Interventions to Prevent Skin Cancer by Reducing Exposure to Ultraviolet Radiation

A Systematic Review

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Abstract: The relationship between skin cancer and ultraviolet radiation is well established. Behaviors such as seeking shade, avoiding sun exposure during peak hours of radiation, wearing protective clothing, or some combination of these behaviors can provide protection. Sunscreen use alone is not considered an adequate protection against ultraviolet radiation. This report presents the results of systematic reviews of effectiveness, applicability, other harms or benefits, economic evaluations, and barriers to use of selected interventions to prevent skin cancer by reducing exposure to ultraviolet radiation. The Task Force on Community Preventive Services found that education and policy approaches to increasing sun-protective behaviors were effective when implemented in primary schools and in recreational or tourism settings, but found insufficient evidence to determine effectiveness when implemented in other settings, such as child care centers, secondary schools and colleges, and occupational settings. They also found insufficient evidence to determine the effectiveness of interventions oriented to healthcare settings and providers, media campaigns alone, interventions oriented to parents or caregivers of children, and community-wide multicomponent interventions. The report also provides suggestions for areas for future research.

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Introduction

Skin cancer is the most common type of cancer in the United States.[1] Estimates for 2004 indicate that more than 1 million people will be diagnosed as having the two most common types of skin cancer—basal cell carcinoma and squamous cell carcinoma—and approximately 2300 deaths from both cancers combined are predicted. Both basal cell and squamous cell carcinoma respond well to treatment. However, melanoma, the third most common type of skin cancer, is much more likely to be fatal. Diagnoses of melanoma are anticipated in approximately 55,000 people and will account for 7900 deaths, more than three quarters of all skin cancer fatalities.[2]

In the United States, although the incidence of most cancers has been declining, melanoma incidence has been on the rise.[3] Since 1973, the annual incidence rate for melanoma (new cases diagnosed per 100,000 people) has more than doubled, from 6.8 per 100,000 in that year to 17.4 cases per 100,000 in 1999.[4] The increase is likely a result of several factors, including increased exposure to ultraviolet (UV) radiation and, possibly, earlier detection of melanoma.[5] From 1973 to 1999, the number of melanoma deaths also rose: Annual deaths per 100,000 people from melanoma increased by about 40% during this period, from 1.9 to 2.7 per 100,000 people. During the past 10 years, however, melanoma mortality rates have remained relatively stable among women, but less so among men.[3,6,7] (Mortality rates for white males by economic area are presented in Figure 1.)

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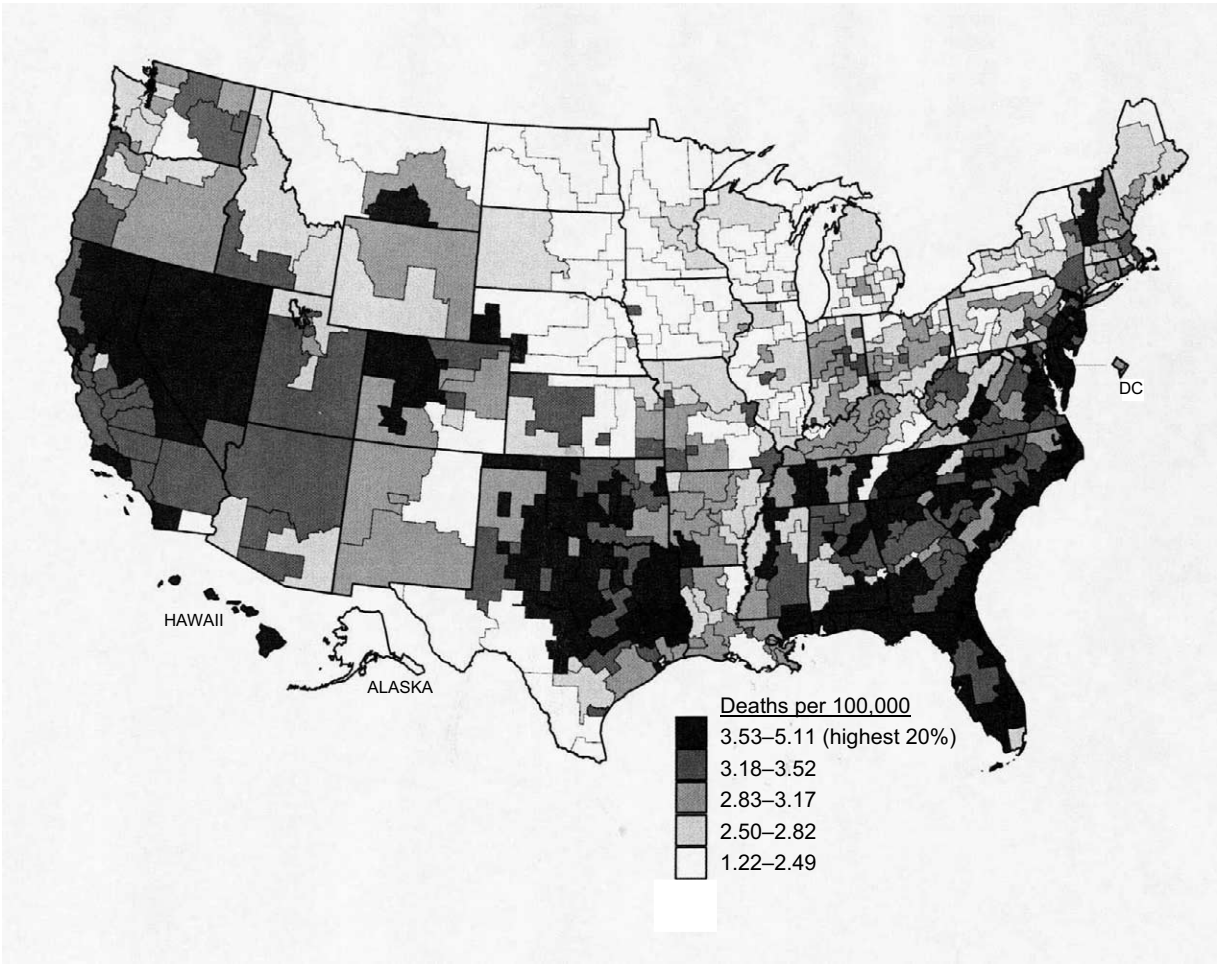

Figure 1. Cancer mortality rates by state economic area, white males, 1970 to 1998 (age-adjusted 1970 U.S. population). Death rate for United States overall: 3.07/100,000.

Preventable Risk Factors for Skin Cancer

Excessive Exposure to UV Radiation

High levels of exposure to UV radiation increase the risk of all three major forms of skin cancer, and approximately 65% to 90% of melanomas are caused by UV exposure.[8] Studies have shown that the damage caused by UV radiation, particularly damage to DNA, plays a central role in the development of melanoma.[9] Risk of melanoma and other skin cancers can therefore be reduced by limiting exposure to sunlight, which is the primary source of UV radiation. (Sunlamps and tanning beds are other sources.) Total UV exposure depends on the intensity of the light, duration of skin exposure, and whether the skin is protected by shade, clothing (including hats), or sunscreen. Severe blistering sunburns are associated with an increased risk of both melanoma and basal cell carcinoma. For these cancers, intermittent intense exposures seem to carry a higher risk than do lower-level, chronic, or cumulative exposures, even if the total amount of UV exposure is the same. The risk of squamous cell carcinoma, in contrast, is strongly associated with chronic UV exposure but not with intermittent exposure.[10]

Childhood and Adolescent UV Exposure

Exposure to UV radiation during childhood and adolescence plays a role in the future development of both melanoma and basal cell cancer.[11–16] The risk of developing melanoma is strongly related to a history of one or more sunburns (an indicator of intense UV exposure) in childhood or adolescence.[12,17–19] Sunburns during these periods have also recently been found to increase the risk of basal cell carcinoma.[14,15]

Nevi, or moles (lesions of pigment forming skin cells), are an important risk factor for skin cancer, and most develop in childhood through early adulthood. It may be that sun exposure in childhood heightens the risk of melanoma by increasing the number of moles.[18] Sun protection during childhood may therefore reduce the risk of melanoma in adulthood.[20,21]

Children and adolescents have more opportunities and time than adults to be exposed to sunlight,[22] and thus more opportunities to increase their risk of developing skin cancer.[9,23,24] At least 25% of a person's lifetime UV exposure occurs during childhood and adolescence.[25–27]

Skin Color and Ethnicity

Although anyone can get skin cancer, people with certain characteristics are particularly at risk. Whites are 80 times more likely to develop basal cell and squamous cell carcinoma than African Americans,[28] and 20 times more likely to develop melanoma.[29] Hispanics appear to be at lower risk of melanoma than non-Hispanic whites: a study conducted in Los Angeles found Hispanic incidence rates to be 2 to 3 per 100,000, whereas the rate for non-Hispanic whites is 11 per 100,000.[30] According to the data from the Surveillance, Epidemiology, and End Results (SEER) cancer registry[31] for the 1995–1999 period, average annual age-adjusted incidence rates for melanoma per 100,000 population were 23.5 for men and 15.7 for women for non-Hispanic whites; 3.8 for men and 3.7 for women for Hispanics; 1.8 for men and 1.3 for women for Asians; 1.5 for men and 0.9 for American Indian/Alaskan Natives; and 1.2 for men and 0.9 for women for non-Hispanic blacks.

