ARTICLE

A Randomized Trial of a Multicomponent Intervention for Adolescent Sun Protection Behaviors

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Objective: To evaluate a multicomponent primary care–based intervention to increase sun protection behaviors among adolescents. Excessive sun exposure in childhood increases the lifetime risk of melanomas and other forms of skin cancer. Interventions to improve sun protection behaviors in childhood have been based primarily in school and community settings, with little attention to the role of primary care physicians.

Design: A 2-year randomized controlled trial.

Setting: Primary care physician offices and participant homes.

Participants: Eight hundred nineteen adolescents aged 11 to 15 years.

Interventions: At the study onset and the 12-month follow-up, the adolescents engaged in an office-based expert system assessment of sun protection behaviors followed by brief stage-based counseling from the primary care provider. Participants also received up to 6 expert system–generated feedback reports, a brief printed manual, and periodic mailed tip sheets. Participants randomized to the comparison condition received a physical activity and nutrition intervention.

Main Outcome Measure: A self-reported composite measure of sun protection behavior.

Results: A random-effects repeated-measures model indicated a greater adoption of sun protection behaviors over time in the intervention group compared with the control group. The intervention effect corresponded to between-group differences at 24 months in avoiding the sun and limiting exposure during midday hours and using sunscreen with a sun protection factor of at least 15. Secondary analysis indicated that, by 24 months, more adolescents in the intervention group had moved to the action or the maintenance stage of change than those in the control group (25.1% vs 14.9%; odds ratio, 1.74; 95% confidence interval, 1.13-2.68). Sun protection behavior was also found to be positively associated with the completion of more intervention sessions ($P = .002$).

Conclusion: Primary care counseling coupled with a minimal-intensity expert system intervention can improve adolescents' sun protection behaviors.

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THE INCIDENCE OF SKIN CANCERS continues to increase.[1-3] More than 1 million cases of nonmelanoma basal and squamous cell carcinomas occur each year in the United States but are usually highly treatable. The next most common type of skin cancer is melanoma, which accounts for most skin cancer deaths. The lifetime probability of developing melanoma is 1.92% (1/52) in males and 1.30% (1/77) in females.[3]

Exposure to UV radiation increases the risk of all 3 types of skin cancer.[4] Behavioral risk factors for skin cancer include a history of excessive sun exposure, sunburns, and use of tanning booths. The recommended prevention for skin cancer is limiting exposure to the sun during the midday hours; wearing protective clothing such as hats, long-sleeved shirts, and long pants; wearing sunglasses; and using sunscreen with a sun protection factor (SPF) of 15 or higher.[3] The Healthy People 2010 objective is to increase to 75% the proportion of people who use at least 1 of these strategies to reduce the risk of skin cancer.[5]

Learning and adopting sun protection behaviors in childhood is critical because 25% of a person's lifetime UV exposure occurs during childhood and adolescence.[6] Sunburns in adolescence or earlier have been found to be associated with development of melanoma and basal cell carcinoma.[7,8] Sun protection programs may be particularly important during adolescence because this is a time of increased sun exposure and decreased parental influence.

The Task Force on Community and Preventive Services recently conducted a comprehensive review of interventions to decrease UV exposure and increase sun protection behaviors.[6,9] From 85 qualifying studies, sufficient evidence of effectiveness was only found for educational and policy interventions in primary schools and in recreational and tourism settings. The Task Force found insufficient evidence that clinician counseling was effective at changing patient behaviors related to skin cancer prevention, as well as insufficient evidence for the effectiveness of interventions in secondary schools targeting adolescents. Further research in these areas was recommended.

The present study evaluated a 2-year, minimal-intensity intervention to change sun protection behavior among adolescents. The intervention was based in primary care settings and was supported by a computerized expert system that generated tailored behavior-change feedback reports. Expert system interventions have been shown to be effective for smoking cessation, dietary behavior change, and sun protection in adults[10-12] and adolescents.[13,14] We hypothesized that the benefits of the expert system–based primary care counseling could also extend to improving sun protection behaviors in adolescents.

