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A Randomized Trial of Skin Cancer Prevention in Aquatics Settings: The Pool Cool Program

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Skin cancer is increasing, and prevention programs are essential. This study evaluated the impact of a skin cancer prevention program on sun-protection habits and swimming pool environments. The intervention included staff training; sun-safety lessons; interactive activities; providing sunscreen, shade, and signage; and promoting sun-safe environments. A randomized trial at 28 swimming pools in Hawaii and Massachusetts tested the efficacy of this program (Pool Cool) compared with an attention-matched injury-prevention control program. Results showed significant positive changes in children's use of sunscreen and shade, overall sun-protection habits, and number of sunburns and improvements in parents' hat use, sun-protection habits, and reported sun-protection policies and environments. Observations corroborated the positive findings. Pool Cool had significant positive effects at swimming pools in diverse audiences.

Key words: skin cancer prevention, sun protection, child health, melanoma, aquatics

Skin cancer is the most common form of cancer in the United States, and it accounts for an estimated 1.3 million new cases of cancer each year (American Cancer Society, 2000). The incidence rate of melanoma, the most deadly form of skin cancer, has more than doubled since the early 1970s (American Cancer Society, 2000; National Cancer Institute, 1999) and continues to rise (Jemal, Devesa, Fears, & Hartge, 2000). Skin cancer is most common in fair-skinned individuals, and persons who live in tropical, sunny climates when they are young are at increased risk (Gilchrest, Eller, Geller, & Yaar, 1999; Harras, 1996). It is believed that lifelong protection from the sun's rays would prevent most skin cancers (Gilchrest et al., 1999). Because sun exposure during childhood accounts for an estimated 80% of the total lifetime exposure (Preston & Stern, 1992), and children in elementary school receive more solar exposure than preschool and secondary school students (Diffey, Gibson, Haylock, & McKinlay, 1996; Hall, McDavid, Jorgensen, & Kraft, 2001), these children can benefit substantially from preventive actions.

Although skin cancer is the most common cancer, it is also one of the most preventable cancers. Behavioral recommendations for primary prevention of skin cancer include the following: Limit time spent in the sun, avoid the sun during peak hours (10 a.m. to 4 p.m.), use sunscreen with a sun-protection factor of 15 or higher when outside, wear protective clothing (hats, shirts, pants) and sunglasses, seek shade when outdoors, avoid sunburn, and make sun safety a family habit (American Cancer Society, 2000; Hill & Ferrini, 1998).

Although awareness about skin cancer is growing, the practice of preventive behaviors remains relatively low in the United States (Centers for Disease Control and Prevention, 1998; Koh, Bak, & Geller, 1997; Robinson, Rigel, & Amonette, 1998). Preventive interventions have demonstrated modest success, with the majority of programs being delivered in school settings (Buller & Borland, 1999). A recent comprehensive review of more than 80 studies concluded that the ideal intervention strategies for reducing exposure to ultraviolet radiation (UVR) are coordinated, sustained, community-wide approaches that combine education, mass media, and environmental and structural changes. The results of that review further showed how interventions within specific organizational settings provide useful ways to reach important audiences, like children, and are suitable venues for structural supports, such as environmental and policy change that complement educational efforts (Glanz, Saraiya, & Briss, in press).

Outdoor recreation settings are especially promising for skin cancer prevention activities (Glanz, Chang, Song, Silverio, & Muneoka, 1998; Glanz, Lew, Song, & Murakami-Akatsuka, 2000; Rosenberg, Mayer & Eckhardt, 1997). In particular, aquatics settings such as swimming pools are uniquely suited to sun-safety programs for several reasons: Children and adults are minimally clothed, swimming lessons offer a structure for teaching sun-safety skills, families and communities often gather at swimming pools in

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the summer, lifeguards and aquatics instructors can serve as role models, and environmental changes and supportive policies can promote solar protection for all pool users. The fact that most pools are willing to adopt skin cancer prevention curricula (Rosenberg et al., 1997) suggests that such efforts can succeed.

Only two studies of aquatics-based skin cancer prevention programs have been published (Lombard, Neubauer, Canfield, & Winett, 1991; Mayer, Slymen, et al., 1997). Lombard et al. (1991) used peer leader modeling, posted feedback and goals, and a commitment raffle at two swimming pools and found significant increases in sun protection over a 3- to 6-week period. Mayer, Slymen, et al.'s (1997) multicomponent SUNWISE program combined a poolside curriculum and home-based activities for children at four YMCA swimming pools. The intervention group reported more hat wearing after the intervention, but the intervention did not affect most solar protection measures. Both these studies were novel and showed some effects, but they were constrained by small samples, were conducted in limited geographic areas, and emphasized either educational efforts (Mayer, Slymen, et al., 1997) or environmental–behavioral efforts (Lombard et al., 1991).

We report here on a randomized trial of the Pool Cool Program, a multicomponent skin cancer prevention program that was evaluated in 28 swimming pools in two very different locations. We hypothesized that Pool Cool, which combined education, interactive activities at the pool, and poolwide environmental changes, would effect greater improvements than an attention-matched injury prevention control program in sun-protection behaviors, pool sun-safety policies, and sunburn reduction among susceptible children who received a sun-protection program.

