

Diffusion of an Effective Skin Cancer Prevention Program: Design, Theoretical Foundations, and First-Year Implementation

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This article describes the design and theoretical foundations of the Pool Cool Diffusion Trial and reports 1st-year findings. Aims of the study are to evaluate the effects of 2 strategies for diffusion of the Pool Cool sun safety program on implementation, maintenance, and sustainability; improvements in environmental supports for sun safety in swimming pools; and sun protection habits and sunburn among participating children. There was a high rate of program participation (86.6%; $n = 375$ swimming pools) in the 1st year and somewhat lower study participation (75.8%). Analysis of pool manager surveys revealed a time effect for overall sun safety programs and for sun safety policies, environmental strategies, and programs for pool users. There were few differences in implementation between treatment groups in year one.

Keywords: skin cancer prevention, sun protection, diffusion, aquatics, melanoma

Effective cancer prevention programs will have little impact if they are not used beyond testing in controlled trials (Hiatt & Rimer, 1999). To improve the public’s health, evidence-based interventions must be disseminated. We need not only dissemination of well-researched interventions but real-world diffusion studies to help us learn about their exportability and effectiveness in less controlled conditions (Rimer, Glanz, & Rasband, 2001). Dissemination is the step in intervention development that has received the least attention and resources (Schwartz & Baer, 1991). Far too often, evidence-based interventions languish for lack of a distribution system or linkage system (Monahan & Scheirer, 1988; Rimer et al., 2001). Also, without special efforts, most health promotion programs will not continue in the organizations where they were tested or in new settings (Patterson et al., 1998; Thompson, Lichtenstein, Corbett, Nettekoven, & Feng, 2000). Partnerships between researchers and practitioners are essential to achiev-

ing the ultimate goals of interventions: improved health behaviors and health status.

Skin cancer, the most common form of cancer in the United States, is increasing (American Cancer Society, 2004; Jemal, Devesa, Fears, & Hartge, 2000), and childhood exposure to the sun’s ultraviolet rays increases the risk for skin cancer later in life (Gallagher, 1997). Most skin cancers can be prevented by reducing sun exposure: seeking shade, using sunscreen properly, and wearing protective hats and clothing (American Cancer Society, 2004). Prevention programs for children in outdoor aquatic settings may influence youth, their parents, and swimming pool environments. They can achieve significant public health benefits if they are widely disseminated and successfully adopted, maintained, and continued (Saraiya et al., 2003).

The Pool Cool skin cancer prevention program is a multicomponent educational and environmental intervention that was systematically developed, pilot tested, and evaluated in a randomized trial at 28 swimming pools in Hawaii and Massachusetts. The Pool Cool program had significant positive effects on children’s sun protection behaviors and on sun safety environments at swimming pools (Glanz, Geller, Shigaki, Maddock, & Isnec, 2002) and reduced sunburns among lifeguards/aquatic instructors (Geller et al., 2001) in two ethnically and geographically distinct audiences. A pilot dissemination project at 186 pools in the United States and Canada, in 2000, demonstrated the acceptability and feasibility of implementing Pool Cool in diverse settings. In the summer of 2001, 282 pools participated in continued dissemination, including 113 that had also taken part in Pool Cool during the summer of 2000 (Glanz, Isnec, Geller, & Spangler, 2002).

In 2003, the National Cancer Institute provided funding for the Pool Cool Diffusion Trial. The aims of this study are to evaluate the effects of two strategies for diffusion of the Pool Cool skin

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cancer prevention program on (a) program implementation, maintenance, and sustainability; (b) improvements in organizational and environmental supports for sun protection at swimming pools; and (c) sun protection habits and sunburns among children. A key ancillary aim was to examine organizational predictors of Pool Cool program implementation, maintenance, and sustainability at the swimming pools.

This article describes the design and theoretical foundations for the Pool Cool Diffusion Trial and reports 1st-year findings from pool manager surveys. We examine changes in pools' provision of general sun safety programs and sun safe policy as well as changes in environmental and program strategies for pool users, and we assess the comparability of treatment groups in the trial for 1st-year Pool Cool implementation.

Method

Overview

The Pool Cool Diffusion Trial uses a three-level nested experimental design across 3 years of intervention (see Figure 1). The three levels are field coordinators, swimming pools, and children ages 5–10 in swimming lessons. The study design requires at least 32 field coordinators from metropolitan regions across the United States—each responsible for a cluster of pools—to be randomized into basic and enhanced (reinforcement plus feedback) diffusion conditions. The intervention is continuing for 3 years. Each field coordinator is working with between 4 and 15 pools per year for 3 years ($n = 320$ pools, final sample). A sample of 20 parents per pool is being surveyed about their children at baseline and at the end of each summer ($n = 6,400$, final sample); a cohort subsample will be followed over multiple years. The main outcomes of interest are pool-level

diffusion endpoints of implementation, maintenance, and sustainability across successive years; organizational–environmental change at pools; and child sun protection habits and sunburns. Process evaluation will supplement outcome data and provide observational corroboration of self-reported behavioral and pool environment data.

Theoretical Foundations

This study is grounded in theories of individual and organizational–environmental change and in diffusion of innovative health programs in organizations. We draw on social–cognitive theory (Bandura, 1986), diffusion of innovations applied to health promotion (Monahan & Scheirer, 1988; Orlandi, Landers, Weston, & Haley, 1990; Rogers, 1995, 2003), and theories of organizational change (Steckler, Goodman, & Kegler, 2002). These models are complementary, and there is considerable overlap among them (Bandura, 1986; Glanz, 2002). Our intent is not to test a single model but to apply the most promising constructs from these models to the problem of skin cancer prevention and program diffusion in aquatic settings. Table 1 shows key constructs used from each of the three theories, definitions, the application of the constructs in this study, and examples of related measures.

Social–cognitive theory (SCT) explains human behavior in terms of a three-way, dynamic, reciprocal model in which personal factors, environmental influences, and behavior continually interact. SCT synthesizes concepts and processes from cognitive, behavioristic, and emotional models of behavior change (Bandura, 1986). Although SCT includes many constructs, several of the most important are pertinent to this study: (a) reciprocal determinism, (b) behavioral capability, (c) observational learning, and (d) reinforcement. In this study, SCT assumptions are the basis for the Pool Cool program model, which aims to influence individual children, caregivers (lifeguards/aquatic instructors and parents), and swimming pool environments, and for the enhanced diffusion strategy.