METHODS

PARTICIPANTS

Adolescents aged 11 to 15 years were recruited through their primary care providers. Forty-five primary care providers from 6 clinic sites in San Diego County, California, sent an initial letter to all parents with adolescent children in the eligible age range informing them that they may receive a telephone call about a health promotion study. A postcard to opt out was included with the letter, allowing parents to request that they not be contacted about the study. After the initial mailing, adolescents were recruited (1) by telephoning the patients of participating health care providers when they had an upcoming scheduled physician's visit and (2) by making cold calls at random to the patients of the participating health care providers who did not return the opt-out postcard from the initial mailing. A target sample size of 760 adolescents was determined to provide 80% power to detect a small effect size (Cohen $d=0.21$) for a 2-tailed test, with α set at .05.

Adolescents were excluded from the study if they had health conditions that would limit their ability to comply with physical activity or diet recommendations. Parents gave written consent for their child to participate, and each adolescent provided signed assent. Adolescents and parents were informed that the study involved randomization to a sun protection intervention or a physical activity and diet intervention and therefore were not blinded to the intervention conditions. After baseline measures, but before seeing the health care provider, participants were randomized to 1 of the 2 intervention conditions. The study was approved by the participating health care organizations and university institutional review boards.

On completion of the scheduled assessment visits and telephone calls, adolescents in both study groups received lottery tickets for small cash prizes ($10-$50) in lotteries conducted every 6 months. Adolescents also received $10, $15, $20, and $40 for completing the baseline and 6-, 12-, and 24-month assessments, respectively.

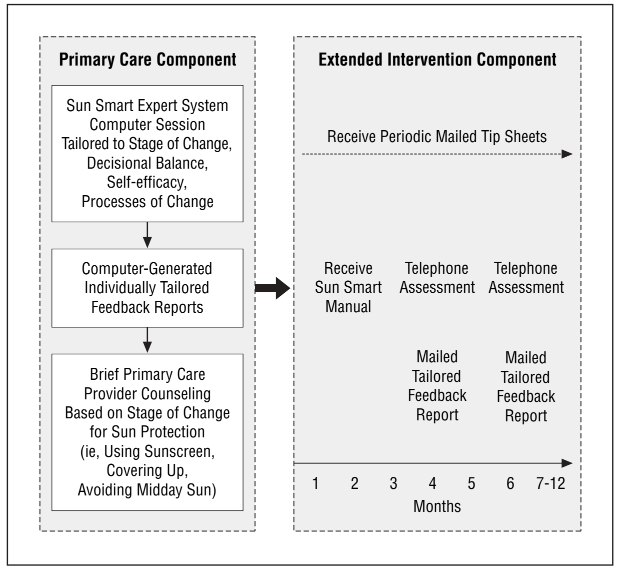

Figure 1. Overview of the Sun Smart intervention model.

SUN PROTECTION INTERVENTION

The components of the sun protection intervention included brief counseling from the primary care providers, interactive computer sessions, telephone assessments, printed tailored feedback, a brief printed manual, mailed tip sheets, and samples of SPF 15 sunscreen. **Figure 1** displays the model of the intervention delivery in year 1 of the study, which was repeated in year 2.

The intervention incorporated the Sun Smart sun protection expert system computer program developed at the University of Rhode Island.[15] The Sun Smart expert system was based on the transtheoretical model and included assessment and feedback of the stage of change, decisional balance, self-efficacy, and the processes of change.[16,17] The expert system was implemented as (1) an interactive tailored computer session in the primary care office at the start of the intervention and at 12 months and (2) a means of generating printed tailored feedback reports between office visits.