Method

Design and Setting

Pool Cool was evaluated in a randomized, controlled trial conducted at 28 swimming pools in Hawaii and Massachusetts during the summer of 1999. The program was for children 5 to 10 years of age (primarily those taking swimming lessons), their parents, and lifeguards and aquatics instructors. The participating pools included public municipal and suburban pools, YMCA pools, and military pools.

The swimming pool site was the unit of randomization and intervention. Randomization was done separately in Hawaii and Massachusetts, using a blocking procedure to balance pool size and geographic location. We approached a total of 35 pools, 32 of which were eligible on the basis of size and provision of swimming lessons. Twenty-nine pools agreed to participate and were randomized, but one was lost to the study because of prolonged construction at the pool site through the summer, resulting in a final sample of 28, or 87.5% of eligible pools. Sites in the sun protection (SP) arm ($n = 15$ pools) received staff training; a series of sun-safety lessons; on-site interactive activities; provision of sunscreen, shade, and signage; and promotion of sun-safe environments. Sites in the injury prevention (IP) arm ($n = 13$ pools) received a parallel program that included lessons and activities on bicycle and rollerblading safety, fire safety, traffic and walking safety, poisoning and choking prevention, and playground safety.

The main evaluation was based on self-administered surveys that parents completed for themselves and their children at the beginning of the summer and approximately 8 weeks later. Response samples were two independent cross-sections of parents accompanying or picking up their children at the pools. Additional evaluation data came from observations conducted by Pool Cool research staff and monitoring forms completed by lifeguards and aquatics instructors. The sample size for the trial was determined by power calculations based on effect sizes found in a randomized trial of SunSmart, a previous skin cancer prevention intervention trial that was conducted in outdoor recreation settings (Glanz et al., 2000).

Pool Cool Intervention

Conceptual framework. Strategies used in the project were based on social cognitive theory applied to health behavior (Bandura, 1986; Glanz, Lew, Song, & Ah Cook, 1999). Social cognitive theory suggests that behavior is influenced by social and physical environments along with the features of the behavior and that there are continuous reciprocal interactions among people, their environments, and behaviors (Bandura, 1986). The key sun-protection behavior outcomes of interest were using sunscreen, wearing hats and shirts, wearing sunglasses, seeking shade, and avoiding sunburn. Drawing on social cognitive theory constructs, the intervention strategies sought to influence these behaviors by emphasizing the proper skills, social acceptability, ease, and appeal of practicing sun protection. We considered environmental or structural changes as outcomes in their own right in this study, although they might also be viewed as proximal outcomes intended to stimulate behavior change in a sequentially delivered intervention. Environmental outcomes that we sought to influence included the availability of sunscreen, shaded areas, widely visible sun-safety signage, and pool policies favoring sun safety.

Pilot test. Materials and methods were selected and refined using a social marketing process (Lefebvre & Rochlin, 1997). This included focus groups with aquatics staff and pool managers and a large pilot study. In the summer of 1998, we conducted a pilot study of Pool Cool at six pools, three in Hawaii and three in Massachusetts. Results of the pilot study were central to determining the final trial design. First, we found that pools were increasingly providing on-site sunscreen, so it would not be possible to separate "environmental" and "educational" strategies as we had in a previous study (Glanz et al., 2000). Second, the pool staff and children reacted favorably to Pool Cool as a whole and provided guidance for refining the intervention for evaluation in a larger controlled trial. Finally, the pilot test revealed the importance of providing a program for control sites, which was the basis for offering the IP program rather than simply asking pools randomized to that arm to participate in data collection.

Intervention procedures. The Pool Cool SP intervention included a 1-hr orientation and training and leader's guide for pool staff and educational and environmental components for the children and their parents. Educational components were (a) a series of eight sun-safety lessons (provided on waterproof laminated sheets) to be taught at the start of each swimming lesson, (b) a "big book" to make lessons more interactive, (c) on-site interactive activities, (d) and incentives to reinforce the sun-safety messages. The lessons were designed to introduce and reinforce the four Pool Cool Rules, which reminded children to (a) use sunscreen, (b) cover up, (c) protect their faces and eyes, and (d) seek shade and limit exposure. Each lesson was printed on a color-coded, two-sided laminated sheet that included the goal of the lesson, key discussion points and skill demonstration activities, and a main sun-safety message. Lessons were intended to take 4–6 min to deliver and could be completed during the time of a typical swimming class (usually 8–10 lessons over 2 or 4 weeks). The book ("big book") to go with the lessons had lively and colorful pictures and could be propped at the poolside to provide visual reinforcement for the lessons. Interactive activities on the pool deck included demonstrations, games, and puzzles to supplement and support the lessons and engage parents' participation. Small incentives that ranged in value from fifty cents to $4 each were used as "prizes" for the activities and incentives for completing surveys.

Environmental components included providing sunscreen, shade, and signage and promoting sun-safe environments. Each pool received a refillable pump sunscreen container, a portable shade structure or umbrellas (of their choosing), durable sun-safety signs modeled after traffic signs, and a sunscreen tips poster. A booklet entitled *Decision Maker's Guide for Sun Safe Swimming Pools*, along with informal consultations, was used to guide pool managers toward more sun-safe pool environments and policies. Table 1 provides additional detail on the program components.