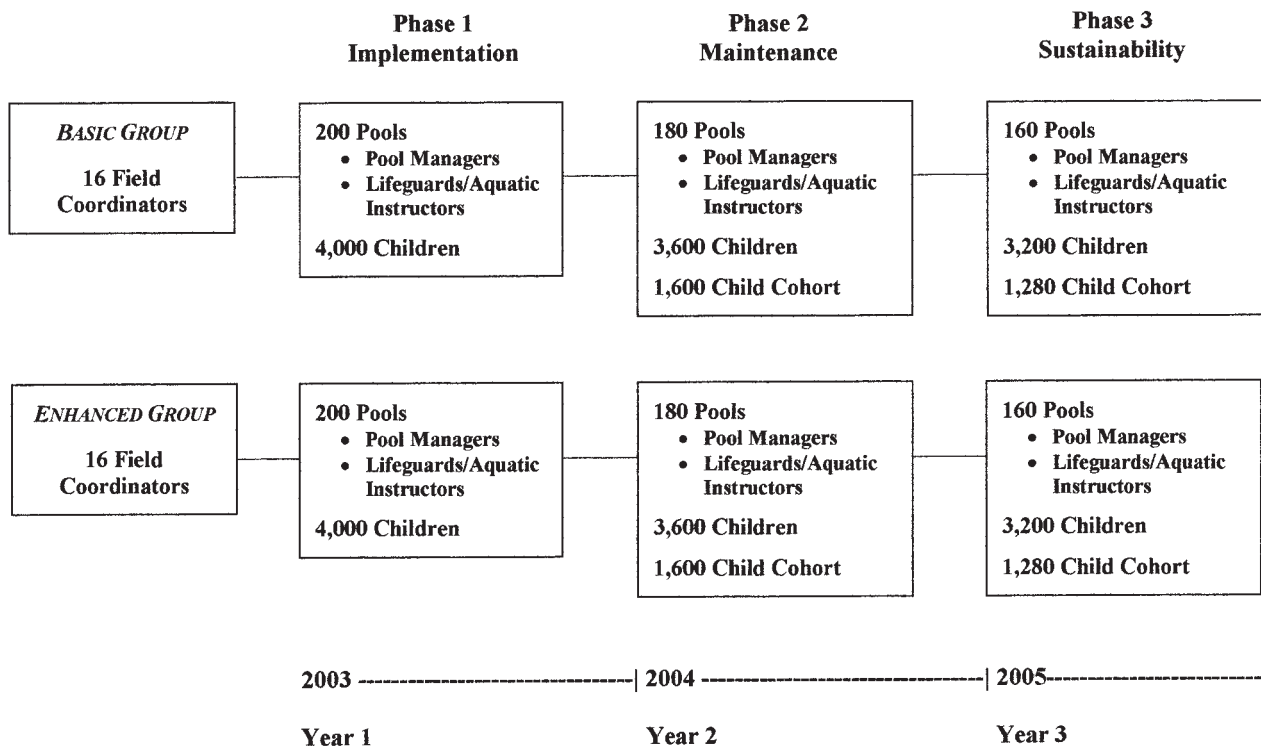


Figure 1. Pool Cool Diffusion Trial study design.

Table 1
Theoretical Foundations, Application of Constructs, and Examples of Related Measures

Construct and definition	Application of construct	Examples of related measures
Social-cognitive theory		
Reciprocal determinism Changes result from interactions of people and environments	Educational and environmental strategies Pool Cool lessons and activities Training for lifeguards/AIs	Educational activities (PM survey) Policy, environmental supports (PM survey) Implementation of lessons and trainings (PM survey)
Behavioral capability Knowledge and skills for action	Enhanced treatment group: Diffusion strategies, including feedback and incentive system	Impact on child sun protection (parent surveys)
Reinforcement Response to behavior that increase or decrease changes of recurrence		Process evaluation, FC logs, program records of incentive points
Diffusion of innovations		
Linkage system Organizational support for diffusion	National Recreation and Park Association (national partners)	Process evaluation tools: FC training evaluations, FC logs, study center logs of events
Linkage agents Individuals who disseminate the program to adopting organizations	FCs Use of Pool Cool program components at pools	Program implementation measure (PM survey) = main organizational outcome Year 1 Maintenance measure (PM survey) = main organizational outcome Year 2
Implementation Putting program strategies in action	Continued use of Pool Cool program at pools	Sustainability Index (PM survey) = main organizational outcome Year 3
Maintenance Continuing program strategies	Capacity to continue Pool Cool program after formal study period	
Sustainability Program used over longer time		
Theories of organizational change		
Implementation strategies Methods to increase organizational adoption of program	Skill training, modeling, reinforcement, persuasion	Process evaluation FC logs
Enhanced strategies for maintenance and sustainability Intervention to improve diffusion	Problem solving, reinforcement, support, community linkage systems	Process evaluation FC and staff logs
Organizational predictors of implementation, maintenance, and sustainability	Organizational (pool) characteristics Environmental supports and barriers	Sustainability Index (PM survey) Location, pool usage, staff size, and turnover (PM survey)
Systems for sustainability Strategies and relationships to ensure sustainability	Community-wide acceptance Collaborative relationships	Parent agency support for activities, financial resources (PM survey) Sustainability Index (PM survey) Process evaluation: site visits and interviews

Note. PM = pool manager; AI = aquatic instructor; FC = field coordinator.