Before visiting with their physician, adolescents spent approximately 20 minutes completing the Sun Smart expert system assessments and received stage-tailored normative feedback on each transtheoretical model construct. The expert system included an audio component that mirrored all text appearing on the computer screen along with color graphics and music. On completion of the computer session, the expert system printed 2 copies of a 2-page feedback report, which contained the same feedback presented during the interactive session. One copy was for the adolescent to keep, whereas the second copy was placed in the patient file and used by the primary care provider to conduct brief 2- to 3-minute counseling sessions with the adolescent to further prompt for questions and reinforce the messages presented in the expert system session.

At the 3-, 6-, 15-, and 18-month interventions, adolescents were contacted by a health counselor by telephone and completed the expert system assessments during the telephone interview. During the telephone calls, the health counselors inquired about progress and the challenges participants were facing in protecting themselves from sun exposure. After completing the telephone call, the health counselor entered the assessment responses into the expert system and generated a tailored feedback report. This report was similar in appearance and length to the initial feedback report but also contained personalized feedback relative to the participant's previous responses. For example, a report may include praise for moving from the preparation stage to the action stage of change. The feedback report was mailed to the participant, along with a 90-mL bottle of SPF 15 sunscreen. Health counselors could also send tip sheets to participants on various topics related to sun protection.

CONTROL CONDITION

The physical activity and diet intervention was designed to promote adoption and maintenance of improved physical activity and eating behaviors.[18] The intervention consisted of a computerized expert system kiosk in the primary care provider's office, coupled with monthly stage-matched telephone calls, a printed manual, and mail contact for 24 months. The intervention was based on social cognitive theory[19] and the transtheoretical model.[16] This control condition targeted physical activity, sedentary behavior, total intake of fat, and servings per day of fruits and vegetables.

MEASURES

Sun Protection Behavior Scale

Adolescents self-reported their sun protection behaviors with a 7-item scale.[20] Items included the following: How often do you wear a shirt? How often do you stay in the shade? How often do you avoid the sun during the midday hours? How often do you limit your exposure to the sun during the midday hours? How often do you use a sunscreen? How often do you use a sunscreen with an SPF of 15 or more on your face? and How often do you use a sunscreen with an SPF of 15 or more on all your sun-exposed areas? Participants responded to each item on a 5-point Likert scale with anchors of 1 (never) to 5 (always), to generate a sun protection score. One-week test-retest reliability, assessed in a subsample of 33 adolescents, was found to be good for the scale (intraclass correlation coefficient, 0.70), and internal consistency for the scale at baseline was good (Cronbach $\alpha = 0.78$).

Stage of Change

We used a previously developed short algorithm to classify adolescents into stages of change for sun protection defined by (1) avoiding sun exposure, (2) wearing protective clothing, and (3) using sunscreens with an SPF of 15.[21] The algorithm used self-reported intention to consistently protect from exposure to the sun and the sun protection score to classify adolescents into 1 of 5 stages of change labeled precontemplation, contemplation, preparation, action, and maintenance. The stage-of-change measure had good reliability (intraclass correlation coefficient, 0.70) from a 1-week test-retest, assessed in a subsample of 33 adolescents.

Sun Sensitivity

Vulnerability to sun exposure was determined from a previously validated instrument.[22] Scores ranged from 0 to 10 based on the skin's reaction to the sun, untanned skin color, and hair color. A score of less than 3.3 indicated good natural protection; 3.3 to 6.6, moderate sensitivity to sun exposure; and 6.6 or higher, high sensitivity to sunlight.

STATISTICAL ANALYSES

The primary outcome was the sun protection score measured at the baseline and 6-, 12-, and 24-month assessments. A mixed-model repeated-measures analysis was conducted to compare the effect in the Sun Smart intervention group with that in the control group during the 2-year intervention period. The mixed-model analysis allowed for use of all of the available data from the full sample of randomized participants without imputing missing values. The model was specified with a between-subjects factor of treatment group (1, Sun Smart intervention group; 0, control group), a within-subject factor of time (0, baseline; 1, 6 months; 2, 12 months; 3, 24 months), and the treatment $\times$ time interaction. Models with nonlinear quadratic change parameters of time^2 and treatment $\times$ time^2 were also tested. Maximum likelihood estimation determined population parameter estimates for the fixed effects. Model fit was compared with the Akaike information criterion and the Schwarz Bayesian criterion. The sun protection score was standardized to T scores (mean, 50; SD, 10) to allow for easy interpretation of the fixed-effects parameter estimates as standardized effects.