The racial and ethnic differences in skin cancer rates are mostly due to skin color, which is determined by the amount of melanin produced by skin cells called melanocytes. These cells protect the skin from the damage produced by UV radiation. However, although darkly pigmented people develop skin cancer on sun-exposed sites at lower rates than lightly pigmented people, incremental UV exposure does increase their risk of developing skin cancer.[32] The risk of skin cancer is greater among those who sunburn readily and tan poorly,[33] namely those with red or blond hair and fair skin that freckles or burns easily.[34–36]

See related Commentaries on pages 482 and 484.

Other strong predictors of melanoma include having a large number of nevi, or moles, including atypical nevi; family history of melanoma; and increasing age.[33,37–39] The incidence of skin cancer increases exponentially with age because older people have had more opportunities to be exposed to UV radiation and their capacity to repair the damage from UV radiation is diminished.[9,34,35]

Environmental Factors Affecting UV Radiation

Environmental factors that increase the amount of UV exposure include proximity to the equator; higher altitude; lower levels of cloud coverage (which can allow up to 80% of UV rays to penetrate the atmosphere); the presence of materials that reflect the sun, such as pavement, water, snow, and sand; exposure to the sun around midday; and spending time outside in the spring or summer.[30,40] Ozone depletion could potentially increase levels of solar radiation at the Earth's surface.[30,41]

Sun-Protective Behaviors

Behaviors that reduce skin cancer risk include limiting or minimizing exposure to the sun during peak hours (10 A.M. to 4 P.M.) because UV rays are more intense around midday, wearing protective clothing, or using appropriate sunscreen protection.

Scientific knowledge about sunscreen has undergone some recent evolution. Although sunscreen is thought to be an important adjunct to other types of UV protection, it should not be counted on to provide UV protection by itself. Sunscreen clearly prevents sunburn, and using sunscreen is one of the most commonly practiced behaviors for preventing skin cancer. Clinical trials have found sunscreens effective in reducing the incidence of actinic keratoses, the precursors to squamous cell carcinoma,[42,43] and one randomized clinical trial showed sunscreens to be moderately effective in reducing squamous cell carcinoma itself.[44] Another randomized trial found sunscreens effective in reducing the number of moles—the precursors and strongest risk factor for melanoma[45]—among high-risk children.

However, recent research suggests that sunscreen, by itself, is not an adequate strategy for UV protection. Many people use sunscreens if they intend to stay out in the sun for a long period of time, and they reduce the use of other forms of sun protection (e.g., clothing or hats). They thereby receive the same or even a higher amount of UV exposure than they would have obtained during a shorter stay with no sunscreen.[46,47] Some studies have shown a high incidence of sunburning despite relatively high rates of sunscreen use,[48,49] which may be the result of weakened sun-protection qualities of sunscreen when inadequately or infrequently reapplied. For these reasons, although an expert group recently concluded that topical use of sunscreen probably prevents squamous cell carcinoma of the skin, the panel drew no conclusions about sunscreen's contribution to reducing the incidence of basal cell carcinoma or melanoma.[50] The panel recommended avoiding the sun, seeking shade, or wearing protective clothing that reduces exposure to the full spectrum of UV radiation as the first line of protection against skin cancer, with sunscreen as an adjunct form of protection only.

In some instances, sunscreen may be the only viable option. However, to be effective, it must be applied correctly.[51–53]

Prevalence of Sun-Protective Behaviors

In 1992, a total of 53% of U.S. adults were "very likely" to protect themselves from the sun by practicing at least one protective behavior (sunscreen,

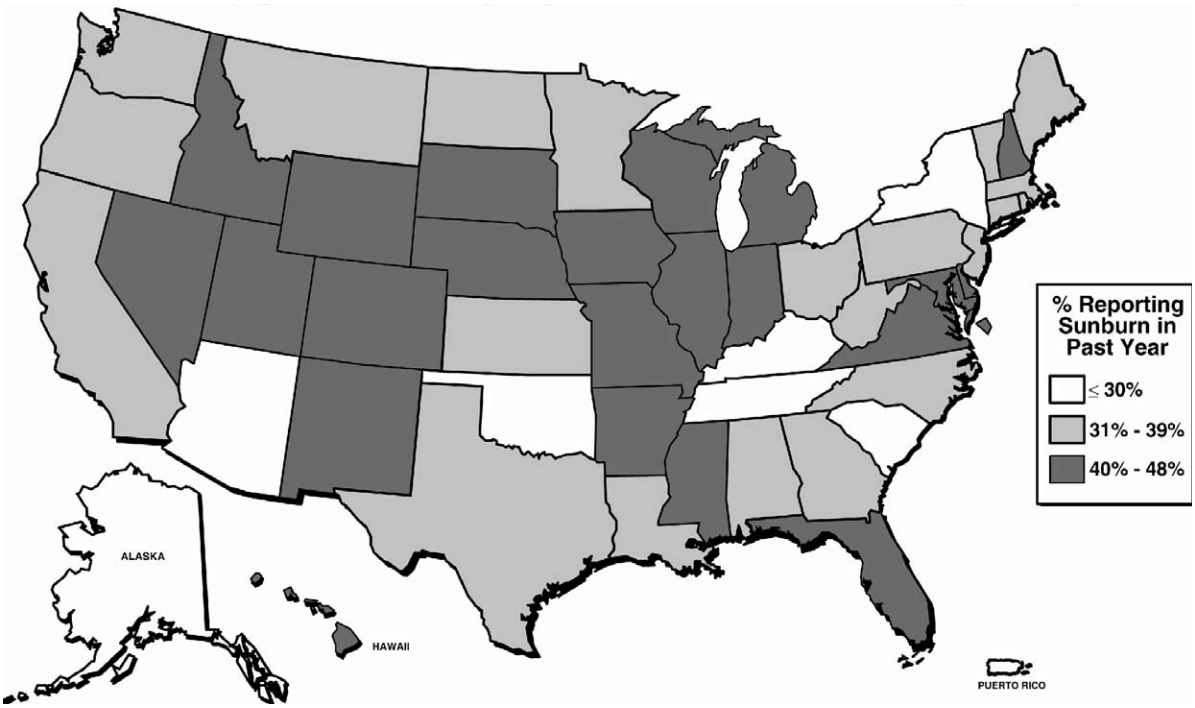

Figure 2. Sunburn rates among white people by state in the United States, Behavioral Risk Factor Surveillance System (BRFSS), 1999 (age and ethnicity adjusted to the 1999 BRFSS population).

wearing clothing, or seeking shade).[54] Less than one third of white adults used sunscreen (32%), sought shade (30%), or wore protective clothing (28%). Among African Americans, 28% wore sun-protective clothing and 45% sought shade, but only 9% used sunscreen.[55] The sun-protective behaviors of both whites and African Americans were more common among those who were more sensitive to the sun, were female, and were older. When the survey was repeated in 2000, the prevalence of sun-protective behaviors was similar (A. Hartmann, National Cancer Institute, personal communication, January 2003). Two independent surveys, conducted in 1999 and in 2000, showed that sunburn rates over the past year in the U.S. population were between 35% and 40% and were highly variable by state[56] (Figure 2).

Among youth aged 11 to 18 years, 72% reported having had at least one summer sunburn, 30% reported at least three, and 12% reported at least five sunburns.[49] Routinely practiced sun-protective behaviors among these youth on sunny days were wearing sunglasses (32%) or long pants (21%), staying in the shade (22%), and applying sunscreen (31%). At the beach or pool, 58% used a sunscreen with sun-protective factor (SPF) of ≥15.[57] Among U.S. white children aged 6 months to 11 years, 43% experienced one or more sunburns within the past year, with sunscreen (62%) and shade (27%) being the most frequently reported protection methods.[58,59]

The *Guide to Community Preventive Services*

The systematic reviews in this report represent the work of the independent, nonfederal Task Force on Community Preventive Services (the Task Force). The Task Force is developing the *Guide to Community Preventive Services* (the *Community Guide*) with the support of the U.S. Department of Health and Human Services in collaboration with public and private partners. The Centers for Disease Control and Prevention (CDC) provides staff support to the Task Force for development of the *Community Guide*. A special supplement to the *American Journal of Preventive Medicine*, "Introducing the *Guide to Community Preventive Services*: Methods, First Recommendations, and Expert Commentary," published in January 2000, presents the background and methods used in developing the *Community Guide*.