Table 1
Pool Cool Sun Protection Program Intervention Components

Intervention	Description
	Lifeguard/aquatic instructor training
Leader's guide	Skin cancer and sun safety basics
	How to include Pool Cool into swim lessons
	Other Pool Cool activities and incentives
	Evaluation Activities: Monitoring forms and surveys
	Educational components
Sun-safety lessons	Introducing Pool Cool: Rules for Sun Safety
	Water, Water Everywhere
	The Ins and Outs of Sunscreen, Part 1
	The Ins and Outs of Sunscreen, Part 2
	Covering Up With Protective Clothing
	Hats and Sunglasses
	Shady Deals
	Pool Cool Review
Big book	Pool Cool Rules for Sun Safety (to use with lessons)
Activities	The UV index—weather watch
	Sun Jeopardy game
	UV light machine (Dermascan)
	Colored sunscreen demonstration
	Sun protective clothing
	UV solar exposure cards
	Skin examination
	Pool Cool review
Incentives	Sun-safe message pens
	Pool Cool lanyards
	Sunscreen samples
	T-shirts
	Pool Cool refrigerator magnets
	Photosensitive water bottles
	Glitter sunscreen
	Lip balm
	Pool Cool hats
	Insulated lunch sacks/can holders
	Environmental components
Sunscreen	Pump bottles
Shade structure	Tent
	Canvas/tarp cover
	Umbrella for lifeguard stands
Sunscreen tips	Poster
Sun signs	Official-looking metal traffic signs adapted for sun-safe messages (for fences)
Consultations	Informal, on environmental and policy changes

Note. UV = ultraviolet.

Each educational component of the Pool Cool SP intervention was directed toward one or more of the three main audiences: aquatics staff, children in swimming lessons, and parents. The pool staff were reached mainly through the orientation and training and leader's guide, through their experience teaching the Pool Cool lessons, and by participating in on-site activities (Geller et al., 2001). Children were the main audience for the lessons, activities, and incentives. Parents were reached by the activities when they came to the pool and through the information their children brought home. Each of these groups was exposed to environmental and normative influences, though in slightly different ways—for example, the children saw lifeguards as role models and could use the sunscreen and shade areas, whereas the parents were more likely to be prompted to take precautions by the sun-protection signs around the pool area.

Data Collection

Surveys. The main sources of data were self-administered surveys of parents (for themselves and their children). Surveys were distributed at the pool before and after swimming lessons to include parents (or other caregivers) of children ages 5 to 10 years who were taking swimming lessons. Research project staff approached adults, inquired as to their eligibility, invited parent participation, and explained that participation was voluntary. Parents who agreed to complete the survey were given a clipboard and pen and completed the surveys on site. This procedure was completed at the beginning of the summer and about 8 weeks later, near the end of the swimming lessons season. Parents received a small incentive (sunscreen samples, lanyards, and/or hats, and T-shirts for the children) to thank them for completing the survey.

Observations. To ascertain structural and environmental changes objectively, the Pool Cool staff conducted observations at three times: at the beginning (Time 1), middle (Time 2), and end (Time 3) of the summer. Observations examined the sun-safety environment (availability of sunscreen, shaded areas, and sun-safety signage) and lifeguard sun-safety practices (hat and shirt wearing). Only those measures that achieved greater than 80% interobserver agreement during the pilot test were included in the main trial. During the pilot study, we found that observations of children and parents at the pool would be too unreliable because of high levels of activity and external influences such as pool regulations that required children to leave hats and cover-ups in lockers or storage areas. Each observation form was completed by two independent observers. The lead observer reviewed the forms before the team left the pool and reconciled any discrepancies by identifying the correct information (for example, the observer who saw sunscreen available might point it out to the one who had not seen it).

Process evaluation. To determine the extent of program implementation, receipt, and reactions to Pool Cool, aquatics staff completed monitoring forms, project staff tracked distribution of program incentives and kept logs of participation, and parents completed follow-up survey questions about participation, incentives received, and their reactions.

Measures

Parent–child surveys asked about demographic characteristics of the parent and child, skin cancer risk factors, knowledge about skin cancer and sun-protection guidelines, attitudes, and policies for sun protection at the swimming pool. These surveys also asked about both parent and child's sun-protection practices and the child's previous sunburn experience and sunburns during the study summer. Measures for questionnaire items were selected or adapted from previous surveys on this topic that have been published in the literature (Arthey & Clarke, 1995; Newman, Agro, Woodruff, & Mayer, 1996; Weinstock, 1992) or used in earlier studies conducted by the project team (Glanz et al., 1998, 1999; Koh et al., 1997).

Because key behaviors and other variables were measured using multiple items, we created composite measures. An additive approach was used to construct summary indexes for sun-protection practices of parents and children (Sun Protection Habits score), knowledge, and sun-protection policies at the pool site. Sun-protection practices were assessed by measuring five protective behaviors (using sunscreen, wearing a shirt, wearing a hat, seeking shade, and wearing sunglasses) on 4-point ordinal scales ranging from 1 (*rarely or never*) to 4 (*always*), adding the responses for each behavior, and dividing by the number of items answered to obtain a summary score (ranging from 1 to 4). Calculation of a composite score required responses on at least three of the five protective behaviors.