Diffusion of innovations is a conceptual framework for understanding the spread and adoption of innovative ideas and practices in populations (Rogers, 2003). It concerns attributes of the innovation (intervention), characteristics of adopters, and communication channels. When applied to health behavior interventions, there are three main stages in program use: adoption (including awareness and decision); implementation (use); and maintenance and institutionalization, or sustainability (Bartholomew, Parcel, Kok, & Gottlieb, 2000; Green & Johnson, 1996). Also, in a departure from classic diffusion theory, applications to health programs emphasize the importance of a linkage system to enable the development of user-relevant health education programs and to influence the success of the diffusion process (Monahan & Scheirer, 1988; Orlandi et al., 1990). In this study, diffusion theory is operationalized across the study design, intervention, and measures. For pools that agree to participate in the study, the recruitment and informed consent process indicate their adoption decision. The design then focuses on assessing three sequential diffusion outcomes: implementation, maintenance, and sustainability of the Pool Cool skin cancer prevention program. The intervention emphasizes the involvement of a linkage system (the National Recreation and Park Association) and linkage agents (field coordinators). It further emphasizes continual updating or "reinvention" of the intervention in the enhanced study arm, to keep the program interesting and effective over time and to encourage maintenance of the intervention (Bartholomew et al., 2000; Rogers, 1995).

Theories of organizational change complement diffusion of innovations and SCT as a basis for improving and measuring the diffusion of Pool Cool (Steckler et al., 2002). Stage theory and organizational development theory propose that different strategies are needed at various stages. Interorganizational relations theory emphasizes how organizations work together (Steckler et al., 2002) and is germane to the sustainability phase of the study. Organizational development theory is the basis for studywide strategies for the implementation stage and for enhanced strategies for maintenance and sustainability (Steckler, Goodman, McLeroy, Davis, & Koch, 1992).

Participants

The study is being conducted at swimming pools in communities in metropolitan regions across the United States. There are four types of populations in this study: swimming pools and parents with their children are units of outcome measurement, and field coordinators and lifeguards/aquatic instructors are key linkage agents and potential mediators of program effects. *Swimming pools* are the main organization-level unit of study and the unit of measurement for organization-level diffusion outcomes. *Children* aged 5–10 taking swimming lessons at participating pools are the primary audience for the Pool Cool intervention. Their *parents* (or caretakers) are a secondary audience for the skin cancer prevention pro-

gram and are proxy informants for children's characteristics and behaviors. *Field coordinators* are the linkage agents, and the clusters of pools affiliated with each field coordinator are the main unit of randomization and intervention for the diffusion trial. *Lifeguards/aquatic instructors* participate in delivering the Pool Cool intervention to children in swimming lessons and are considered potential mediators of program effects on children.

The target sample size for the study is based on the need to ensure adequate statistical power to detect differences between the study arms both at the pool level and for primary sun protection behavior outcomes among children at the swimming pools (Cohen, 1988). Because of the nested study design, power calculations also included a term for the field coordinator effect, even though the main outcomes are at the pool (organization) and child (individual) levels. Thus, the accrual goal for the 1st year was to include at least 32 field coordinators and 400 pools, with a total of approximately 4,000 lifeguards/aquatic instructors and 8,000 parents and children to be surveyed in each of the 3 study years (see Figure 1). If we assume an estimated 20% attrition over the duration of the study, this sample size is sufficient to detect differences in pool-level diffusion endpoints and in child sun protection habits and sunburns.

Web sites, magazine "advertorials," mailings, and conference displays were used to recruit field coordinators and swimming pools for the study. They were recruited in cooperation with the National Recreation and Park Association (www.nrpa.org), whose members include aquatics professionals who manage thousands of swimming pools across the United States and Canada. Interested persons completed a Web-based or paper application form to sign up for the study.

Field coordinators are experienced aquatics/recreation professionals who complete a training program on skin cancer prevention and the Pool Cool program. Each field coordinator is responsible for delivering the program materials, demonstrating the key program components in a lifeguard/aquatic instructor training program, and assisting the study team with data collection for his or her region. Eligible swimming pools are those outdoor pools that offer swimming lessons to children aged 5–10, are interested in the Pool Cool skin cancer prevention program, are willing to commit to the 3-year study, and are in a region that has enough pools and an available field coordinator. We excluded from the diffusion trial 10 pools that took part in both the efficacy trial and the dissemination pilot study, but we allowed pools where the program was conducted in 2000–2002 to take part. This was done to sustain good will with the pools; it was not considered a large threat to validity because the intervention was low intensity and there was no structured research design during those years.

Groups of pools were randomized after enough pools and field coordinators associated with each group of pools had been identified. The assignment of pools to field coordinators occurred prior to randomization of field coordinators to study conditions. Randomization was expected to produce study groups that were comparable with respect to confounding variables. However, because of the relatively small number of field coordinators, we defined groups for a stratified randomization scheme on the basis of pool size (measured by number of lifeguard staff) and latitude (north central vs. south and tropical). A computer-randomization program was used to assign the clusters of pools to two equal groups.

Materials

There are two treatment groups in the trial: basic and enhanced. Differences between the basic and enhanced diffusion strategies occur at both the level of field coordinator and the level of swimming pool. Both groups received all the main components of the Pool Cool Diffusion Trial intervention. The extra strategies for the enhanced group are described below.

There are two main components of the Pool Cool diffusion trial intervention: (a) the field coordinator training program and (b) the Pool Cool skin cancer prevention program provided at swimming pools. Because

clusters of pools were not randomized to study arms until after the field coordinators had completed the 1st-year training program, the same training program was provided to all field coordinators in Year 1. The training program was conducted in four locations around the country, to accommodate geographically dispersed participants. The training combined lecture, discussion, and interactive activities and was organized around the "3 D's" required for effective field coordinator performance: *demonstrate*, *deliver*, and *document*. Topics covered included skin cancer and skin cancer prevention, using the components of Pool Cool, methods for training pool staff, fieldwork procedures, and evaluation activities. At the swimming pool level, key program components are the lifeguard/aquatic instructor training and leader's guide, educational strategies (sun safety lessons, poolside activities, incentives for activities), and environmental and policy components (decision maker's guide, sunscreen tips poster and sun signs, large pump container of sunscreen; Glanz, Geller, et al., 2002).