Healthy People 2010 Goals and Objectives for Preventing Skin Cancer

The interventions reviewed in this article may be useful in reaching the objectives set in *Healthy People 2010*[60]:

1. Increase to 75% the proportion of people who use at least one of the following protective measures that may reduce the risk of skin cancer: avoid the sun between 10 A.M. and 4 P.M., wear sun-protective clothing when exposed to the sun, use sunscreen

with a sun-protection factor (SPF) of ≥15, and avoid artificial sources of ultraviolet light.
2. Reduce melanoma deaths to <2.5 per 100,000 people.

Recommendations from Other Advisory Groups

International Agency for Research on Cancer

In 2001, the International Agency for Research on Cancer (IARC), an independent organization supported by the World Health Organization, convened a work group to address sunscreen use. The work group made the following recommendations:[50]

- Protect the skin from solar damage by wearing tightly woven protective clothing that adequately covers the arms, trunk, and legs, and a hat that provides adequate shade to the entire head; seeking shade whenever possible; and avoiding outdoor activities during periods of peak UV radiation.
- Avoid the use of sunscreens as the first choice or the sole agent for protection against the sun or for extending the duration of solar exposure, such as prolonging sunbathing.
- Residents of areas of high UV radiation who work outdoors or engage in regular outdoor recreation should daily use sunscreen with a high SPF (>15) on exposed skin.
- Pay particular attention to adequate solar protection for children. The first two recommendations above (protecting the skin against sun damage and avoiding reliance on sunscreen as the primary or sole sun-protection agent) are more important during childhood than at any other time in life, and should be rigorously applied by parents and school personnel.

The IARC also recommended the following public health strategies[50]:

- Design health promotion interventions to increase the appropriate and effective use of sunscreens by the general public, as well as those subgroups at particular risk for skin cancer because of their skin type or a tendency to seek solar exposure.
- Stringently evaluate the safety of sunscreens, particularly with regard to long-term effects, and make such data available in the public domain, to allow independent scientific evaluation.
- Subject sunscreens to the same regulatory safety requirements as pharmaceuticals.
- Require sunscreen advertising to promote a global sun-protection strategy rather than portraying sunscreen use for intentional exposure to the sun or promoting a false sense of security for people using sunscreen.

Centers for Disease Control and Prevention

In 2002, the CDC published guidelines recommending that schools engage in skin cancer prevention activities.[61] Specific recommendations include implementation of policies; creation of physical, social, and organizational environments that facilitate protection from UV rays; education of young people; professional development of staff; involvement of families; health services; and program evaluation. These guidelines received the support of the National Cancer Institute, the American Academy of Dermatology, the American Academy of Pediatrics, and the American Cancer Society.

U.S. Preventive Services Task Force

In 2003, in the *Guide to Clinical Preventive Services*,[62] the U.S. Preventive Services Task Force (USPSTF) drew the following conclusions:

- The benefits of sun-protective measures exceed any potential harms.
- Evidence is poor to determine the effects of sunlamp use or skin self-examination on melanoma risk.
- There is fair to good evidence that increased sun exposure increases the risk of nonmelanoma skin cancer.
- The relationships between sun exposure and melanoma risk are complex, and observational studies suggest that intermittent or intense sun exposure is a greater risk factor for melanoma than chronic exposure.
- Light-skinned people are at much higher risk for skin cancer than are those with darker skin.
- There is good evidence that sunscreens can reduce the risk of squamous cell cancer.
- There is insufficient evidence to determine the effect of sunscreen use on risk of melanoma.
- There is insufficient evidence to determine whether clinician counseling is effective in changing patient behaviors to reduce skin cancer risk.
- Counseling parents may increase their use of sunscreen for children, but there is little evidence to determine effects of counseling parents on other protective behaviors (use of protective clothing, reducing sun exposure, avoiding sun lamps, or practicing skin self-examination).

Methods for Conducting the Review

The general methods used to conduct systematic reviews for the *Community Guide* have been described in detail elsewhere.[63,64] The specific methods for conducting this review, including selection of interventions and outcomes and the search strategy for interventions to increase sun-protective behaviors, are presented in Appendix A. The conceptual approach to the review, critical both for describing the

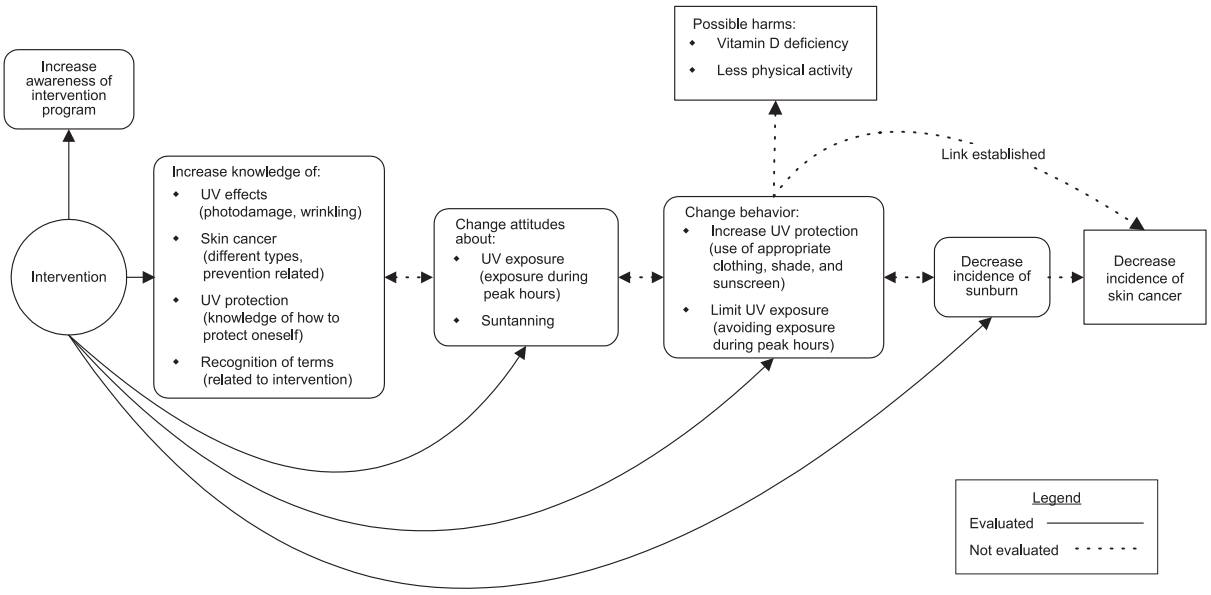

Figure 3. Analytic framework for media interventions to reduce ultraviolet exposure and increase sun-protective behaviors. Major stratification variables were type of media (e.g., small media [posters, brochures] vs large media [TV, radio]); characteristics of target population (e.g., age, sex, skin color, skin type, baseline risk, socioeconomic status, sunburn incidence, occupation); intervention intensity (i.e., comparison; some intervention; high level of intervention); geographic/environmental characteristics (e.g., urban, rural, climate of location [e.g., sunny vs cloudy]); and intervention characteristics (e.g., size, access to media). The analytic frameworks for the other interventions were similar to this example; however, other frameworks might include environmental and policy components. Key to shapes in analytic framework: circles indicate interventions; rectangles with rounded corners indicate intermediate outcomes; and rectangles with square corners indicate health outcomes.

methods and for understanding the results of the review, is described below.

Conceptual Model

First, the team (i.e., the authors of this article) developed a logic framework as a model to depict its overall conceptual approach to preventing skin cancer by reducing UV exposure. Then for each intervention we reviewed, we developed an analytic framework, a conceptual model that shows the relationship of the intervention to relevant intermediate outcomes (e.g., knowledge, attitudes, beliefs, and intentions), key sun-protective behaviors, and the assumed relationships between sun-protective behaviors and skin cancer prevention. The analytic framework for mass media interventions (Figure 3) is a representative example. Analytic frameworks for the other interventions are similar to this example, although some include environmental and policy components.

The analytic frameworks focused on sun-protective behaviors (e.g., avoiding peak sun, covering up, or using sunscreen) and intermediate outcomes that were postulated to be associated with sun-protective behaviors (e.g., knowledge, attitudes, intentions, and environmental characteristics). We also sought information on selected health outcomes (e.g., sunburn or nevi). Recommendations were based on either improved health outcomes (rare in this subject matter because cancer outcomes occur long after the intervention) or sun-protective behaviors thought by the systematic review development team to be established proxies for cancer outcomes (in this case, avoiding sun or covering up and not sunscreen use alone). In general, although we think sunscreen use is an important outcome of sun-protection programs, we did not consider it, by itself, to be an established proxy for better health (see Sun-Protective Behaviors section above). Increased sunscreen use had to be a part of a program that also had improvements in other behaviors such as avoiding the sun or covering up. Similarly, if an intervention could not discern the individual sun-protective behaviors (especially sunscreen use) and just reported composite behaviors, the results of the intervention could not be considered as evidence for improving behaviors as it would be unclear what particular behavior was contributing to the improved overall behavior.

The relationship between UV radiation and risk of skin cancer was assumed by the review team to be well established and, subsequently, was not the focus of the systematic review. Instead the team focused on interventions to decrease UV exposure.