The Knowledge index was created by scoring answers to 8 questions as 0 (*incorrect*) or 1 (*correct*) and adding up the scores to calculate a summary Knowledge score. A similar approach was used for SP Policy index scores, by adding up 1 (*yes*) and 0 (*no*) responses to 4 items querying whether swimming pool sites required or encouraged sun-protective actions. Objective measures of supporting policies were available from surveys of aquatics staff (reported in Geller et al., 2001) and observations (described above).

The Cronbach's alpha (α) coefficient of reliability for the main dependent variables, the child Sun Protection Habits score and the parent Sun Protection Habits score, were determined in earlier studies to be acceptable at 0.70 and 0.70, respectively (Glanz et al., 1999). The alpha coefficients for the Pool Cool trial for these variables were 0.59 (parents) and 0.54 (children). New alpha coefficients were calculated as 0.82 for the Policy index and 0.40 for the Knowledge index; these measures were newly modified for use in the aquatic setting.

Statistical Methods

The study sample included 1,172 children from 28 pool sites. For these analyses, we included all parent–child respondents who completed usable surveys (answered >50% of all items and completed outcome behavior measures) and had a child in swimming lessons. The analyses used surveys from 1,010 parents at baseline and 842 parents at follow-up.

Statistical analysis was completed using SAS statistical software. After calculating frequencies for the variables of interest, we created the composite indexes. Bivariate analyses were completed using chi-square and *t* tests.

Principal study outcomes were intervention effects, defined as the difference between change in sun protection pool sites and the change in control (injury prevention) pools. The main dependent variables were children's Sun Protection Habits index, sunburns, and individual sun-protection behaviors (using sunscreen, wearing a shirt, wearing a hat, staying in the shade, wearing sunglasses); parents' Sun Protection Habits index, parents' Knowledge index, and pool sun-protection policies. Analyses of sunburns included only children at moderate or high risk for skin cancer, because those at low risk rarely reported any previous sunburns because of their phenotype.

Multivariate analyses were completed using the Proc generalized linear model (GLM) option in SAS. Each outcome variable was adjusted for sex, risk group (low, moderate, high), and ethnicity. To determine the intervention effect from pretest to posttest between the treatment groups, the model included a Time × Treatment interaction. This interaction term was necessary because we were interested in how the effect is patterned across these two classes over time. Adjusted means shown were calculated using the LSMEANS function in Proc GLM, which allows for adjustment across all covariates and classes.

In the Pool Cool evaluation, data were collected for individuals aggregated at the swimming pool sites. To take into account the effects of clustering by pool site, additional analyses were completed using the MIXED procedure in SAS. The multivariate analysis uses a random-effects model, with pool site as a random effect, to empirically examine the possible effects for site clustering and to validate the primary result (Singer, 1998). We computed the intraclass correlation for the main dependent variables—child and parent sun-protection habits and pool sun-protection policies—and found them to be 0.02, 0.03, and 0.08 respectively, using the full maximum-likelihood function (Littell, Milliken, Stroup, & Wolfinger, 1996). We computed the primary analyses ignoring clusters (Vonesh & Carter, 1987). However, we also reanalyzed the multivariate analyses as random-effects models, including pool site as a random effect, to empirically examine the possible effects of site clustering and validate the primary results.

Results

Sample Characteristics

From a total of 1,172 completed surveys at baseline, 162, or 13.9%, were excluded from analysis because the children were not in swimming lessons at the pool; 1,010 parent–child respondents were included in the analysis at baseline. The baseline response rate from eligible parent respondents was 94.4%; the number of usable surveys per pool ranged from 19 to 83, with an average of 36.1 per pool site. Eight hundred forty-two parent–child surveys were collected at follow-up, reflecting lower pool attendance in the late summer and not a lower response rate (response rate = 95.9%). There were no differences in response rate across study condition or study site.

Table 2 shows the characteristics of parent–child respondents at baseline, by study site (558 SP and 452 IP; 545 from Hawaii and 465 from Massachusetts). Over 80% of the respondents were female (mostly mothers), and the children's genders were nearly

Table 2
Baseline Characteristics of Parents and Children, by Study Site

Characteristic	Total[a] (n = 1,010)	Hawaii (n = 545)	Massachusetts (n = 465)
Parents/caregivers			
Gender (% female)	83.0	75.5	91.4**
Age ($M \pm SD$)	39.2 ± 7.74	39.1 ± 8.51	39.4 ± 6.77
Ethnicity (% Caucasian)	57.2	27.2	90.3**
% college educated	86.0	84.0	88.4**
% household income > $50K	68.4	54.8	85.0**
% moderate or high risk	64.7	49.5	82.2**
Sun Protection Habits index ($M \pm SD$)	2.49 ± 0.58	2.58 ± 0.58**	2.38 ± 0.51
Pool sun-protection policies ($M \pm SD$)	1.25 ± 1.60	1.45 ± 1.71**	1.02 ± 1.42
Knowledge ($M \pm SD$)	6.86 ± 1.13	6.78 ± 1.19	6.95 ± 1.06*
Children			
Gender (% female)	47.1	46.3	48.0
Age ($M \pm SD$)	6.6 ± 1.51	6.5 ± 1.57	6.6 ± 1.44
% moderate or high risk	67.8	55.5	82.7**
% with ≥ 1 sunburn last summer	40.9	41.6	40.1
Sun Protection Habits index ($M \pm SD$)	2.31 ± 0.49	2.23 ± 0.48	2.41 ± 0.48*