The enhanced group pool sites receive the standard intervention components plus additional sun safety resources (incentives) for distribution, as well as more ready-made environmental intervention resources than the basic sites, including a set of sun signs. The field coordinators whose pools were randomized to the enhanced treatment group worked with the study team through the 1st year to devise additional motivational and reinforcing strategies for Pool Cool. This effort occurred via conference calls, e-mails, and phone contacts and led to development of a kit entitled "How to Make Pool Cool Programming More Effective," to be distributed to field coordinators and pool managers in Years 2 and 3 of the trial. The kit includes strategies for maintaining interest in the program, adding creative enhancements, and ordering additional sun safety resource items at no cost or at substantial discounts. It also includes rules and tools for attaining levels of special recognition (a bronze, silver, or gold sun-safe pool award) and a "frequent applier program" in which both pools and field coordinators can earn incentive points and prizes based on achievements at their swimming pool sites. For example, they can earn points for adopting new sun safety policies; installing extra environmental supports, such as shade structures; securing local media coverage for the program; submitting photos to a centralized photo contest; and obtaining supporting resources from local organizations. Each action or change requires verification by documentation that can be sent to the research office or confirmed by the field coordinator's report. To avoid contamination between the basic and enhanced groups, we provided separate refresher trainings, conference calls, and e-newsletters for field coordinators in each study arm after the 1st year of the trial.

Procedures

Data collection and measures. There are three main sources of data at the organization level and two types at the individual level. General swimming pool information is first collected on the application form, in either paper or Web-based format. A self-administered *pool manager survey* is completed by the pool manager or designated key informant at the time of the other baseline surveys and again at the time of follow-up during each summer. These surveys include the pool-level measures of implementation, maintenance, and sustainability (Goodman, McLeroy, Steckler, & Hoyle, 1993; Steckler et al., 1992) in each successive year (see Figure 1) and measures of organizational and environmental supports for sun protection at the swimming pools. Observations are being conducted by independent observers at a 10% sample of pools late in the summer during each of the three intervention years, to corroborate (i.e., validate) pool managers' reports of program implementation, maintenance, and sustainability.

Individual-level data sources include the *lifeguard/aquatic instructor surveys* and the *parent surveys*. During each study phase (i.e., each summer), these surveys are completed by self-administration at the pools at baseline. Baseline surveys for lifeguards/aquatic instructors are completed before the Pool Cool training session begins. Parent surveys are collected

when parents register their children for swimming lessons, following a standardized protocol. Lifeguard/aquatic instructor follow-up surveys are self-administered at the end of the summer season, and parent follow-up surveys are collected by phone or Internet. Other data sources, used for process evaluation, include site visit interviews and observations, telephone interviews, field coordinator and study center logs, and project monitoring records.

This study uses measures developed for our earlier studies of skin cancer prevention, including the Pool Cool efficacy trial (Glanz, Geller, et al., 2002; Glanz, Isneec, et al., 2002). Several examples of the measures and their theoretical bases are shown in Table 1. Here we describe only those measures reported in this article, that is, the data from application forms and pool manager surveys.

Data from the application forms are available in a database that is linked to the pool manager survey data. Variables of interest include the number of children taking lessons, geographic location (north vs. south latitude), and field coordinator assignment and treatment group.

Pool manager surveys solicit additional organizational characteristics, including workforce stability and turnover, extent of special events and activities, and recreation department (or parent agency) support for pool-sponsored activities. Data are also collected about the pool manager's demographic characteristics, length of tenure at the pool, skin cancer risk factors (Glanz et al., 2003), sunburns last or this summer, and skin self-examination behavior.

Environmental and organizational strategies for sun protection are assessed at both baseline and follow-up. These variables are assessed with scales developed in a national study, the Survey of the Recreation Industry on Sun Safety (Glanz, Spangler, Elliott, O'Connell, & Black, 2003). Two composite indicators of sun safety programs and policies also are used. The first is a three-item measure of how often the pool provides sun safety or skin cancer prevention programs or policies for lifeguards, programs or policies for swimmers, and educational activities in swimming lessons (labeled *Programs*). The second composite asks whether the pool has implemented 10 components of sun safety policies, environments, and programs for pool users (labeled *Policies*). In addition, at baseline the pool managers are asked to rate the importance of four supporting factors (health concern, risk management, community demand, and community relations) and four possible obstacles to sun safety strategies (budget, lack of information, pool facility design, and low priority).

For the 1st year, implementation was the main dependent variable that represented a pool-level diffusion endpoint. Implementation was assessed at the end of the summer and was measured by a series of items asking whether the main components of Pool Cool (described above) were used, and at what level. There were also two questions about optional pool-initiated activities, asking whether the pools had added shade structures or shaded areas and whether they had developed additional resources for sun safety programs. Other indicators of implementation (not reported here) were based on data from site visits and telephone interviews done for the process evaluation, on lifeguard and parent surveys, and on field coordinator logs.

Data processing and statistical analysis. Baseline surveys were received from 332 pool managers representing 311 pools, and 192 follow-up surveys were received from 182 pools. Because only one survey per pool would be included in these analyses (given that the pool is the level of analysis), 25 respondents' surveys were excluded on the basis of systematic determination of the most senior or responsible manager at each pool. Three criteria were used to exclude the extra surveys: a respondent having (a) shorter tenure or (b) fewer staff reports than another respondent from the same pool or (c) survey incompleteness (missing either baseline or follow-up). The final sample for the analyses reported here included 311 baseline and 182 follow-up surveys, with 170 respondents (54.7%) having complete baseline and follow-up data. The data file contained one record per survey, and a time variable was created to indicate baseline and follow-up administrations.

Some items with repeated measurements were recoded to improve comparability across survey occasions. The items asking about policies were worded to include existing policies as well as planning intentions and actions at baseline, as compared with actions only at follow-up.

After initial screening of the item descriptive statistics, composite scales were created using the mean of nonmissing items, when at least half of the scale items were answered. Coefficient alphas were then computed to assess the internal consistency of items designated a priori to be scales. The scale alphas were good to excellent, as follows: $\alpha = .68$ for Programs; $\alpha = .69$ for Policies; $\alpha = .79$ for Supporting Factors, and $\alpha = .62$ for Obstacles.

Attrition analysis was conducted using chi-square tests, Fisher's exact tests, and Wilcoxon rank-sums tests to compare the baseline responses of the 170 respondents who completed follow-up with the responses of the 141 who did not. The same methods and variables were also used for a randomization check of whether treatment groups differed at baseline with regard to their demographics, pool characteristics, and composite scale scores. In addition, *t* tests were conducted to test for differences between the baseline and follow-up respondents on the sun safety Programs and Policies scales. SAS statistical software was used for all data preparation and analyses.