Logistic regression models were specified to test the effect of the intervention on the movement from preaction stages of change at the start of the study to the action or the maintenance stage of change at the 6-, 12-, and 24-month assessments. These models included baseline stage, sex, age category, sun sensitivity, and treatment group.

An intervention dose analysis was conducted with adolescents in the Sun Smart intervention group who completed the 24-month assessment ($n = 317$). A multiple linear regression model was specified with the sun protection score as the dependent variable and the baseline sun protection score, sex, sun sensitivity, and the number of intervention sessions completed (range, 2-6) as the independent variables.

All analyses were conducted using SPSS statistical software, version 12.0 (SPSS Inc, Chicago, Ill). The *P* values were not adjusted for multiple tests. All reported *P* values are for 2-sided tests, with effects considered statistically significant at $P < .05$.

RESULTS

Recruitment occurred from May 21, 2001, through July 16, 2002. **Figure 2** displays the study flow diagram. Contact was attempted with 3366 households during the recruitment period. Among these attempted contacts, eligibility could not be determined for 1684 households because of a wrong telephone number ($n = 462$), refusal to participate ($n = 892$), or inability to reach a household member after 8 attempts ($n = 330$). Of the remaining households eligible to participate, 503 did not complete the baseline assessment. Baseline assessments were completed by 878 adolescents, 819 of whom began the intervention at the physician's office and are included in the analyses.

No differences were found between the randomized participants who began the intervention and those who did not ($n = 59$) in terms of age, sex, ethnicity, primary health care provider site location, highest household educational level, sun sensitivity, or treatment group. No differences were found between the intervention and control groups for sex, age, highest household educational level, or sun sensitivity level at baseline. More nonwhite adolescents were randomized to the control group (45.3%) compared with the Sun Smart intervention group (37.7%) ($P < .05$). **Table 1** displays the demographic characteristics of the study sample. The study sample was di-

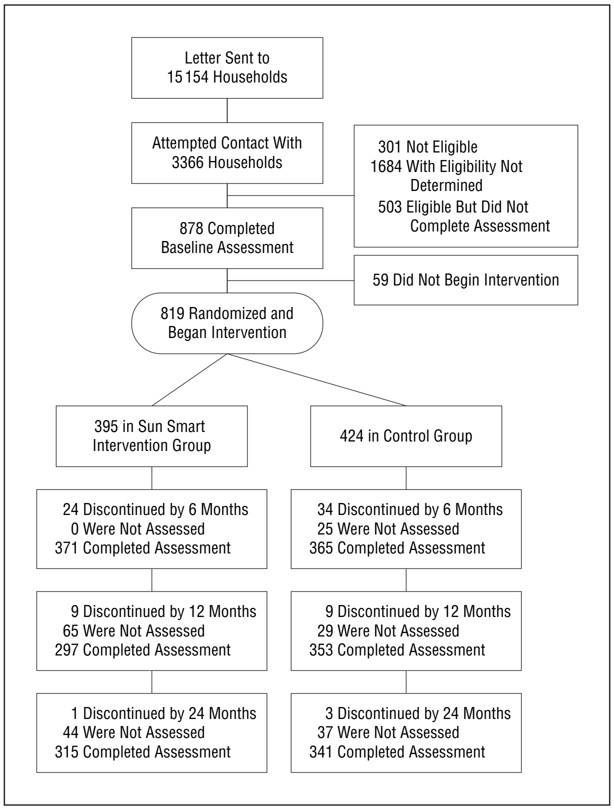

Figure 2. Study flow diagram.

verse, with 41.6% indicating race/ethnicities other than non-Hispanic white. Overall, 69.1% of the sample was considered to be moderately to very sensitive to UV exposure, and about 86.7% of the sample was in the first 3 preaction stages of change for sun protection.