Note. Asterisks indicate significantly higher value for that site. Chi-square tests for categorical variables; *t* tests for continuous variables.
[a] Sample sizes smaller for some items because of missing data.
* $p < .05$. ** $p < .01$.

equally divided between male and female. The average age of parent respondents was 39.2 years, and the mean age of the participating children was 6.6 years. There were several differences between sites in parent–caregiver characteristics: Massachusetts respondents were far more likely to be Caucasian (90.3% vs. 27.2%, $p < .001$), and were more highly educated, more affluent, and at higher risk for skin cancer. Parents in Hawaii practiced more desirable sun-protection habits at baseline and reported pools with more sun-safety policies, but Massachusetts respondents had higher Knowledge scores. Children in Massachusetts were at higher risk than those in Hawaii, reported using more sun protection, and had no more sunburns than Hawaii youth.

The average rates of sun-protection behaviors in both study sites were moderate (usually below 2.5 on a scale of 1 to 4), between 2 (*sometimes*) and 3 (*usually*). For children, using sunscreen was the behavior most often practiced ($M = 3.15$) and wearing sunglasses was the behavior least practiced.

We also examined treatment group equivalence at baseline. The only difference between SP and IP respondents at baseline was that more male parents responded in the IP arm of the study (19.2% vs. 14.6%, $p < .05$). There were no other significant treatment-group differences at baseline.

Effects of Pool Cool Sun-Protection Intervention

Child sun protection and sunburns. Table 3 shows the adjusted means at baseline and follow-up for children's sun-protection habits and sunburn, in the SP pools and IP (control) pools. Parent reports of children's use of sunscreen, shade, and the composite Sun Protection Habits index in the SP arm were significantly higher at follow-up in the SP arm than in the IP group. Although the improvements in sun-safety behaviors in the treatment group were modest, these variables decreased in the control-group children. There were no significant differences between the SP arm relative to the IP arm for wearing shirts, hats, or sunglasses. The effect sizes, using Cohen's formula (Cohen, 1988), were $d = .17$ (sunscreen), $d = .23$ (shade), and $d = .22$ (overall Sun Protection Habits score). The SP group surveys reported a 23% reduction in child sunburns compared with the preceding summer, whereas the IP group reported only a 1% reduction ($p = .04$; $d = .22$).

Parent Sun Protection Habits and Knowledge indexes and pool sun-protection policies. Table 4 shows the results for parents' Sun Protection Habits and Knowledge indexes and pool sun-protection policies. The pattern of changes followed a pattern similar to what was found for the child endpoints for those variables where significant differences occurred. The relative difference between parents' reported use of sunscreen and hats and the composite Sun Protection Habits index in the SP arm revealed a significant treatment effect, but there were no significant differences for wearing shirts or sunglasses or for seeking shade. Decrements in sun-safety behaviors in the IP group were seen in parents as they were among children. The effect sizes for parent outcomes were $d = .17$ for sunscreen, 0.17 for hats, and 0.19 for overall Sun Protection Habits. Knowledge scores, relatively high

Table 3
Effects of Pool Cool Intervention on Child Sun Protection Habits and Sunburn

	Sun protection		Injury prevention (control)		
Variable	Baseline[a] ($n = 558$)	Follow-up ($n = 452$)	Baseline ($n = 446$)	Follow-up ($n = 396$)	F (dfs)[b]
Use sunscreen*					3.83 (1, 1813)
M	3.09	3.15	3.13	3.05	
SE	0.03	0.04	0.04	0.04	
Wear a shirt					0.04 (1, 1814)
M	2.45	2.52	2.43	2.48	
SE	0.04	0.04	0.04	0.05	
Wear a hat					1.09 (1, 1812)
M	2.05	2.05	2.12	2.04	
SE	0.03	0.04	0.04	0.04	
Stay in shade*					6.82 (1, 1804)
M	2.12	2.16	2.20	2.07	
SE	0.03	0.03	0.03	0.04	
Wear sunglasses					4.25 (1, 1810)
M	1.74	1.64	1.79	1.61	
SE	0.03	0.04	0.04	0.04	
Sun Protection Habits index*					4.69 (1, 1789)
M	2.29	2.30	2.33	2.24	
SE	0.02	0.02	0.02	0.02	
Sunburns[c]*					4.25 (1, 1221)
M	0.77	0.54	0.71	0.70	
SE	0.05	0.05	0.06	0.05	

Note. Means calculated with adjustment for covariates: sex, risk group, ethnicity. Asterisks indicate significant interaction effect (differences between groups, from baseline to follow-up). Range of values: 1 (*rarely*) to 4 (*always*).
[a] *n*s for separate analyses lower because of some missing data. [b] F test denotes the Group × Time interaction effect. [c] Includes only children at moderate or high risk ($n = 622$ at baseline and $n = 602$ at follow-up).
* $p < .05$.