Selecting and Summarizing Information on Outcomes

Many of the studies included in the body of evidence targeted several sun-protective behaviors: seeking shade; avoiding the sun; wearing protective clothing; using sunscreen; or composite behaviors, a combination of at least two of these behaviors. We abstracted one measure per study for each of these behavioral constructs (avoiding sun [includes seeking shade], protective clothing, using sunscreen, and composite) when they were available. Although the measures in the individual studies were diverse, within these four categories the team considered the available measures to be sufficiently similar

conceptually to transform the measures to a common scale and summarize the results when it was otherwise appropriate.

Selection of Interventions for Review

Interventions to reduce UV exposure are diverse and difficult to classify. Although some studies can be easily identified within a single category, many more involve several methods or communication strategies. Intervention studies often target multiple audiences, such as parents and children or physicians and patients. Bearing in mind these complexities, it is useful to provide a broad typology of four types of interventions that readers may use to group various strategies and studies[65]: (1) individual-directed strategies, (2) environmental and policy interventions, (3) media campaigns, and (4) community-wide multicomponent interventions. Each type of intervention is briefly characterized here. Because the nature of interventions is also strongly influenced by their organizational context or setting (i.e., the setting is often a proxy for important characteristics of both the target population and relevant providers), the team has tended to organize both individual-directed strategies and environmental or policy changes by the setting in which they are conducted.

Individual-directed strategies. These strategies include informational and behavioral interventions aimed primarily at individuals or relatively small groups. These interventions usually occur within an organizational context, such as school, recreation program, or healthcare settings. They typically aim to educate and motivate individuals by providing knowledge, teaching attitudes, and teaching behavioral skills for skin cancer prevention. They include the use of small media (e.g., brochures, pamphlets, printed materials); didactic programs (e.g., classroom lessons, lectures); interactive activities (e.g., games, multimedia programs); and skill development (e.g., role playing, instruction in sunscreen application). These strategies can be directed toward any age, occupation, or risk group and are often combined with other strategies.

Environmental and policy interventions. These interventions aim to provide or maintain a physical, social, or informational environment that supports sun protection and promotes sun-safety practices for **all** people in a defined population (e.g., school, community setting), not just those who are highly motivated. The interventions reach populations by passively reducing UV exposure, providing sun-protection resources, and broadening the accessibility and reach of skin cancer prevention information. Examples include increasing shade areas, supplying sunscreen, providing environmental sources of information and prompts, and many other possible strategies. **Policies** establish formal rules or standards that lead to organizational actions, legal requirements, or restrictions related to skin cancer prevention measures. Policies may be developed by a school, school board, or community organization, or by other legal entities, such as municipal, state, and federal governments. **Environmental strategies** provide supportive resources for skin cancer prevention in the physical, social, or informational environment. They may be based on, and restricted or assisted by, policies. However, environmental supports can also be undertaken in the absence of a formal policy.

Media campaigns. These campaigns use mass media channels such as print media (e.g., newspaper, magazines), broadcast media (e.g., radio, television), and the Internet to disseminate information and behavioral guidance to a wide audience. They may be aimed at specific target audiences, but typically use broad distribution channels. Media campaigns have some of the characteristics of individual-directed interventions, but they lack the face-to-face interpersonal interaction and "captive audience" that is possible in a defined organizational setting. Media campaigns tend to have a public health orientation and often seek to raise levels of awareness or concern, and to help shape the policy agenda that drives other interventions.

Multicomponent programs and comprehensive community-wide interventions. These interventions, often called population-wide programs or campaigns, combine elements of the three other types of strategies into an integrated effort in a defined geographic area (city, state, province, or country). They often include individual-directed strategies carried out in a range of settings, environmental and policy changes, media campaigns, and a variety of setting-specific strategies delivered with a defined theme, name or logo, and set of messages. The team included studies in this review if they addressed a defined geographic area and included at least two components or at least two settings. Additionally, comprehensive community-wide interventions are further defined as interventions that may include more than two components and two settings to drive the campaign.

Classification of Strategies to Create a Practical Taxonomy for Reviews

The team organized most individual-directed strategies (mostly informational and behavioral interventions) by the setting in which they were conducted. Some of these interventions also incorporated the following environmental and policy interventions:

- Educational and policy interventions in child care settings
- Educational and policy interventions in primary schools
- Educational and policy interventions in secondary schools and colleges
- Educational and policy interventions in recreational and tourism settings
- Programs in outdoor occupational settings
- Healthcare system and provider settings

The team defined the category of mass media campaigns without other activities to include either mass media alone or mass media in combination with small media.

The team organized one individual-directed intervention by the target population of interest: programs for caregivers (e.g., parents or teachers).

A final category was community-wide multicomponent programs, including comprehensive community-wide interventions, which combine two or more of the other strategies into an integrated effort for an entire defined geographic area.

Results. Part I: Interventions to Decrease UV Exposure and Promote UV Protection in Specific Settings

Educational and Policy Interventions in Child Care Centers

Interventions in child care settings involve efforts to promote sun-protective behaviors among children aged <5 years who attend programs in these settings. These interventions include at least one of the following: (1) provision of information directly or indirectly to the children (through instruction or small media education); (2) additional activities to influence children's behavior (modeling, demonstration, or role playing); (3) activities intended to change the knowledge, attitudes, or behavior of teachers, parents, and other caregivers; and (4) environmental or policy approaches (such as providing sunscreen and shade or scheduling outdoor activities to avoid hours of peak sunlight).

A large proportion of lifetime sun exposure occurs in childhood.[25,66] Sun exposure among infants and preschool-aged children is largely dependent on the discretion of parents and adult care providers, and is highly variable. Studies have found that parental protective behaviors often depend on whether the child tends to sunburn, and that parents often rely on sunscreen as the most common method of protection.[59,67–71] As children progress from infancy to childhood, increased mobility and a greater tendency to play outdoors often lead to increased UV exposure.[72]

Additionally, the responsibility for limiting the sun exposure of young children is shifting from the parent to alternate care providers. In 1995, approximately 31% of preschool-aged children were being cared for in child care centers; this number is expected to grow with the increasing number of women entering the workforce (projected to include 64% of all eligible women by the year 2005).[73] Child care centers therefore represent an important opportunity to reduce children's UV exposure. However, a recent study found that of 25 child care centers surveyed in Connecticut, nearly all held outdoor activities during peak UV hours, and only one third had 50% shade in the play area. Furthermore, the observed use of sunscreen and protective clothing was limited.[74]

Effectiveness. The team's search identified nine reports[75–83] on the effectiveness of interventions in child care centers. Information about the disposition of the reports is provided in Table 1. After exclusions for quality and redundancy, two reports of least suitable design remained for review. Details of the two qualifying reports are available at *www.thecommunityguide.org/cancer*.

One report[75] evaluated the "Be Sunsafe" curriculum, which includes interactive classroom and take-home activities that promote covering up, finding shade, and asking for sunscreen. The report did not evaluate behavioral or policy outcomes. Another study[78] used a workshop for staff, an activity packet for parents, and a working session to develop skin protection plans for centers. The intervention focused on increasing application of sunscreen, scheduling activities to avoid peak sun, increasing availability of shade, and encouraging children to play in shady areas and to wear protective clothing. This study did not show statistically significant effects on policy outcomes or measures of children's behavior. Both studies showed generally consistent and statistically significant improvements in the intermediate outcome of knowledge. Evidence of effectiveness is insufficient because of (1) limitations in the design and execution of available reports; (2) small numbers of qualifying reports; (3) variability in interventions evaluated; (4) short follow-up times; and (5) little substantial or statistically significant improvement in outcomes other than knowledge and attitudes.

Table 1. Interventions in child care centers: information about reports[a]

	Number
Reports meeting inclusion criteria	9[75–83]
Reports excluded, limited quality of execution[b]	2[76,79]
Reports on the same study	5[77,80–83]
Qualifying reports	2[75,78]
Design suitability	
Least	2[75,78]

[a]Reports may include more than one intervention arm.
[b]Grant-Petersson[79] had two designs, one on school policies and another on behavioral outcomes, which were independently evaluated as separate studies.

Applicability. Evidence about applicability was not collected because effectiveness of the intervention was not established.

Other positive or negative effects. The reports included in the team's search for effectiveness did not include information on other potential additional benefits of these interventions, such as reduction in the risk of overexposure to heat, nor on potential harms, such as reductions in outdoor physical activity or transmission of lice via hats or other clothing.[84]

Economic efficiency. Economic evaluations were not performed because effectiveness of the intervention was not established.

Barriers to implementation. Evidence about barriers to implementation of this intervention was not collected because effectiveness was not established.