Altogether, 71.9% of participants had complete data at all 4 assessment points. Having complete data was not associated with treatment group, sex, age, sun sensitivity, or baseline sun protection score. More nonwhite participants (32.0%) did not complete 1 or more of the assessments compared with white participants (25.3%) ($P = .04$), and we observed a trend indicating that higher household education was related to having complete data ($P = .07$).

Participants could receive up to 6 intervention contacts consisting of 2 interactive sessions at the physician's office and 4 mailed feedback reports. The mean ± SD number of intervention contacts was 3.9 ± 1.3, with about 70.1% of participants receiving 4 to 6 contacts. All of the adolescents completed the first interactive session at the physician's office (94.0%) or at the research office (6.0%). Of randomized participants, 228 (57.7%) completed the second interactive session at the physician's office, with an additional 69 adolescents completing the 12-month assessment by telephone and receiving a mailed feedback report.

PRIMARY OUTCOME ANALYSIS

Figure 3 displays the sample means and 95% confidence intervals (CIs) for the sun protection score by treatment group at each assessment point. The pattern of the means shows that the Sun Smart intervention group had a greater increase in sun protection scores compared with the control group, with the trajectory of scores flattening between 12 and 24 months.

Table 1. Sample Demographic and Stage of Change Characteristics*

Characteristic	Study Group: Sun Smart Intervention (n = 395)	Study Group: Control (n = 424)	Overall (N = 819)
Sex			
Female	216 (54.7)	222 (52.4)	438 (53.5)
Male	179 (45.3)	202 (47.6)	381 (46.5)
Age, mean (SD), y	12.7 (1.4)	12.7 (1.3)	12.7 (1.3)
Ethnicity			
Asian/Pacific Islander	9 (2.3)	17 (4.0)	26 (3.2)
African American	18 (4.6)	36 (8.5)	54 (6.6)
Native American	3 (0.8)	3 (0.7)	6 (0.7)
Hispanic	46 (11.6)	61 (14.4)	107 (13.1)
White	246 (62.3)	232 (54.7)	478 (58.4)
Multiethnic/other	73 (18.5)	75 (17.7)	148 (18.1)
Highest household educational level			
No high school to associate's degree	127 (33.0)	142 (34.1)	269 (33.6)
Bachelor's degree	104 (27.0)	134 (32.2)	238 (29.7)
Graduate or professional degree	154 (40.0)	140 (33.7)	294 (36.7)
Sun sensitivity			
Good natural protection	107 (27.1)	146 (34.4)	253 (30.9)
Moderate sensitivity	182 (46.1)	178 (42.0)	360 (44.0)
High sensitivity	106 (26.8)	100 (23.6)	206 (25.2)
Stage of change for sun protection			
Precontemplation	58 (14.7)	105 (25.1)	163 (20.0)
Contemplation	95 (24.1)	86 (20.5)	181 (22.2)
Preparation	198 (50.1)	168 (40.1)	366 (45.0)
Action and maintenance	44 (11.1)	60 (14.3)	104 (12.8)

*Unless otherwise indicated, data are expressed as number (percentage) of subjects. Percentages have been rounded and may not total 100. Sample sizes vary owing to missing data.

A mixed-effects repeated-measures model was specified to model the pattern of change over time. Adding quadratic change trajectory parameters improved the model fit to the data compared with models with only linear effects as indicated by the Akaike information criterion and Schwartz Bayesian criterion fit indexes. **Table 2** displays the maximum likelihood parameter estimates for the primary outcome model. With the sun protection scores standardized to T scores, 1 point equals one tenth of 1 SD, facilitating interpretation of the parameter effect sizes.