Table 4
Effects of Pool Cool Intervention on Parents' Knowledge, Sun-Protection Habits, and Pool Sun-Protection Policies

	Sun protection		Injury prevention (control)		
Variable	Baseline[a] (n = 558)	Follow-up (n = 452)	Baseline (n = 446)	Follow-up (n = 396)	F (dfs)[b]
Use sunscreen**					6.32 (1, 1787)
M	2.52	2.56	2.64	2.47	
SE	0.04	0.05	0.05	0.05	
Wear a shirt					0.00 (1, 1788)
M	2.44	2.56	2.45	2.57	
SE	0.05	0.05	0.05	0.05	
Wear a hat**					7.11 (1, 1790)
M	2.07	2.15	2.17	2.02	
SE	0.04	0.05	0.05	0.05	
Stay in shade					1.39 (1, 1786)
M	2.42	2.48	2.50	2.47	
SE	0.04	0.04	0.04	0.04	
Wear sunglasses					0.29 (1, 1794)
M	2.81	2.87	2.90	2.91	
SE	0.05	0.05	0.05	0.05	
Sun Protection Habits index*					4.52 (1, 1768)
M	2.45	2.52	2.53	2.49	
SE	0.03	0.03	0.03	0.03	
Knowledge (range: 0–8)					0.00 (1, 1832)
M	6.88	6.88	6.72	6.73	
SE	0.05	0.06	0.06	0.06	
Pool sun-protection policies (range: 0–4)**					34.25 (1, 1847)
M	1.25	2.59	1.22	1.67	
SE	0.07	0.08	0.08	0.08	

Note. Means calculated with adjustment for covariates: sex, risk group, ethnicity. Asterisks indicate significant interaction effect (differences between groups, from baseline to follow-up). Range of values unless otherwise specified: 1 (*rarely*) to 4 (*always*).
[a] *n*s for separate analyses lower because of some missing data. [b] F test denotes the Group × Time interaction effect.
* $p < .05$. ** $p < .01$.

at baseline, remained virtually unchanged in both groups at follow-up. At follow-up, the SP group parent surveys showed substantially greater increases in sun-protection policies at their pools compared with the IP group: 2.59 compared with 1.67, or 55.1% higher on a scale of 0 to 4 ($p < .001$), for a medium effect size of $d = .54$ (Cohen, 1988).

When the child and parent effect models were rerun using the random-effects models to account for within-pool clustering, they remained virtually unchanged. Statistical significance was the same for all variables, adjusted means for parent and child Sun Protection Habits were no more than 0.03 different from the unclustered analyses, and pool sun-protection policy means were within 0.10 of the unclustered findings.

Dose–response analysis. Follow-up surveys included questions about whether the child or parent had received sun-safety information, participated in Pool Cool activities, and received incentive items. Analysis of these items from the SP pool sites (n = 446 parents and children) and a comparison of incentive-item distribution versus reported receipt suggested that many respondents were not fully exposed to the intervention. This appeared most likely due to the repeated cross-sectional design, which meant that some children began attending swimming lessons after some of the lessons and activities were carried out. To explore the impact of this on the study findings, we created a composite measure of the number of lessons and activities that the SP children received ($\alpha = 0.81$). As shown in Figure 1, there was an apparent dose–response effect on Sun Protection Habits for chil-

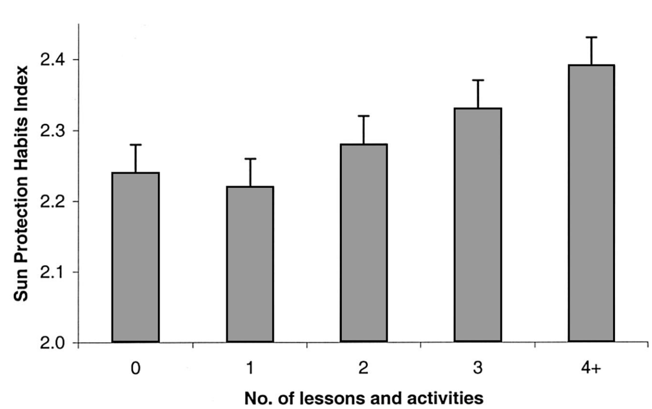

Figure 1. Dose–response and intervention effects on child sun-protection habits. Mean Sun Protection Habits index score (+*SE*) for pools in the sun protection group (n = 446).

dren receiving two or more lessons or activities compared with those whose parents reported that they received zero or one. We tested the "dose" variable for a linear trend, treating it as a continuous variable, and found a small yet significant trend, $F(1, 422) = 5.16$, $p < .05$. This analysis suggests that Sun Protection Habits scores were somewhat higher among the most involved respondents than for the least involved respondents.

Changes in sun-safety environment and observed lifeguard sun protection. Observation data revealed that pools in the SP trial arm had greater improvements in availability of sunscreen, posting of sun-safety signs, and lifeguard shirt use (see Table 5 and Figure 2). There were no significant differences between treatment groups in the presence of shade areas around the pool or in lifeguard hat use across the three observation points. Shade areas were common at many of the pools but were less changeable because our measure was dichotomous and because many pools had shade from permanent structures or trees.

Site differences in outcomes. The findings reported above are based on the combined data from study sites in both Hawaii and Massachusetts. We completed parallel analyses for the two study sites and found no significant differences in effects by site. However, these analyses have limited statistical power, because the trial was powered for the total sample.