Multiple regression models were used to assess treatment group and time effects on the Program and Policy scales, which were composite measures of general sun safety efforts at the pools. Treatment group, respondent gender, and prior Pool Cool implementation were used as covariates. SUDAAN software (Research Triangle Institute, 2002) was used to account for the correlated data resulting from the clustered study design (i.e., clustering by field coordinator) and repeated measurements. Variance estimation and robust standard errors were calculated using DESIGN = WR, which is similar to the generalized estimating equation approach of Liang and Zeger (Zeger, Liang, & Albert, 1988). The models were tested with treatment group, time, and Treatment Group \times Time interaction terms.

Results

Description of Participating Field Coordinators and Swimming Pools

For the 1st year of intervention of the Pool Cool Diffusion Trial, 43 field coordinators completed training and were randomized to the basic or enhanced study arms. Field coordinators came from 28 different metropolitan areas in all regions of the United States (see Figure 2), and each field coordinator was assigned from 4 to 15 pools. Eight regions, each with more than 15 pools, had more than one field coordinator, each of whom was matched with pools based on geographic clustering; each field coordinator's cluster of pools was randomized separately. Recruitment was ultimately a two-way, iterative process: If there were not enough pools signed up in a field coordinator applicant's region, the field coordinator helped identify and recruit pools. Alternatively, if several pools in a metropolitan area wanted to participate but no field coordinator was identified, the pool managers helped to find a suitable and willing field coordinator.

A total of 433 pools were enrolled nationally. Enrollment was defined as being signed up by a field coordinator and having intervention materials mailed out to the pool. The total number of field coordinators and pools enrolled exceeded the target sample size because of greater than expected interest and variation in the number of pools per region.

During the summer, the study team stayed in contact with participating field coordinators and pool contacts by e-mail, fax, mail, and biweekly conference calls. Fifty-eight pools, or 13.4% of

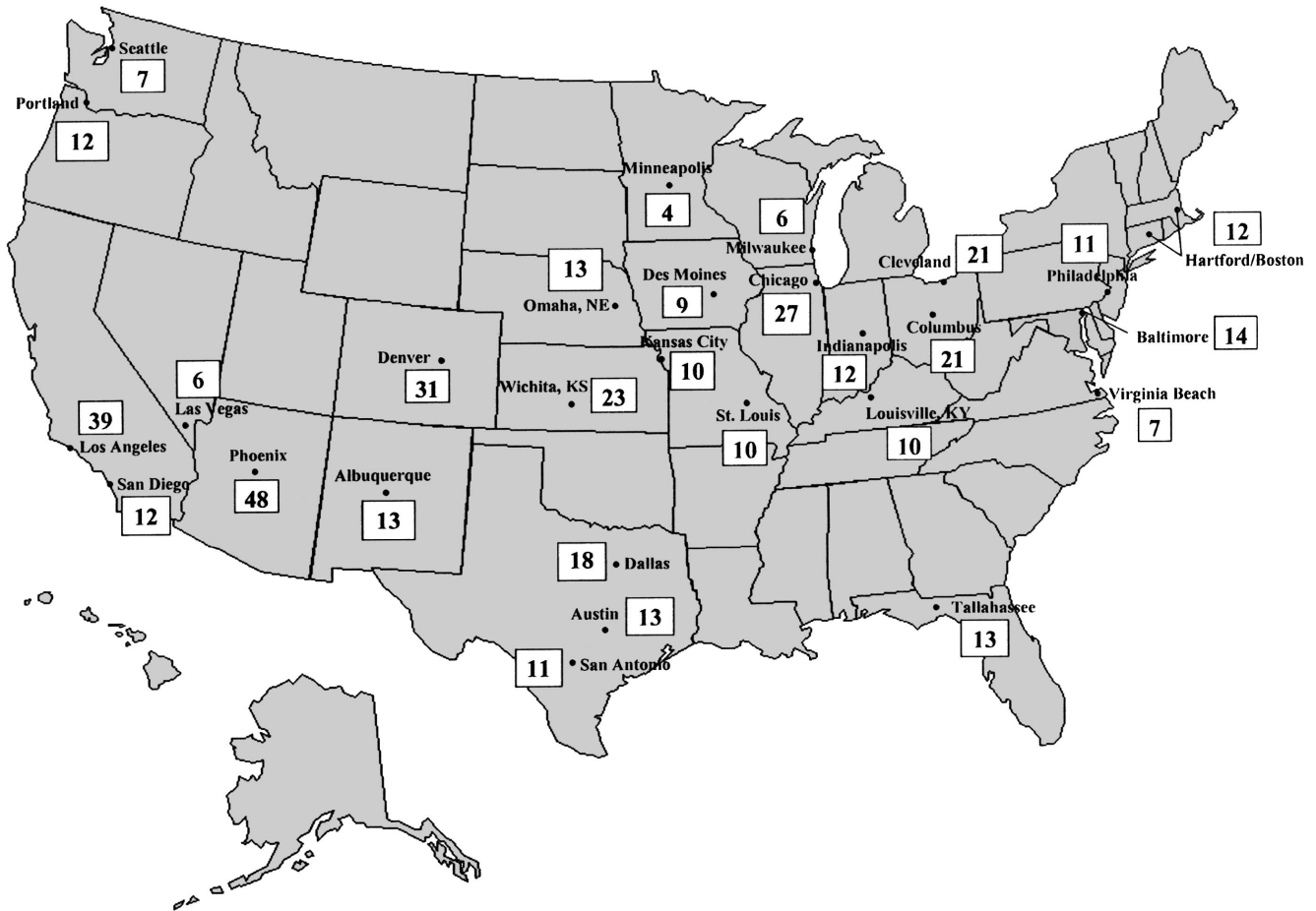


Figure 2. Pools and regions in the Pool Cool Diffusion Trial, 2003.

the total, dropped out or could not be reached by their field coordinators or the study team for a variety of reasons. The main reasons were changes in pool management (36%), lack of time to conduct lifeguard training owing to late receipt of materials (12%), staffing problems unrelated to Pool Cool (26%), and other issues, including maintenance, cancellation of swim lessons, and the need for Spanish-language surveys (7%). Thus, the program participation rate was 86.6%. In all, data from at least one type of survey were received from 328 pools in 39 field coordinators' regions, representing a 90.7% study participation rate for field coordinators and a 75.8% study participation rate among pools from enrollment to the end of the summer.