For the primary outcome model, the group effect (−0.05) indicated no difference in the intercept for the groups (48.03); the intercept represents the initial sun protection behavior status at the start of the study. The time effect (1.74) indicates a significant positive slope for both groups. The group × time interaction (2.36) indicates a differential effect of the treatment group on the slope of the change trajectory; this interaction represents the greater increase in sun protection behavior for the Sun Smart intervention group compared with the control group. The time^2 quadratic parameter (−0.48) represents the change in the slope over time, indicating a curving of the trajectories over time. The group × time^2 effect (−0.49) indicates a small differential in the change in the slope over time between the 2

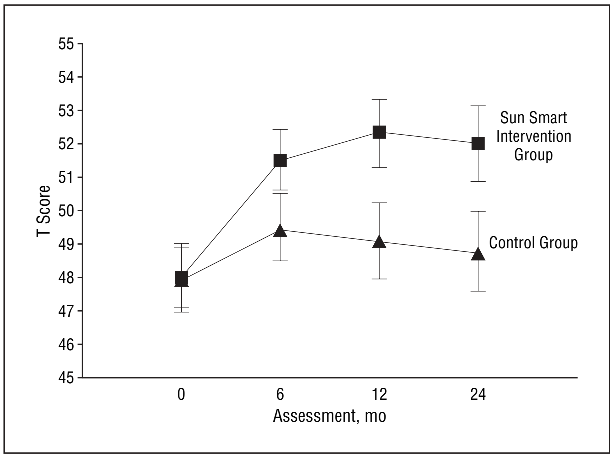

Figure 3. Sample means (95% confidence intervals) for sun protection behavior for the Sun Smart intervention and control group.

Table 2. Mixed-Effects Repeated-Measures Model Parameter Estimates for the Sun Protection Behavior Scale*

Primary Outcome Model†	Parameter Estimate (95% CI)	*P* Value
Intercept	48.03 (47.09 to 49.00)	<.001
Group	−0.05 (−1.43 to 1.32)	.94
Time	1.74 (0.66 to 2.82)	.002
Time^2	−0.48 (−0.84 to −0.13)	.008
Group × time	2.36 (0.79 to 3.94)	.003
Group × time^2	−0.49 (−1.01 to 0.02)	.06

Abbreviation: CI, confidence interval.
*The dependent variable is the sun protection behavior scale score standardized to T scores.
†Group is coded as 0 for control and 1 for Sun Smart intervention; time, 0 for baseline, 1 for 6 months, 2 for 12 months, and 3 for 24 months.

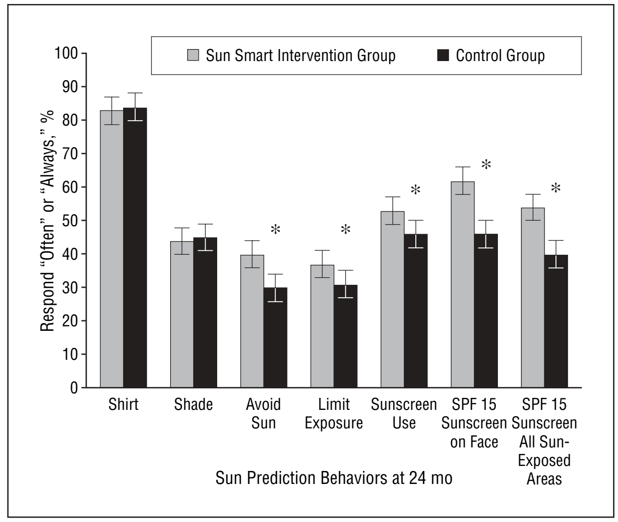

Figure 4. Frequencies (95% confidence intervals) of adolescents responding "often" or "always" to items from the sun protection behavior scale at 24 months. *$P<.05$. SPF indicates sun protection factor.

