. Shade use, while an important strategy for reducing UV exposure, was not validated in this study. Of 88 participants, 19 (22%) reported using shade while at the beach; however, this was not confirmed by direct observation and needs to be included in future assessments. Sunscreen swabbing may have resulted in some reactivity among participants, because we informed them that the process was designed to detect the presence of sunscreen. It is expected, however, that any changes in sunscreen behavior would have been minimal because participants did not know before arriving at the beach that they were going to be involved in the project and any reactivity may have been limited, improving agreement of the follow-up swabs only. Finally, interrater reliability was not obtained for sunburns. Sunburns were assessed by the researcher responsible for the sun habits audit in consultation with the researcher conducting sunscreen swabbing because they were working closely with the participants and actually swabbing the sites where sunburn was being assessed. Interrater reliability for sunburns will be obtained in future assessments.

This study contributes to the paucity of existing research describing the validity of self-report sun habits and has demonstrated that multiple strategies can be effectively adopted to achieve this goal. The moderate to substantial agreement obtained for many self-report measures when compared with objective procedures confirms that self-report is a suitable approach to assess sun habits of beachgoers. The incorporation of objective measures was a time-consuming and labor-intensive exercise, but was a crucial component to the validation process. We have demonstrated that the sunscreen swabbing procedure can be successfully incorporated with other objective measures to assess the validity of self-report sun habits. When used as an adjunct to other assessment instruments, this innovative procedure could be a useful addition to interventions aimed at improving the sun protection practices of individuals.

Further research is required to confirm the utility of our self-report instruments among a broader cross-section of the community. While there is consensus in the need to report findings from validated instruments,[6,27] lacking is the ability to reliably compare findings between studies because of variations in method and terminology used to describe various sun habits. The development of standardized measures, such as those used in other health fields, such as physical activity[28] and nutrition,[29] may improve comparability across studies.

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REFERENCES

1. Jemal A, Devasa SS, Fears TT, Hartge P. Cancer surveillance series: changing patterns of cutaneous malignant melanoma mortality rates among whites in the United States. *J Natl Cancer Inst*. 2000;92:811-818.

2. Jemal A, Devesa SS, Hartge P, Tucker MA. Recent trends in cutaneous melanoma incidence among whites in the United States. *J Natl Cancer Inst*. 2001;93:678-683.
3. American Cancer Society. *Cancer Facts & Figures 2004*. Atlanta, Ga: American Cancer Society; 2004.
4. US Department of Health and Human Services. *Healthy People 2010: Understanding and Improving Health*. Washington, DC: US Dept of Health and Human Services; 2000:50.
5. Creech LL, Mayer JA. Ultraviolet radiation exposure in children: a review of measurement strategies. *Ann Behav Med*. 1997;19:399-407.
6. Glanz K, Mayer JA. Reducing UVR exposure to prevent skin cancer: methodology and prevention. *Am J Prev Med*. 2005;29:131-142.
7. Arthey S, Clarke VA. Suntanning and sun protection: a review of the psychological literature. *Soc Sci Med*. 1995;40:265-274.
8. Girgis A, Sanson-Fisher RW, Tripodi D, Golding T. Evaluation of interventions to improve solar protection in primary schools. *Health Educ Q*. 1993;20:275-287.
9. Girgis A, Sanson-Fisher RW, Watson A. A workplace intervention for increasing outdoor workers' use of solar protection. *Am J Public Health*. 1994;84:77-81.
10. Oh SS, Mayer JA, Lewis EC, et al. Validating outdoor workers' self-report of sun protection. *Prev Med*. 2004;39:798-803.
11. Dusza SW, Oliveria SA, Geller AC, Marghoob AA, Halpern AC. Student-parent agreement in self-reported sun behaviors. *J Am Acad Dermatol*. 2005;52:896-900.
12. Whiteman DC, Brown RM, Xu C, Paterson CL, Miller D, Parsons PG. A rapid method for determining recent sunscreen use in field studies. *J Photochem Photobiol B*. 2003;69:59-63.
13. O'Riordan DL, Lunde KB, Urschitz J, Glanz K. A non-invasive objective measure of sunscreen use and reapplication. *Cancer Epidemiol Biomarkers Prev*. 2005;14:722-726.
14. Maddock JE, O'Riordan DL, Lunde KB, Steffen A. Sun protection practices of beachgoers using a direct observational measure [abstract]. *Ann Behav Med*. 2005;29(suppl):S116.
15. SPSS Inc. *SPSS Version 13.0*. Chicago, Ill: SPSS Inc; 2004.
16. Landis JR, Koch GG. An application of hierarchical kappa-type statistics in the assessment of majority agreement among multiple observers. *Biometrics*. 1977;33:363-374.
17. Muñoz SR, Bangdiwala SI. Interpretation of kappa and *B* statistics measures of agreement. *J Appl Stat*. 1997;24:105-111.
18. International Agency for Research on Cancer. *Sunscreens*. Lyon, France: International Agency for Research on Cancer; 2001.
19. Autier P, Boniol M, Severi G, Dore JF. Quantity of sunscreen used by European students. *Br J Dermatol*. 2001;144:288-291.
20. Stenberg C, Larkö O. Sunscreen application and its importance for the sun protection factor. *Arch Dermatol*. 1985;121:1400-1402.
21. Lott DL, Stanfield J, Sayre RM, Dowdy JC. Uniformity of sunscreen product application: a problem in testing, a problem for consumers. *Photodermatol Photoimmunol Photomed*. 2003;19:17-20.
22. Diffey BL. When should sunscreens be reapplied? *J Am Acad Dermatol*. 2001;45:882-885.
23. Moloney FJ, Collins S, Murphy GM. Sunscreens: safety, efficacy and appropriate use. *Am J Clin Dermatol*. 2002;3:185-191.
24. Milne E, English DR, Johnston R, et al. Reduced sun exposure and tanning in children after 2 years of a school-based intervention (Australia). *Cancer Causes Control*. 2001;12:387-393.
25. Mayer JA, Slymen DJ, Eckhardt L, et al. Reducing ultraviolet exposure in children. *Prev Med*. 1997;26:516-522.
26. Eckhardt L, Mayer JA, Creech L, et al. Assessing children's ultraviolet radiation exposure: the potential usefulness of a colorimeter. *Am J Public Health*. 1996;86:1802-1804.
27. Koh HK, Geller AC. Skin cancer prevention comes of age. *Am J Prev Med*. 2004;27:484-485.
28. Craig CL, Marshall AL, Sjostrom M, et al. International Physical Activity Questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc*. 2003;35:1381-1395.
29. Block G, Woods M, Potosky A, Clifford C. Validation of a self-administered diet history questionnaire using multiple diet records. *J Clin Epidemiol*. 1990;43:1327-1335.