Characteristics of Pool Managers, Pools, Policies, and Programs

Pool managers at 311 pools, or 82.9% of participating pools, completed a baseline pool manager survey, and follow-up pool manager surveys were received from 182 pools, or 58.5% of pools that had completed a baseline survey. Table 2 shows the pool and pool manager characteristics for all baseline and follow-up respondents. Pool managers were predominantly female (about 59%), Caucasian (93%), and highly educated (about 53% had at least a

4-year college degree). Their mean age was in the early 30s but with a wide age range (16–73 years). About half were married, and just over one third reported having children. According to the composite skin cancer risk measure, about two thirds were at moderate or high risk for skin cancer, and over one third reported having had two or more sunburns the previous summer at baseline.

Pool locations were approximately equally divided between urban and suburban/rural locations, large and small communities (i.e., <100,000 residents), and north and south latitude. The majority of pools reported having 1,000 or more visitors each week and mostly seasonal staff. Most of the pool managers had held their jobs for 3 years or longer.

Concerning environmental and organizational strategies for sun protection, most pools reported relatively high baseline levels of general sun safety programs, which included programs and policies for lifeguards and swimmers ($M = 2.16 \pm 0.63$ on a scale of 1–3). Their reported levels of policies and program strategies for pool users were moderate ($M = 1.54 \pm 0.47$ on scale of 1–4). Supporting factors were rated as higher than obstacles at baseline (3.42 vs. 2.82 on scales of 1–4). An attrition analysis revealed only one significant difference on the variables shown in Table 2 between the 170 respondents who completed follow-up surveys

Table 2
Characteristics of Pool Managers, Pools, Policies, and Programs for All Baseline and Follow-Up Respondents

Characteristic	Baseline (<i>n</i> = 311) ^a	Follow-up (<i>n</i> = 182) ^a
Demographics		
Gender (% male)	40.8	42.2
Age: <i>M</i> (<i>SD</i>); range 16 to 73 years	32.1 (11.5)	32.1 (12.1)
Race (% Caucasian)	93.0	92.0
Education (% with 4-year college degree or more)	53.4	48.8
Marital status (% unmarried)	53.6	51.8
Has children (%)	35.4	36.9
Skin cancer risk ^b		
Moderate risk (%)	24.8	18.8
High risk (%)	44.0	46.1
Sunburns (baseline Summer 2002, follow-up Summer 2003)		
None (%)	28.5	41.1
1 sunburn (%)	34.0	32.2
2 or more sunburns (%)	37.5	26.7
Pool community		
Location (% suburban/rural)	53.5	51.5
Latitude (% north)	44.7	48.4
Size (% with fewer than 100,000 residents)	51.9	55.1
Weekly pool visitors (% with 1,000 or more)	57.4	60.0
Pool staff		
Aquatic staff (% with more than 10 FTE)	47.9	45.3
Seasonal (summer only) staff (% all)	69.0	66.9
Average staff tenure (% with 2 years or less)	48.2	49.1
Pool manager tenure (% with 3 or more years)	59.0	61.7
Environmental and organizational strategies for sun protection		
Sun safety and/or skin cancer programs: <i>M</i> (<i>SD</i>) ^c	2.16 (0.63)	2.55 (0.48)*
Policy, environmental, and program strategies for pool users: <i>M</i> (<i>SD</i>) ^d	1.54 (0.47)	2.29 (0.53)*
Supporting factors: <i>M</i> (<i>SD</i>) ^e	3.42 (0.55)	3.45 (0.55)
Potential obstacles: <i>M</i> (<i>SD</i>) ^e	2.82 (0.60)	2.85 (0.66)
Previously conducted Pool Cool (% yes)	13.0	11.3

^a Sample size for specific items varies; some background characteristics were assessed only at baseline. ^b Risk factors include eye color, natural hair color, severe sunburn in childhood, color of untanned skin, tanning tendency, and history of skin cancer; scores were grouped into approximate tertiles (see Glanz et al., 2003). Factors were not assessed at follow-up, so numbers shown reflect baseline responses of respondents who completed follow-up survey. FTE = full-time employees. ^c Range = 1 (*rarely or never*) to 3 (*often/usually/always*). ^d Range = 1 (*rarely or never*) to 4 (*usually/always*). ^e Range = 1 (*not at all important*) to 4 (*very important*). Ratings were not made at follow-up, so numbers shown reflect baseline responses of respondents who completed the follow-up survey.

* $p < .0001$ for *t* test.

and the 141 respondents who did not; pool managers who completed both surveys were less likely to have moderate skin cancer risk than those who completed the baseline only.

Baseline to Follow-Up Change in Sun Safety Programs and Policies

Simple *t* tests showed that the cross-section of pools at follow-up had significantly higher scores on sun-safety Program and Policy scales than those responding at baseline (see Table 2). Regression models of the cohort completing both surveys also showed significant increases in sun-safety Program and Policy scales from baseline to follow-up, with adjusted means indicating a 19.8% increase in overall programs, and a 52.3% increase in policies, environments, and programs for pool users (data not shown). The overall R^2 values for these models were .19 and .42, respectively. Gender of the pool manager and treatment group

were not significant in the models, but having previously conducted Pool Cool was significant for both outcomes. Sites that had conducted Pool Cool previously had adjusted mean scores for the Program and Policy scales that were about 20% higher than mean scores at sites where the program was new.