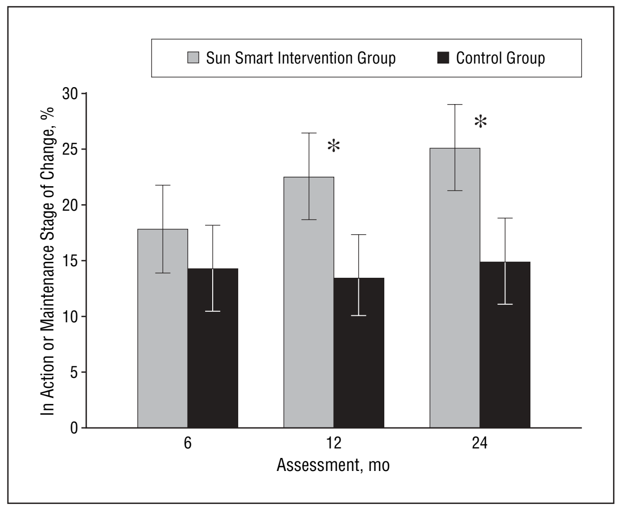

Figure 5. Frequencies (95% confidence intervals) of movement to the action or the maintenance stage of change for adolescents who were in the preaction stages at baseline. *$P<.01$.

groups, with the intervention group having a slightly greater curvature in the trajectory compared with a flatter trajectory for the control group.

To put the primary outcome effect into context, we explored between-group differences at 24 months on the 7 individual items constituting the sun protection behavior scale. Five of the 7 items were statistically significant, with higher sun protection scores for the adolescents in the Sun Smart intervention group compared with those in the control group. **Figure 4** displays the frequencies and 95% CIs for adolescents responding "often" or "always" to each sun protection behavior scale item at 24 months.

MOVEMENT TO THE ACTION-AND-MAINTENANCE STAGE OF CHANGE

Multivariate logistic regression models tested the effect of the intervention on the proportion of baseline preaction-stage adolescents who were classified as being in the action or maintenance stage of change at 6, 12, and 24 months. Sample frequencies and 95% CIs are presented in **Figure 5**. Odds ratios from these models were adjusted for the baseline stage of change, sex, age category, and sun sensitivity. At 6 months, 17.8% of adolescents in the Sun Smart intervention group and 14.3% of adolescents in the control group reported being in the action or the maintenance stage of change (odds ratio, 1.14; 95% CI, 0.74-1.76). At 12 months, more adolescents in the Sun Smart intervention group were in the action or the maintenance stage compared with the control group (22.5% vs 13.4%; odds ratio, 1.71; 95% CI, 1.09-2.68), with similar findings at 24 months (25.1% vs 14.9%; odds ratio, 1.74; 95% CI, 1.13-2.68).

EFFECT OF INTERVENTION DOSE ON SUN PROTECTION BEHAVIOR

A multiple linear regression model for the subsample of adolescents in the Sun Smart intervention group who completed assessments at 24 months (n=315) indicated that sun protection behavior was positively associated with completing more intervention sessions (standardized $\beta=0.16$; $P=.002$), after controlling for the baseline sun protection score, sex, and sun sensitivity (adjusted R^2 for model, 0.17). Interaction terms for intervention sessions × sex and intervention sessions × sun sensitivity were tested but were not statistically significant.

PROGRAM SATISFACTION

Overall satisfaction with the Sun Smart program was high, with 79.4% of participants indicating they liked the program "some" or "a lot." However, when asked about individual program components, 39.4% of participants responded "some" or "a lot" to liking the health counselor; 37.4%, for the *Being Sun Smart Guide*; 40.0%, for the computer program; and 41.6%, for the tip sheets. A total of 67.6% of participants said that they learned some or a lot of new information, and 72.1% said that they would probably or definitely recommend the program to friends.