Process evaluation and implementation. We analyzed monitoring form data ($n = 615$ forms) to ascertain the delivery of both the SP and IP interventions at participating pools. Seventy-six percent of the aquatics instructors reported teaching the lessons, and 61.9% said they taught the majority of the lessons (five or more). Monitoring forms indicated that the average length of time per SP or IP lesson was 5 to 6 min, that about 40% of the children were "interested" or "very interested," and that more of the IP lessons had parents present than did SP lessons (48% vs. 10%).

Table 5
Observational Findings of Changes in Sun-Safety Environments and Lifeguard Sun Protection (n = 28 Pools)

Observation	Time 1	Time 2	Time 3
Sun-safety environment			
Sunscreen available (% yes)			
SP	46.7	60.0	85.7*
IP	45.5	27.3	41.7
Sun-safety signs (% yes)			
SP	0.0	80.0	85.7**
IP	0.0	18.2	16.7
Shade structures/shade areas (% yes)			
SP	66.7	86.7	85.7
IP	90.9	81.8	83.3
Observed lifeguard sun protection			
Hat use (% yes)			
SP	71.4	64.3	78.6
IP	63.6	63.6	66.7
Shirt use (% yes)			
SP	93.3	100.0	100.0**
IP	100.0	54.6	83.3

Note. Significance is based on comparisons of trends over time, between groups, by chi-square tests. SP = sun protection group; IP = injury prevention group (control).
* $p < .05$. ** $p < .01$.

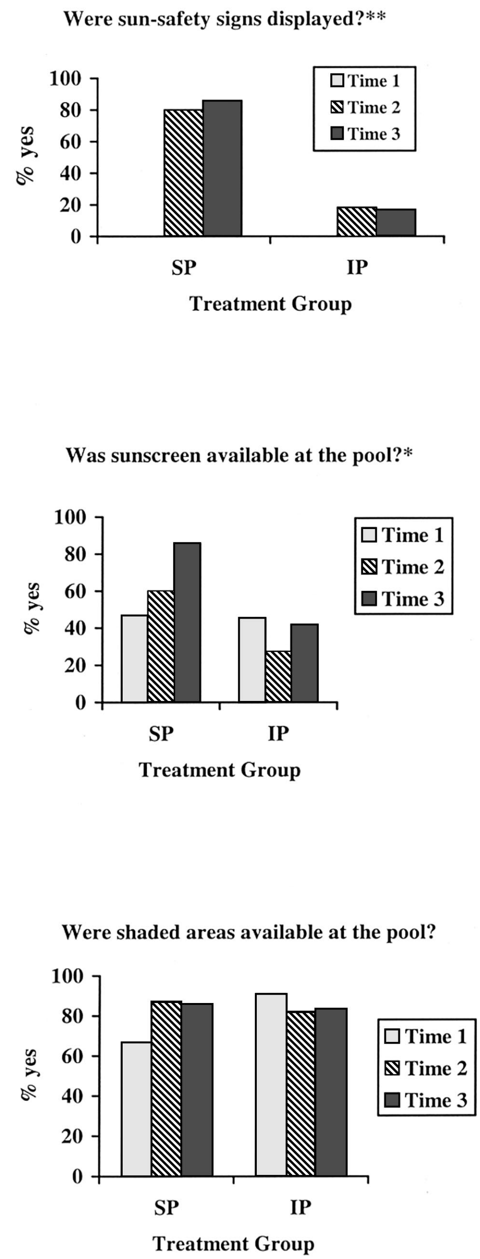

Figure 2. Observational findings of changes in sun-safety environments at swimming pools ($n = 28$ pools). Asterisks indicate a significant group difference controlling for time of observation. SP = sun protection; IP = injury prevention. * $p < .05$. ** $p < .01$.

About two-thirds of parents reported receiving SP or IP information, and 57% said their pool taught these health topics in swimming lessons, though activity participation was reported at a fairly low level (see *Dose–response analysis* above). These data indicate that the SP program was successfully implemented and well received in swimming pools, as was the parallel IP control program.

To evaluate contamination as well as social desirability bias, we included "sham" items in the sections of the postintervention survey that asked about receiving incentives that were provided to the other study arm (SP or IP) or to neither study arm. (The IP pools received incentive items unrelated to sun protection during the intervention, such as bike helmets and reflectors, lanyards, and health coloring books.) Between 6% and 7% of respondents at SP pools and at IP pools indicated that they had "received" those items—the same proportion that answered affirmatively to the items provided at none of the pools. This suggested negligible contamination and a slight "yea-saying" tendency.

Discussion

This is the first report of a controlled trial of a skin cancer prevention intervention in aquatics settings that includes both educational and environmental strategies and tests these strategies in a large number of swimming pools in diverse populations and geographic locations. The Pool Cool SP program resulted in statistically significant improvements in children's sunscreen use, shade seeking, and total sun-protection habits, compared with a control program, and in reduced sunburns in fair-skinned children. There was a dose–response effect that linked exposure to Pool Cool lessons and activities to larger program effects and that was consistent with the main outcome analysis of intervention impact. Parents' sunscreen use, hat wearing, and total sun-protection habits were also improved.