Conclusion. Because of the small number of studies, lack of relevant outcome, and inconsistent results, according to *Community Guide* rules of evidence,[64] evidence is insufficient to determine the effectiveness of educational and policy interventions in child care centers in reducing children's adverse health effects or

Table 2. Interventions in primary school: information about reports[a]

	Number
Reports meeting inclusion criteria	33[79–82,88–116]
Reports excluded, limited quality of execution	5[95]
Reports on an already included study	8[80–82,94,99,104–106]
Qualifying reports[b]	20[79,88–93,97,98,100–103,107,108,110–112,115,116]
Design suitability	
Least	7[79,88,93,98,103,115,116]
Greatest	13[89–92,97,100–102,107,108,110–112]

[a]Reports may include more than one intervention arm.
[b]Grant-Petersson[79] report was included for evaluation of knowledge outcomes, but had limited quality of execution for behavioral/policy outcomes.

changing children's behavior related to sun exposure, changing caregivers' behavior related to sun exposure, changing policies and practices in child care centers, or changing children's or caregivers' knowledge or attitudes related to sun exposure and sun protection.

Educational and Policy Interventions in Primary Schools

Interventions in primary schools promote sun-protective behaviors among children in kindergarten through 8th grade. These interventions include at least one of the following activities: (1) provision of information to children (through instruction, small media, or both); (2) activities to influence children's behavior (e.g., modeling, demonstration, or role playing); (3) activities to change the knowledge, attitudes, or behavior of caregivers (e.g., teachers or parents); and (4) environmental and policy approaches (e.g., providing sunscreen, increasing availability of shade, or scheduling outdoor activities to avoid hours of peak sunlight).

Students spend a large amount of their day in school or in school-related activities that occur during peak UV hours. Children are more receptive than adolescents to practicing sun-protective behaviors and are more amenable to parents' or other adults' instruction.[85] Primary schools are also more likely to have success with sun-protection programs than high schools, as is the case with programs in Australia.[86] Formal education settings facilitate integration of skin cancer education into existing learning situations, and support policy and environmental interventions. Recent review articles have addressed many of these studies in detail.[22,87]

Effectiveness. The team's search identified a total of 33 reports (30 intervention arms)[79–82,88–116] on the effectiveness of educational and policy interventions in primary schools. Information about the disposition of the reports is provided in Table 2. Many of the reports included several intervention arms and multiple intermediate and behavioral outcomes. Details of a subset of the 20 qualifying studies that evaluated behavioral outcomes (increased sun-protective behaviors or improvement in health outcome) are provided in Appendix B and at *www.thecommunityguide.org/cancer*.

A wide range of intervention activities was used, including didactic classroom teaching,[103,108,116] didactic teaching using sunscreen samples,[97] interactive class and home-based activities,[89,91,92,107] health fairs,[91] an educational picture book,[115] teaching by medical students,[98] interactive CD-ROM multimedia programs,[90,101] and peer education.[110,111] Relatively few studies included environmental or policy approaches.

The team did not conduct quantitative analyses of the intermediate outcomes of knowledge, attitude, and intentions. However, the overwhelming majority of intervention arms showed a significant increase in knowledge (22 out of 25) and a significant change in attitude (13 out of 17). Only four reports evaluated intentions and their findings were inconsistent in direction and generally not statistically significant.

Only one study evaluated the effect of an intervention on policies. This study reported significant improvements in adoption of a comprehensive sun-protection policy in primary schools, but showed little relationship between adoption of the policy and associated sun-protective behavior changes that might have resulted from the change in policy.[112] Only one study evaluated the effect of an intervention to reduce sunburns; the intervention led to a 43% reduction in reported sunburns.[88]

Table 3 shows summary changes in sun-protective behaviors by study design. Specific sun-protective behaviors included (1) covering up (wearing hats, long-sleeved clothing, or pants); (2) using sunscreen; (3) avoiding the sun (seeking shade, rescheduling activities, not going out in the sun during peak UV hours); and (4) composite behaviors (a combination of at least two of the above behaviors). Study design markedly affected the effect size in these data. For sun-avoidance behaviors, the median relative change was 4% for those studies that had a concurrent comparison group and 16% for those studies that had a before-and-after design. For covering-up behaviors, the median relative change ranged from 25% (concurrent comparison) to 70% (before-and-after). For sunscreen

Table 3. Median and interquartile relative changes in sun-protective behaviors from interventions in primary schools[a]

Outcome behaviors[b]	Intervention arms	Relative change		
		25th	Median	75th
Studies with concurrent comparison groups				
Avoid sun	7	0.92	1.04	1.16
Cover up	13	1.01	1.25	1.04
Use sunscreen	6	1.02	1.17	1.32
Composite[c]	15	0.94	1.02	1.72
Before-and-after studies				
Cover up	5	1.42	1.70	2.00
Use sunscreen	2	NA	1.34	NA
Avoid sun	1	NA	1.16	NA

[a]Based on six reports.[88,89,92,98,100,107] (A report may have more than one intervention arm and more than one outcome measure.)
[b]Outcome behaviors: avoiding the sun includes behaviors such as staying in the shade, and avoiding the sun during peak UV hours; and cover up includes wearing long-sleeved clothing or wearing a hat.
[c]Composite behavior was a combination of at least two of the following behaviors: avoiding sun, using protective clothing, and using sunscreen. Often, presentation of the results did not allow differentiation of the effect of one outcome from another behavioral outcome.
NA, not available.

use, the median relative change ranged from 17% (concurrent comparison) to 34% (before-and-after). Composite behaviors were measured only in studies with controls, where the median relative change was 2%.

In general, evidence is sufficient to determine the effectiveness of interventions in primary schools in improving the covering-up behavior; however, evidence is insufficient to determine effectiveness in improving other sun-protective behaviors, such as avoiding the sun (minimizing UV exposure by seeking shade or not going outside), because of inconsistent results. Evidence is also insufficient to determine the effectiveness of interventions in primary schools in changing policies and practices or health outcomes, based on small numbers of studies and limitations in their design and execution. These interventions improved knowledge and attitudes related to skin cancer prevention. They also increased sunscreen use (although this is not, by itself, a recommendation outcome, as previously discussed).

Applicability. Studies that examined the team's recommendation outcomes of policies, behaviors, or health outcomes were conducted in diverse geographical locations, including Arizona,[89–92] North Carolina,[101] Australia,[97,107,112] Canada,[98] and France.[88] Most of the studies that reported race and ethnicity[89–91,98] were conducted among a predominantly white population, and one study included only children of European ancestry.[107] Four studies did not report race or ethnicity.[88,92,97,112]

Other positive or negative effects. The studies included in the team's search for effectiveness did not include information on other potential benefits of these interventions, such as reduction in the risk of overexposure to heat, or on potential harms, such as reductions in outdoor physical activity or transmission of lice via hats or other clothing.

Economic efficiency. No studies were found that met the requirements for inclusion in a *Community Guide* review.[63]

Barriers to implementation. A potential barrier to intervention implementation might be the concerns of parents or teachers that these interventions will lead to reductions in physical activity. Parents or teachers may also be concerned that covering up will lead to wearing gang insignia. (Until recently, California schools did not permit children to wear clothing such as hats because of concerns about gang affiliation. Now, students in California can wear hats to protect themselves from the UV rays and, ultimately, skin cancer.) Possible transmission of head lice among younger children who share hats has also been raised as a concern; however, none of the intervention studies cited this as a barrier. One paper has examined the issue and reported that hats were not a major factor in transmission.[84]

Conclusion. According to *Community Guide* rules of evidence,[64] available studies provide sufficient evidence of the effectiveness of interventions in primary schools in improving covering-up behavior. Evidence was insufficient to determine effectiveness in improving other sun-protective behaviors (e.g., avoiding the sun) because of inconsistent evidence; evidence was also insufficient to determine effectiveness in decreasing sunburns because only a single study, with limitations in design and execution, reported on this outcome.

Educational and Policy Interventions in Secondary Schools and Colleges

Interventions in secondary schools and colleges involve efforts to promote sun-protective behaviors among adolescents and young adults. These interventions include at least one of the following activities: (1) provision of information to adolescents and young adults (e.g., instruction, small media, or both); (2) additional activities to influence the behavior of adolescents and young adults (e.g., modeling, demonstration, role playing); (3) activities intended to change the knowledge, attitudes, or behavior of caregivers (i.e., teachers or parents); and (4) environmental and policy approaches (e.g., providing sunscreen and shade, or scheduling outdoor activities to avoid hours of peak sunlight).