Treatment Group Differences in Implementation of Pool Cool

At baseline, few differences were found between the basic and enhanced treatment groups; the only significant difference was that pool managers at basic group pools were younger than those at enhanced group pools ($M = 30.3$ years vs. 34.13 years, $p < .01$). As shown in Table 3, at the time of follow-up, 97.7% of pool managers reported that Pool Cool had been conducted at their pools during the summer. They reported high rates of implementation for all key Pool Cool components, with specific key strat-

Table 3
Implementation Comparisons by Treatment Group

Item	Basic group (n = 99)	Enhanced group (n = 83)	p
Was Pool Cool program conducted this summer? (% yes)	97.9	97.5	ns
How often did your pool teach lessons? M (SD) ^a	3.06 (0.94)	2.94 (0.98)	.04
How often did instructors use the leader's guide? M (SD) ^a	2.77 (0.96)	2.67 (0.96)	ns
Did your pool . . . (% yes)			
Use mini big book?	88.8	86.4	ns
Conduct any poolside activities?	86.3	89.0	ns
Display sunscreen tips poster?	94.4	87.5	ns
Display aluminum sun safety signs? ^b	93.4	71.6	.001
Use sunscreen provided?	100.0	97.6	ns
Add shade structures or shaded areas? ^c	34.3	28.9	ns
Develop additional resources? ^c	7.1	11.3	ns

^a Range = 1 (*rarely or never*) to 4 (*usually/always*). ^b A set of sun signs was provided for each pool in the enhanced group; however, basic group pools could have signs from previous years of Pool Cool or could produce them from the zip disk provided to all pools. ^c These were not key components of Pool Cool but were optional pool-initiated activities.

egies reported between 71.6% and 100% of the time. Two optional activities, adding shade structures and developing additional resources, were reported much less frequently. There were significant differences between treatment groups in reported frequency of teaching the sun safety lessons and in display of sun safety signs. These findings were the opposite of what might have been expected, although the magnitude of difference in teaching lessons was very small (0.12 on a 4-point scale, or one eighth of a standard deviation). For the signs, basic group pools received only a sunscreen tips poster, but enhanced group pools received both a sunscreen tips poster and a set of sun signs. However, the sunscreen tips poster is aluminum like the sun signs. Also, basic group pools could have made sun signs from the artwork provided on a zip disk, might have kept signs from previous summers of Pool Cool, or might have received sun safety signs from other cancer prevention or health promotion sources.

Discussion

The Pool Cool Diffusion Trial is an ambitious, comprehensive effort to study the process of diffusion and to compare two approaches to promoting dissemination of a cancer prevention program on a national scale. A large and complex study such as this presents challenges for planning, design, and execution. Here we summarize the 1st-year findings, discuss design and measurement considerations, and share lessons learned to date.

Participation and Response Rates

The 1st year's experience documents the successful completion of recruitment of linkage agents (field coordinators) and swimming pools according to the original targets. In fact, we exceeded the sample size targets; this reflected both the variability in the number of pools per field coordinator region and enthusiasm for the study. The 1-year dropout rate was modest; 86.6% of pools participated through the summer. Program participation was high, with nearly all pools (over 97%) implementing the skin cancer prevention program and most program elements being adopted at more than 80% of the pools.

Only 75.8% of enrolled pools provided data, so attrition was modest but still higher than the expected 20%. Study participation was uneven across various surveys (pool manager, lifeguard/aquatic instructor, and parent, as well as baseline vs. follow-up), reflecting the challenge of relying on geographically dispersed linkage agents (field coordinators) and pool staff for data collection. The most significant limitation encountered was the relatively poor response rate (58.5%) for follow-up pool manager surveys. Although attrition analysis revealed few systematic differences between nonresponders who had completed baseline surveys, this nevertheless represents a major caveat. In later years of the study, additional reminders and incentives will be used to ensure high follow-up response rates.

Program Implementation

We found that sun safety programs increased from baseline to follow-up at participating pools. Pools where the Pool Cool program was conducted in previous summers had higher levels of skin cancer prevention programming. This suggests an upward adoption curve that occurred concurrently with what we think of as "maintenance" in pools that had the program before. This may reflect the self-reinforcing nature of a good experience with the program, the effect of familiarity on easier implementation of the program, or higher levels of motivation of pools that have participated in the program and the research over multiple years.

Implementation of Pool Cool was found to be high among respondents to the follow-up pool manager surveys, but there was little difference between the diffusion trial treatment groups. There was limited time to implement the planned "enhanced" strategies with field coordinators in the treatment group. The seasonal nature of the swimming pool season, and therefore the intervention, did not allow enough time in Year 1 to complete recruitment, train field coordinators, collect data, obtain field coordinator input for enhanced strategies, and implement the enhancements.

Design Considerations

Numerous types of design decisions need to be made in planning diffusion research (Pentz, 2004). The design of this study

posed several challenges, given its aims to investigate not only program implementation, maintenance, and sustainability but also the efficacy of the Pool Cool intervention as implemented broadly. We chose to randomize clusters of pools at the level of field coordinators, even though there would have been more units of randomization and fewer levels of nesting had randomization been done at the swimming pool level (as in the efficacy trial). The alternative model would involve centralized national dissemination. Although feasible, this would likely be more expensive, less manageable, and less responsive to local needs than using regional field coordinators. The field coordinator approach is also more realistic and sustainable outside of the research context. The distribution of pools to field coordinators prior to randomization is a limitation of the design.

Another key design decision was not to have a true control group. Both basic and enhanced pools receive the standard Pool Cool program. This study design, in which the basic group approximates a “usual care” approach to program dissemination, is appropriate for a diffusion trial. Adding a measurement-only control group or delayed control group would provide a stronger design but at too high a cost to be practical.

Phases of the Study and Measurement Targets

The study design arbitrarily designates each of three phases—each year of intervention—as corresponding to successive program diffusion endpoints: implementation, maintenance, and sustainability. This is a logical sequence and is based on both theoretical and practical considerations, although we realize that some pools may move through these diffusion stages more rapidly. Following the design (see Figure 1), the organization-level measures (completed by the pool manager) include new items to assess maintenance in Phase 2 and sustainability in Phase 3. For the study as a whole, the principal diffusion endpoint is sustainability of the Pool Cool skin cancer prevention program at the end of 3 years. Sustainability will be assessed by an adaptation of Steckler et al.’s (1992) and Goodman et al.’s (1993) Sustainability Index. The second level outcome is sun protection habits and sunburn among the children, and the principal endpoint for this population will also be measured at the end of Phase 3. The main measurement targets for the study outcomes are the swimming pools (organization level) and the children (individual level).