COMMENT

To our knowledge, this is the first study of a primary care–based intervention to improve provider counseling for skin cancer prevention for adolescents through the use of expert system behavior assessment and tailored follow-up. The computerized expert system guided brief counseling on sun protection behavior by the primary care provider and delivered periodic tailored feedback reports designed to encourage behavior change between primary care visits. This intervention program has the potential to be integrated into primary care as a primary prevention service that physicians could provide to their patients.[23]

The size of the treatment effect was in the small to moderate range[24] but reflected important changes in limiting sun exposure and using sunscreen. The statistical model for the primary outcome included quadratic parameters that modeled the curvature of the change trajectories. The curved trajectories indicated that the intervention effects accelerated between 6 and 12 months and then flattened and stabilized between 12 and 24 months. This finding, combined with the positive relationship between sun protection behavior and intervention dose, suggests that there may be a benefit to increasing the number of tailored reports to create more sustained treatment effects. However, some evidence from a trial testing a smoking cessation expert system intervention suggests that the number of feedback reports (1, 2, 3, or 6) did not result in differential intervention effects.[25] An alternative strategy for those needing more intensive treatment would be to combine the expert system program with other types of intervention components such as group education/counseling sessions or ongoing Web-based programs.

By 24 months, 68.5% more adolescents in the Sun Smart intervention group compared with the control group (25.1% vs 14.9%) moved from the preaction stages of change at baseline to the action or the maintenance stage. This is nearly double the initial 12.8% of adolescents in the action or the maintenance stage at baseline. Three previous studies[10-12] of sun protection with adults had similar findings, with the percentage of participants in the action or maintenance stage at 24 months ranging from 23.4% to 31.5% for the expert system conditions and from 14.4% to 25.5% for the control conditions. These findings suggest that expert system intervention effectiveness is comparable for adolescents and adults. However, these rates of meeting the behavior criteria for sun protection are far below the Healthy People 2010 goal of 75% of the population using at least 1 protective measure to reduce skin cancer,[5] so improved interventions are needed.

It is likely that the impact of individual-level interventions is constrained by the broader policy and environmental contingencies existing in communities. Environmental changes such as providing shady areas at outdoor public places and media campaigns that influence the social norm perceptions about sun protection could create a more favorable setting for implementing individually tailored intervention programs.

Similar to other sun protection intervention trials, this study is limited by the reliance on self-reported measures for the primary outcome.[26] Self-reported measures are subject to social desirability and recall biases. Some previous studies have used observational measures to further validate the self-report indexes,[27,28] but this is difficult to undertake in large studies, especially studies based in a primary care setting where direct observation of sun protection behaviors is not feasible. Although the sun protection behavior scale in the present study had good test-retest reliability and has been validated in other studies, the reliability of the individual items ranged from poor to good, making the interpretation of changes in individual sun protective behaviors less feasible.

The generalizability of these findings may be limited to adolescents who have health insurance and to regions of the United States where there is little seasonal fluctuation in sun exposure and temperate weather that allows for year-round opportunities to be outside. The roughly 25% refusal rate during participant recruitment may have limited the extent to which the sample represented the region. The results may not be generalizable to children younger than 11 years because of the fifth- to sixth-grade reading level of the feedback reports and assessments. However, a similar intervention program could be tested with older adolescents and adults. Two recent studies have combined tailored sun protection expert systems with additional health behavior change programs (diet and smoking) in adult samples, suggesting that targeting sun protection in the context of multiple behavioral interventions is as effective[10,12] as single risk-behavior interventions such as these.[11]

Strengths of the study include the large sample size of adolescents and the diverse ethnic backgrounds. We found the intervention applicable to adolescents regardless of their vulnerability to sun exposure (data not shown). The study reflects an evaluation of a theoretically based expert system program incorporated into a primary care intervention and supports the feasibility of disseminating this intervention in a new setting. Thus, this study provides additional evidence supporting the generalizability of expert system programs to a variety of populations and settings.[13,29,30] This study also provides evidence of an effective intervention for sun protection in a setting where the recent Task Force for Community Preventive Services report found insufficient evidence of effective programs in health care settings.[6]

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The Manilow Method

The discouragement of loitering in public places by broadcasting music that is offensive to young people, particularly the songs of singer Barry Manilow.
—From WordSpy, www.wordspy.com, accessed July 30, 2006