It is of particular importance that pool sun-protection policies and environments improved substantially in the SP arm of the trial. The survey reports were corroborated by independent observations that showed significant environmental and normative improvements in sunscreen availability, sun-safety signage, and lifeguards' wearing hats. The effects were seen in both Hawaii and Massachusetts, two disparate ethnic and climatic locations.

We found that most behavioral variables were lower in the control group at follow-up than at baseline. This phenomenon was not seen in an earlier randomized trial in recreation settings (Glanz et al., 2000), which used a cohort design. We speculate that a seasonal effect occurred, wherein people became less vigilant in the later summer when they were less likely to get sunburned. This decrease in sun-protection behaviors may be offset by a testing effect in cohort studies, as appeared to be the case on the basis of an extensive review of the intervention literature on reducing UVR exposure (Glanz et al., in press). Another possible explanation is that the respondents to the follow-up surveys had different behaviors than those who answered the baseline surveys. We are also unable to fully explain why sunscreen availability and shirt use were reduced at Time 2 in the IP group (Table 5 and Figure 2). It is possible that some pools ran out of sunscreen and replenished their supplies by the Time 3 observations. It is harder to explain the lower levels of shirt use; we surmise that this practice may be subject to a great deal of random variation in the absence of a sun-safety intervention.

The intervention effects found for Pool Cool were similar to those found in the Hawaii SunSmart trial, which was conducted in outdoor recreation settings (Glanz et al., 2000). The effect sizes were small for individual behaviors and sunburn reduction and medium for pool sun-protection policies. It is open to debate whether these observed changes are clinically significant. We contend that small changes across a large population may produce shifts in risk or protective behavior that, if sustained over time, can have a substantial disease-prevention effect (Prentice & Miller, 1992; Rosenthal, 1990). If the intervention had been intensive and conducted at a high per-person cost, such effects might be considered impractical, but the Pool Cool intervention is inexpensive and easily exportable. Because it was not effective in promoting greater use of shirts, hats, and sunglasses, intervention components related to these behaviors probably warrant greater emphasis in future dissemination of the intervention.

Compared with the two other swimming pool skin cancer prevention studies reported to date (Lombard et al., 1991; Mayer, Slymen, et al., 1997), the Pool Cool trial was both much larger and more comprehensive. It was far less intensive than Lombard et al.'s (1991) behavioral intervention and produced smaller effects, but that study had no control group and was probably too demanding to be practical for wide dissemination. To our knowledge, it has not been replicated or disseminated elsewhere. The SUNWISE trial did not include environmental change strategies but did include physical assessments of children's sun exposure using a colorimeter (Mayer, Slymen, et al., 1997). Its results were more modest than those found in this study, a cohort design was used, and the sample was much smaller than in this trial, possibly because of the subject burden imposed by the physical measurements.

Limitations

Limitations of the study include its short intervention time frame (one summer season), the lack of longer term follow-up, the repeated cross-sectional design, and reliance on brief self-report measures. Using parents' reports on behalf of their children presents an additional limitation, though this is common in the skin cancer prevention literature (Mayer, Sallis, et al., 1997; Whiteman & Green, 1997) and likely to provide more accurate data on a large sample than self-report from children ages 10 and younger. Although key outcome measures relied on parents' self-reports, the use of observational measures partially offsets this limitation with respect to structural and environmental outcomes. Given the constraints of the field setting, our response rates were excellent.

It is possible that weather conditions at the time of the surveys might have been modifiers of responses, though the emphasis on habitual behaviors (rather than behaviors on a given day) makes this a lesser concern. It was not possible to conduct definitive analyses of whether the intervention effects differed in the two geographic study sites because of insufficient statistical power, because the cost of powering the study for each geographical site would have been prohibitive. Finally, and importantly, the SP intervention was a multicomponent program, and the two-arm trial design makes it impossible to separate out the effects of different parts of the intervention.

Conclusion

Preventive practices may reduce morbidity and mortality from skin cancer for people of all ages, though the greatest potential for benefit is for children, people in tropical and sunny climates, and in settings where people are minimally clothed with little access to shaded areas. Strengths of the Pool Cool trial include the two geographical locations, a large sample, ethnic diversity of participants, and the demonstrated feasibility and acceptability of this cancer prevention program in a variety of aquatics settings. Self-report behavioral and policy data were corroborated by reports of sunburns and observational data, and process evaluation and dose–response analysis provide for a richer interpretation of the findings.

Although the ideal interventions for reducing exposure to UVR are coordinated, sustained, community-wide approaches (Dietrich, Olson, Sox, Tosteson, & Grant-Petersson, 2000; Glanz et al., in press; Montague, Borland, & Sinclair, 2001), interventions in particularly relevant organizational settings such as swimming pools are important elements of skin cancer prevention. To date, there have been few rigorously tested skin cancer prevention interventions for children and even fewer conducted in outdoor settings where children are most exposed to ultraviolet radiation. Most importantly, there is a need for programs that are low cost, adaptable to various climates and ethnic groups, and widely disseminated. Future research needs to examine the longer term impact of these interventions over longer periods and, ideally, multiple years; use cohort designs in large samples and many sites; and evaluate strategies for diffusion of successful program models. The findings reported here add to the understanding of interventions that can produce a significant impact on skin cancer prevention behaviors.

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