Interventions in secondary schools and colleges are potentially important because adolescents and young adults are more likely to be exposed to UV radiation

Table 4. Interventions in secondary schools and colleges: information about reports[a]

	Number
Reports meeting inclusion criteria	17[110–112,121–134]
Reports excluded, limited execution quality	4[110,111,122,124]
Qualifying reports	13[112,121,123,125–134]
Design suitability	
Least	1[126]
Greatest	12[112,121,123,125,127–134]

[a]Reports may include more than one intervention arm.

than younger children and are less likely to adopt sun-protective behaviors, parents and caretakers have less influence in promoting sun protection, and high schools and colleges can provide an infrastructure to support intervention activities. Some data indicate that despite high levels of knowledge about the health effects of unprotected sun exposure, changes in attitudes and social norms during adolescence are associated with increases in high-risk behaviors and present a unique challenge to health educators.[117–119] Overall, sun-protection programs have reported more success in improving sun-protective practices for infants (by parents) and among younger children, but less success among adolescents.[118] Efforts in sun-protection education, supportive environments, and policies are difficult to sustain effectively as primary school children transition to secondary schools.[120]

Effectiveness. The team's search identified a total of 17 articles (25 intervention arms)[110–112,121–134] on the effectiveness of education and policy interventions in secondary schools and colleges. Information about the disposition of the reports is provided in Table 4. Most intervention arms reported on multiple outcomes. Details of the qualifying reports are provided at *www.thecommunityguide.org/cancer*.

The intervention activities used in these studies included didactic classroom teaching combined with some interactive classroom and home-based activities,[126–128] Internet-based activities,[121] small media,[123,126,129,131–133,135] and provision of sunscreen samples, extra class credit, or money.[129,132,134] One study used a strategy of information dissemination and support of school staff to facilitate policy implementation.[112]

Only four reports (six intervention arms) examined changes in sun-protective behavior or policy,[112,121,128,129] and each report measured different sun-protective behaviors. One report focused on the amount of time spent in the sun[129] and another on sunscreen use.[121] Another report measured a composite behavior, which did not allow us to determine the effect of the intervention on specific protective behaviors.[128] The fourth paper presented self-reported practices, but the presentation did not allow us to determine the relative effect of the intervention.[112] The inconsistency of interventions undertaken and outcomes measured did not allow us to determine the effectiveness of the interventions.

The team did not conduct formal quantitative analyses of the intermediate outcomes of knowledge, attitudes, and intentions. Nine intervention arms generally showed an increase in knowledge as a result of the intervention.[123,126–128,130,131] Seven intervention arms measured attitudes and beliefs, with inconsistent results,[121,125,130,133,134] and seven measured intention[125,129,132–134] (the majority of which looked only at the intention to use sunscreen.); these results were also inconsistent.

Evidence is insufficient to determine the effectiveness of educational and policy interventions in secondary schools and colleges because of (1) limitations in the design and execution of available reports; (2) variability in interventions and evaluated outcomes; (3) short follow-up times; and (4) the small number of studies that examined relevant outcomes such as health outcomes and sun-protective behavioral changes.

Applicability. Evidence about applicability was not collected because effectiveness of the intervention was not established.

Other positive or negative effects. The studies included in the team's search for effectiveness did not include information on other potential benefits of these interventions, such as reduction in the risk of overexposure to heat, or on potential harms, such as reductions in outdoor physical activity or transmission of lice via hats or other clothing.

Economic efficiency. Economic evidence was not collected because effectiveness of the intervention was not established.

Barriers to implementation. Information on barriers to implementation of this intervention was not collected because effectiveness was not established.

Conclusion. According to *Community Guide* rules of evidence,[64] evidence is insufficient to determine the effectiveness of these interventions in secondary schools or colleges to reduce adverse health effects or to change behavior related to UV exposure.

Educational and Policy Interventions in Recreational and Tourism Settings

Interventions in recreational and tourism settings involve efforts to promote sun-protective behaviors among adults, children, and their parents. These interventions include at least one of the following: (1) provision of information to children and adults (i.e., through instruction, small media education, or both); (2) activities intended to change the knowledge, attitudes, beliefs, or intentions of children and adults;

Table 5. Interventions in recreational or tourism settings: information about reports[a]

	Number
Reports meeting inclusion criteria	18[138–155]
Reports excluded, limited quality of execution	2[151,152]
Reports on an already included study	5[140,142,143,145,154]
Qualifying reports	11[138,139,141,144,146–150,153,155]
Design suitability	
Least	2[141,148]
Greatest	9[138,139,144,146,147,149,150,153,155]

[a]Reports may involve more than one intervention arm.

(3) additional activities to influence the behavior of children and adults (such as modeling, demonstration, or role playing); and (4) environmental or policy approaches, including provision of sunscreen or shade, or scheduling of outdoor activities to avoid hours of peak sunlight.

UV exposure often occurs during outdoor recreational activity. The tourism industry has experienced an increase in overseas vacationers traveling from temperate climates to regions where the UV level is high. Domestic U.S. travel increased 8% from 1994 to 2001, and travel with children increased 17%.[136] Of the 1 billion domestic U.S. person-trips that took place in 2001, the top three destination states were California, Florida, and Texas; a high percentage of these vacations involved outdoor activities, including general outdoor activities (17%), visits to beaches (11%), or national or state park visits (10%).[137]

Participation in outdoor leisure activities has also increased, thus increasing exposure to sunlight. Most studies show convincing trends towards increasing risk of melanoma with increasing recreational sun exposure.[34] Recreational and tourism settings are therefore important sites for sun-protection programs. In such settings, skin cancer education can be integrated into existing recreational or tourism activities, and supportive policy and environmental interventions can also be implemented.

Effectiveness. The team's search identified 18 reports (24 intervention arms)[138–155] that evaluated the effectiveness of interventions in outdoor recreational or tourism settings. Information about the reports is provided in Table 5. Details of a subset of the 11 qualifying studies that evaluated behavioral outcomes (increased sun-protective behaviors or improvement in health outcome) are provided in Appendix C and at *www.thecommunityguide.org/cancer*.

The reports in the team's body of evidence evaluated numerous intervention activities aimed at both children (9 arms in 5 reports)[141,144,146,149,150] and adults (21 arms in 10 reports).[138,139,141,144,146–148,150,153,155] Four studies[141,144,146,150] involved interactive sun-protection education activities (stories, games, puzzles, stamps, arts and crafts) and sun-safe environment promotions; one study[149] presented a UV-reduction curriculum at poolside, provided home-based activities for children and their parents, and measured degree of tanness using a colorimeter; three studies[138,139,147] used brochures to help educate participants about the prevalence and severity of skin cancer,[138] the effects of the sun on the skin,[139,147] or sun-protection measures[153,155]; one study[155] involved a sun sensitivity assessment, sun damage imaging photographs, and suggestions on reducing unprotected UV exposure; and one study[148] relied on peer-leader modeling by lifeguards, a poster listing goals, other informational posters and fliers, and a "commitment raffle" to influence sun-protective behaviors of children and adults.

Eleven arms from six reports[141,144,146,148–150] examined changes in parent-reported, sun-protective behaviors among children (using sunscreen; seeking shade; wearing a hat, shirt, or other protective clothing; and composite behaviors). One report[146] examined the incidence of children's sunburn, and one examined[149] children's degree of tanness. Six arms from five reports[141,146,148,153,155] examined adult sun-protective behaviors, and two arms[139,153] looked at incidence of adult sunburn. Four arms from one report[147] examined information-seeking behavior and follow-up study participation of adults; six arms from three reports[141,146,147] examined adult knowledge; two reports[141,147] examined adult attitudes or beliefs; and 13 arms from four reports[138,147,149,153] examined adult intentions. Four arms from three reports[141,144,146] examined parent-reported sun-protection measures and environmental supports at outdoor recreational centers or swimming pools.

Five arms from three reports[146,148,155] demonstrated sufficient evidence of effectiveness of the intervention on the **adult** sun-protective behavior of wearing protective clothing (hat or shirt), showing a median relative difference of 11.2% (interquartile range 5.1% to 12.9%). Available studies that measured children's sun-protective behavior demonstrate inconsistent effects of the intervention on wearing a hat, wearing a shirt, and seeking shade. Two arms from one report[146] demonstrated a desirable effect (a decrease) in the incidence of children's sunburn (relative difference, −41.2%); however, this evidence is insufficient for a recommendation because of an inadequate number of studies. Overall, the evidence of effectiveness was inconsistent for adult incidence of sunburn[139,153] and children's sun-protective behaviors.[141,144,146,148–150]

Five arms from four reports[141,144,146,149] provided evidence of effectiveness on children's sunscreen use (median relative difference, 9.8%), and composite sun-protective behaviors (median relative difference, 15.4%). Available reports found inconsistent effects on the adult outcomes of information-seeking behavior or

follow-up study participation,[147] knowledge,[141,146,147] attitudes or beliefs,[141,147] and intentions.[138,147,148,150] Available reports[141,144,146] also demonstrated inconsistent effects on sun-protection measures and environmental supports at outdoor recreational centers or swimming pools.

Applicability. These interventions from the evidence subset took place in diverse outdoor recreational and tourism settings such as recreational pools, beaches, zoos and wild animal parks, and airplanes and in diverse geographical settings, including Australia,[153] England,[139] Hawaii,[141,144,146] southern California,[147,149,150] Virginia,[148] and New England.[138,146,155] Study participants' ages ranged from 6.5 years to 79 years, with a median age of 31.5 years. Most of the reports that identified race or ethnicity were based on studies conducted with a predominantly white population. Three reports[141,144,146] involved Hawaiian or Asian/Pacific Islander populations, and five[138,139,147,150,153] did not report race or ethnicity. Of the reports that identified gender,[138,139,141,144,146,147,149,153,155] most were of studies conducted among predominantly (≥50%) female populations.[138,139,141,144,147,149,153,155] Annual household income of study participants ranged from $20,000 to >$90,000. Only one study[141] reported education level; in this study, 88% of the participants were high school graduates.