There are two other important populations involved in the study: field coordinators and lifeguards/aquatic instructors. These groups are essential liaisons and potential role models. The field coordinators are responsible for delivering the diffusion intervention (basic or enhanced), and the lifeguards/aquatic instructors are responsible for teaching lessons, conducting poolside activities, and maintaining environmental and policy changes at their pools. We are collecting survey data from both field coordinators and lifeguards/aquatic instructors, and process evaluation data are being obtained from the field coordinators on an ongoing basis and from the lifeguards/aquatic instructors during site visits. This will enable us to evaluate the field coordinator clustering effect beyond including it as a random effect term in multilevel modeling analyses and to learn more about how lifeguards/aquatic instructors function as role models and leaders of Pool Cool to children at their pools, even though they are not the central measurement targets for trial outcomes.

Self-Report Data

The main outcome measures are self-report data from the pool managers and parents’ reports of children’s sun protection habits and sunburns. It is necessary to use self-report because of the difficulty and expense of conducting observations at all pool sites in the study and the impracticality of conducting physical measures of sun exposure or protection for the thousands of children in the study. However, we realize that reliance on self-report alone may result in reporting bias. Thus, we are collecting observational data at 10% of pools and telephone interviews with another 20% of pools each year through an independent process evaluation (separate from the main study coordination). Conducting pool site observations at a single point in time also has limitations, however, due to the weather, timing of program activities, and other factors (e.g., the large pump container of sunscreen may have run out). We are seeking funding to conduct a validation study of children’s behaviors using newly available technologies, including polysulphone dosimeters (to assess sun exposure; O’Riordan, Stanton, Eyeson-Annan, Gies, & Roy, 2000) and skin swabbing (to assess sunscreen use; Whiteman et al., 2003). Finally, we will be able to triangulate data about pool-level changes and program adoption on the basis of data from pool manager surveys, observations, telephone interviews, field coordinator logs, and study records. Our previous research suggests that the multiple data sources converge relatively well, but if large discrepancies are found, we will follow up to learn more about what happened.

Diffusion Research and the Consequences of Innovations

According to Everett Rogers’s descriptions of the research tradition of diffusion research in social sciences, there are eight main types of diffusion research, which are predominantly observational and aimed at studying topics such as rates of adoption of innovations, opinion leadership, and communication channel usage (Rogers, 2003). Field experiments, a design approach that helps overcome the limitation of not being able to evaluate causality, are important but less common in the broad tradition of diffusion research. In health behavior and health promotion research, intervention studies of diffusion (i.e., diffusion trials) are the preferred way to study the adoption of evidence-based interventions (Oldenburg & Parcel, 2002; Orlandi et al., 1990). The Pool Cool Diffusion Trial is rooted in diffusion concepts and theory (see, e.g., Table 1) and is distinct from the efficacy trial completed prior to developing the program for wider dissemination (Glanz, Geller, et al., 2002; Glanz, Isneec, et al., 2002). However, it was also designed as a field experiment (randomized trial)—a type of design that is not unique to diffusion research. Though there is no widely acknowledged set of criteria for calling a study a “diffusion trial,” the evolution and methodology of this study clearly fit the tradition of diffusion research (Pentz, 2004).

An important feature of this study is that it was designed to evaluate not only the diffusion process and related organizational endpoints (pool-level implementation, maintenance, sustainability) but also the consequences of the innovation after diffusion (sun protection habits and sunburns in children). Although the Pool Cool program can have little effect if it is not adopted and distributed, the ultimate aim is to improve health. We believe, as Glasgow and others propose in the Reach, Efficacy, Adoption, Imple-

mentation, and Maintenance model (known as *RE-AIM*), that public health impact depends on adoption, implementation, and maintenance *as well as* reach and efficacy/effectiveness (Glasgow, Vogt, & Boles, 1999).

Challenges and Lessons Learned

There are enormous challenges in designing, conducting, and analyzing a study with the scope and complexity of the Pool Cool Diffusion Trial. At each stage of the research, we face decisions about balancing methodological rigor and practical constraints. This study would not have been possible without extensive preliminary research and pilot testing of intervention and data collection procedures. Because the main study period each year occurs during a season of about 6 months, there is much to do before and during spring and summer. Even so, there are always surprises and unanticipated bumps along the road. There is a tight time frame for confirming participation of field coordinators and pools, preparation and distribution of materials and surveys, and problem solving along the way. Sometimes shipments of support materials such as sunscreen and ultraviolet-sensitive cards for poolside activities have been delayed. Defective water bottles have had to be returned to the manufacturer and replaced after the pools received them. Data collection challenges abound.

Communication is a critical challenge. The study center needs to maintain ongoing communications with vendors, research and practice partners, and more than three dozen field coordinators each year. Information technology supports these efforts. We rely heavily on tools such as e-newsletters for the field coordinators, biweekly conference calls with basic and enhanced groups of field coordinators, Internet registration, and the distribution of Web-based materials.

One of the most difficult aspects of the study involves ensuring a high response rate for data collection and minimizing dropout from the study. The low follow-up response rate for pool manager surveys in the 1st year of this study was a significant concern. Variable rates of return of parent surveys were also a problem. We are taking several steps to address these problems. The study office has increased the steps involved to confirm pools' participation and has added incentives for returning pool manager surveys in a timely manner. This must be done carefully, without threatening the integrity of the two-arm experimental design.

Finally, a nationwide diffusion study such as the Pool Cool Diffusion Trial requires continual learning from experience, flexibility within the framework of a planned research design, energetic and dedicated research staff, and the willingness to solve new problems and cross the bounds of research and practice. The research is complicated, ambitious, and ultimately somewhat messy. However, we have also found the research rewarding in the relationships it has fostered locally and nationally and in the contribution it is making to further our understanding of diffusion of public health interventions.

Conclusion

This diffusion study is unique in its methods and goals, which include examining sun protection strategies, environments, and behaviors from a multilevel perspective and across multiple years. Few health behavior diffusion studies to date have gone beyond

measuring program implementation and maintenance to examine whether the ultimate audience improves their behaviors or health (Glanz, 2002). To our knowledge, this is one of the largest intervention studies of skin cancer prevention (Saraiya et al., 2003). It aims to both add to the science base about diffusion and cancer prevention and establish sustainable practical linkage systems in communities across the United States. Ultimately this study will link research and practice to translate epidemiologic knowledge into effective action in communities.

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