Other positive or negative effects. The studies in this review did not include information on other potential effects of interventions in recreational or tourism settings. These may include reaching populations not otherwise exposed to skin cancer prevention and reducing the risk of overexposure to heat and UV radiation resulting from over-reliance on sunscreen. Potential negative effects of the intervention include reductions in outdoor physical activity.

Economic efficiency. No reports were found that met the requirements for inclusion in a *Community Guide* economic review.[63]

Barriers to implementation. Three potential barriers to implementation were identified in the literature or by experts. Recreational center staff may have only limited time to implement the special activity component of an intervention[144]; swimming class schedules may limit intervention activities at swimming pools[141]; and some in the tourism trade might worry that sun-safety concerns might adversely affect their business, and hence the trade might be unwilling to partner in efforts that may involve more than sunscreen use.

Conclusion. According to *Community Guide* rules of evidence,[64] available reports provide sufficient evidence of effectiveness of interventions in recreational or tourism settings to increase adult sun-protective behavior of covering up. Available reports provide insufficient evidence to determine effectiveness of interventions in reducing sunburn in adults[139,153] and children,[146] because results were inconsistent (adult sunburn) or too few in number (children's sunburn).

Available reports[141,144,146,149] also demonstrate evidence of effectiveness of the intervention based on children's sun-protective behaviors, including sunscreen use and composite sun-protective behaviors; these, however, are not recommendation outcomes.

Programs in Outdoor Occupational Settings

Interventions in occupational settings promote sun-protective behaviors among workers. These interventions include at least one of the following: (1) provision of information to the workers (instruction, education through small media, or both); (2) additional activities intended to change the knowledge, attitudes, beliefs, intentions, or behaviors of workers (i.e., modeling or demonstration); and (3) environmental or policy approaches, including provision of sunscreen and shade.

Outdoor workers in the United States are a crucial audience for receiving skin cancer prevention information. According to the U.S. Census Bureau,[156] in 1991, over 8% of the U.S. national workforce (>9 million workers) primarily worked outdoors in one of the following occupational groups: construction, farm, forestry, fishing, land surveying and mapping, gardeners, groundskeepers, mail carriers, and amusement park or recreational center attendants. From both scientific and programmatic perspectives, occupational settings are ideal sites for sun-protection programs. High rates of nonmelanoma (basal cell and squamous cell) skin cancer have been found among occupational groups that work outdoors, and rates for nonmelanoma skin cancer among outdoor workers are significantly associated with cumulative UV exposure.[28,157] Outdoor workers may receive up to six to eight times the dose of UV radiation that indoor workers receive.[157] A recent Canadian survey found low levels of sun protection among outdoor workers[158]: 44% seek shade, 38% avoid the sun, 58% wear a hat or protective clothing, and 18% to 23% reported using sunscreen while at work. Because outdoor workers receive intense and prolonged exposure to the sun, and are at increased risk of developing squamous cell cancer, interventions that educate these workers and modify their work environment are well suited to the workplace and could provide substantial benefit.

Effectiveness. The team's search identified 14 reports (16 intervention arms)[140–142,145,148,151,159–166] that evaluated the effectiveness of interventions in occupational settings. More detailed information is provided in Table 6. Details of the eight qualifying reports[140,142,145,159,161–163,165] are available at *www.thecommunityguide.org/cancer*.

Table 6. Interventions in occupational settings: information about reports[a]

	Number
Reports meeting inclusion criteria	14[140–142,145,148,151,159–166]
Reports excluded, limited quality of execution	3[151,161,166]
Reports on an already included study	3[140,142,159]
Qualifying reports	8[141,145,148,160,162–165]
Design suitability	
Least	2[141,148]
Greatest	6[145,160,162–165]

[a]Reports may involve more than one intervention arm.

The reports in the team's body of evidence involved numerous intervention activities, and evaluated a variety of outcomes. Five reports[141,145,160,162,163] consisted of interventions that provided sun safety training to workers; two[160,164] involved sun-protection and skin cancer education sessions and skin exams by a physician; six studies[141,145,148,160,162,163] promoted covering-up behaviors; five[141,145,148,162,163] involved role-modeling by lifeguards or aquatics instructors; one[160] provided sun protection to outdoor workers (sunglasses, brimmed hat, and sunscreen); one[165] used educational brochures designed for men aged >45 and a body chart for self-assessment of pigmented lesions to educate male workers about skin cancer; and two[145,163] used environmental supports (sunscreen dispensers and shade structures) to promote sun-protective behavior.

Eleven arms from seven reports[141,145,148,160,162–164] examined changes in sun-protective behaviors and UV exposure, and one[163] examined incidence of sunburn. Six arms from five[141,145,163–165] reports[141,145,163–165] examined knowledge; five arms from four reports[141,145,163,164] examined attitudes or beliefs; and three arms from two reports[145,163] examined environmental pool policies.

Available reports provided insufficient evidence to determine effectiveness of the intervention in increasing the sun-protective behaviors of covering up[162,163] or seeking shade,[163] or in decreasing the incidence of sunburn[163] and UV exposure,[160] because of the small number of reports and inconsistent results.[162,163]

Three arms from two reports[145,163] examining sun protection demonstrated desirable effects of the intervention on sun safety measures and environmental supports (provision of sunscreen dispensers and portable shade structures) at recreational centers and swimming pools. Six arms from five reports[141,145,163–165] demonstrated inconsistent effects on knowledge, and five arms from four reports[141,145,163,164] demonstrated inconsistent effects on attitudes or beliefs.

According to *Community Guide* rules of evidence,[64] available reports provide insufficient evidence to determine the effectiveness of interventions in occupational settings because of too few reports and inconsistent evidence. Although available reports demonstrate evidence of effectiveness of the intervention, based on improvements in sun-protection measures and environmental supports at outdoor recreational centers and swimming pools, these policies are not, by themselves, thought to be adequate proxies for decreased UV exposure or better health.

Applicability. Evidence about applicability was not assessed for this intervention because effectiveness was not established.

Other positive or negative effects. Reviewed studies did not include information on other potential effects of these interventions. Other positive effects may include reaching populations that might not otherwise be exposed to skin cancer prevention and reducing risk of overexposure to heat. Potential negative effects of the intervention may include worker requests for reductions in time spent working outdoors.

Economic efficiency. Economic evidence was not collected for this intervention because effectiveness was not established.

Barriers to implementation. Evidence about barriers to implementation of this intervention was not collected because effectiveness was not established.

Conclusion. Available reports provide insufficient evidence to determine the effectiveness of interventions in occupational settings to reduce UV exposure and increase sun-protection behavior because of too few reports and inconsistent evidence.

Healthcare System and Provider Settings

Interventions to reduce UV exposure and promote sun-protective behaviors can take place in healthcare settings (e.g., pharmacies, drugstores, clinics, physician's offices, and medical schools) or can target healthcare providers (e.g., physicians, nurses, physician assistants, medical students, and pharmacists). The team included studies of interventions oriented toward primary prevention and average-risk populations. They usually include at least one activity aimed at providers (to increase knowledge, attitudes, and intentions; increase positive role modeling for patients and clients; increase counseling behaviors or information provision to patients and clients) or placed within a healthcare setting (to promote increased knowledge, attitudes, and intentions about sun-protective behaviors among patients and clients; to promote provision of information about skin cancer to patients and clients; and to increase sun-protective behaviors among patients and clients).

Healthcare settings and primary care providers are in a unique position to provide advice and preventive

Table 7. Interventions in healthcare systems (healthcare settings and healthcare providers): information about reports[a]

	Number
Reports meeting inclusion criteria	21[94,99,168–186]
Reports excluded, limited execution quality	9[94,168–170,173,177,184–186]
Reports on an already included study	1[180]
Qualifying reports	11[99,171,173–176,178,179,181–183]
Design suitability	
Least	5[99,174–176,182]
Moderate	1[178]
Greatest design suitability	5[171,173,179,181,183]

[a]Reports may include more than one intervention arm.

services to the majority of the general population. People in the United States make an average of 1.7 visits to a primary care provider annually,[167] and surveys consistently show that healthcare providers are a trusted and important source of health information. For these reasons, healthcare providers and systems have a unique opportunity to affect population knowledge, attitudes, and beliefs about reducing UV exposure and increasing sun-protective behaviors. Through increasing knowledge, changing attitudes and intentions, role modeling behaviors, and even establishing policies, healthcare providers and healthcare settings can greatly influence the behavior of the clients and patients who use their services.

According to the USPSTF,[62] evidence is insufficient to recommend for or against regular counseling by primary care clinicians to decrease sun exposure, avoid sun lamps, use sunscreen or protective clothing, or practice skin self-examination. This review expands on the USPSTF review by evaluating a broader range of providers and by including system approaches not limited to providers. This review did not evaluate interventions that focused on early detection of skin cancers.

Effectiveness. The team's search identified 21 reports[80,94,99,168–186] on the effectiveness of interventions oriented to providers and healthcare systems. More detailed information about the reports is provided in Table 7. Details of the 11 qualifying studies[99,171,173–176,178,179,181–183] can be found at *www.thecommunityguide.org/cancer*.

The targets of the reviewed interventions were diverse, as were the content of the interventions and the media by which they were delivered. Several of the studies were targeted to diverse healthcare providers. Two interventions[171] evaluated brief educational sessions for physicians and house staff in a large, urban teaching hospital; another[181] evaluated a didactic skin cancer prevention module aimed specifically at nurses; and another[178] conducted a skin cancer prevention curriculum for medical students. One study[182] taught physicians through a curriculum on how to accurately triage skin lesions and counsel patients on skin cancer; two studies used the Internet to train physicians[174] (or physicians, medical students, and house staff[175]) about skin cancer; one study taught medical students about skin cancer control, and then used the students to go into elementary school classrooms and teach younger students about skin cancer control; and a final study[179] used videotapes and role modeling training procedures to teach and encourage pharmacists to engage their clients in more skin cancer control behaviors.

Other studies were oriented to clients in healthcare settings. One study[183] used the community drugstore to promote the message of appropriate sunscreen use and SPF. Another study[176] used a physician's waiting room to recruit and educate people about the importance of sunscreen. A final study[173] tested the effects of different message content and sources of message on client behaviors.

Two of the qualifying studies assessed recommendation outcomes,[171,178] but results were generally inconsistent in direction and statistical significance. Measurements of provider behaviors were diverse in type and inconsistent in direction and statistical significance. None of the studies in the review reported on behaviors or exposures among clients, only on behaviors of providers toward clients. Several, but not all, qualifying studies showed improvements in intermediate outcomes, such as changes in knowledge, attitudes, beliefs, and intentions of providers.[99,178,181] Studies measuring client knowledge, attitudes, beliefs, or intentions tended to show results in the desirable direction, although they did not consistently reach a level of statistical significance.[173,176,183]

Lack of measurement of key behaviors and health outcomes among clients and lack of consistency in results provided insufficient evidence to determine the effectiveness of the intervention.

Applicability. Evidence about applicability was not collected because effectiveness of the intervention was not established.

Other positive or negative effects. The studies included in this body of evidence did not measure negative effects of reducing UV exposure. None of the studies evaluated effects of these interventions on clinic efficiency or delivery of other preventive or clinical care.

Economic efficiency. Economic evidence was not collected because effectiveness of the intervention was not established.

Barriers to implementation. Evidence about barriers to implementation of this intervention was not collected because effectiveness was not established.

Table 8. Interventions in mass media: information about reports[a]

	Number
Reports meeting inclusion criteria	12[189–200]
Reports excluded, limited execution quality	8[191,194–200]
Reports on an already included study	1[190]
Qualifying reports	3[189,192,193]
Design suitability	
Least	1[193]
Greatest	2[189,192]

[a]Reports may include more than one intervention arm.

Conclusion. According to *Community Guide* rules of evidence,[64] evidence is insufficient to determine the effectiveness of interventions in healthcare settings or for healthcare providers in reducing UV exposure or increasing sun-protective behaviors. Not enough studies of sufficient design and execution quality evaluated the effectiveness of these interventions in changing recommendation outcomes.

Results. Part II: Interventions to Decrease UV Radiation and Increase UV Protective Behaviors in Cross-Cutting Settings

Mass Media Campaigns Alone

Mass media campaigns can promote sun-protective behaviors in a community. They provide information through mass media (e.g., television, radio, newspapers, magazines, and billboards), and can also include small media (e.g., brochures, flyers, newsletters, informational letters, and posters). Mass media has been widely used in public health programs to address behavioral risk factors, and is a recognized vehicle for reaching wide audiences, particularly for the purpose of raising awareness and concern about an issue. These interventions include activities to change the knowledge, attitude, beliefs, intentions, sun-protective behavior, or health outcomes of children or adults.

In the area of skin cancer prevention and control, several mass media campaigns in the United States have been initiated in the past decade, including campaigns by the Skin Cancer Foundation (*www.skincancer.org*); the federal government (*www.chooseyourcover.gov*); the American Academy of Dermatology (*www.aad.org*); the American Cancer Society (*www.cancer.org*); and the Weather Channel (*www.weather.com*). These campaigns were launched because of the reported success of Australia's regional programs, which rely heavily on mass media,[187] but, to date no systematic reviews have been conducted on the effectiveness of such campaigns.[188]

Effectiveness. The team's search identified a total of 12 reports (eight intervention arms)[189–200] on the effectiveness of mass media campaigns without other activities. More information is provided in Table 8. Details of the qualifying studies can be found at *www.thecommunityguide.org/cancer*.

The interventions included a three-segment television program that emphasized early detection and the dangers of sun exposure and sunburn[193]; the use of a CD-ROM–based information kiosk housed at sites accessible to the public[192]; media reporting of skin cancer advisories in the form of a UV index[189]; and a rating of sunlight intensity coupled with recommendations for appropriate sun-protective measures. The team did not review interventions that did not allow for evaluation of the effect of mass media alone on behavior change. Studies that included mass media as part of multicomponent programs are evaluated below (see Multicomponent and Comprehensive Community-Wide Interventions section).

Only two of the three included reports measured behavior change, and neither of those studies allowed assessment of specific sun-safe behaviors.[189,192] One report examined the outcome of self-reported change in nonspecific sun-safe behavior among a select population (those who were aware of the UV index) as a result of media dissemination of the UV index. Another report measured change by using a composite score of eight behavioral questions, which included a component of early detection or self-detection behaviors, and thus did not allow the team to disentangle primary prevention from secondary prevention behaviors. Thus, these studies provide insufficient evidence to determine the effectiveness of mass media approaches to promote sun-safe behaviors or reduce UV exposure. All three reports found that mass media campaigns tended to show increases in some aspects of knowledge.

Applicability. Evidence about applicability was not collected because effectiveness of the intervention was not established.

Other positive or negative effects. The studies in this review did not include information on other potential effects of the interventions. Some authors, however, have cited a concern that a primary prevention campaign may result in increased unnecessary excisions of benign skin lesions; this should be addressed in future skin cancer public awareness campaigns.[201]

Economic efficiency. Economic evidence was not collected because effectiveness of the intervention was not established.

Barriers to implementation. Evidence about barriers to implementation of this intervention was not collected because effectiveness has not been established.

Conclusion. According to *Community Guide* rules of evidence,[64] evidence is insufficient to determine the effectiveness of mass media interventions alone in changing sun exposure behaviors. Evidence is insufficient because of (1) limitations in the design and

Table 9. Interventions for parents or caregivers: information about reports

	Number
Reports meeting inclusion criteria	16[87,95,140–142,144,146,149–151,200,206–210]
Reports excluded, limited quality of execution	3[95,151,200]
Reports on an already included study	4[87,140,142,208]
Qualifying reports	9[141,144,146,149,150,206,207,209,210]
Design suitability	
Least	2[141,209]
Greatest	7[144,146,149,150,206,207,210]

execution of available studies; (2) the small number of qualifying studies; and (3) variability in interventions and outcomes evaluated.

Programs for Caregivers

Interventions for parents or caregivers involve activities that primarily promote sun-protective behaviors for children under their care. A caregiver is defined as a nonparental adult who assumes responsibility, at least part-time on a regular basis, for the care of at least one child (e.g., professional nannies, mother's helpers, babysitters, grandparents, or other family or household members, or daycare providers). Occupational or volunteer caregivers such as lifeguards, teachers, coaches, or scout leaders were not included in this category of interventions, but were instead included in the team's review of interventions in outdoor recreational and tourism or occupational settings (see "Occupational Settings" and "Recreational and Tourism Settings").

Recommendation outcomes included changes in health and behavioral outcomes of adults (i.e., parents or other caregivers) or children. Interventions for parents and caregivers include at least one of the following: (1) provision of information to parents or caregivers and the children under their care (through instruction, education through small media, or both); (2) activities intended to change the knowledge, attitudes, beliefs, intentions, or behavior of parents or caregivers and the children under their care (i.e., modeling, demonstration, or role playing); or (3) environmental or policy approaches, including provision of sunscreen or shade, or scheduling of outdoor activities to avoid hours of peak UV radiation.

Parents and caregivers play an important role in protecting children from UV radiation. In addition to directly reducing children's UV exposure, parents and caregivers can support sun-protective behaviors by incorporating preventive behaviors into family routines and by serving as role models for the children under their care. Parental beliefs about and involvement in disease prevention are important components of successful skin cancer prevention programs for children, especially young children. Parents control family resources and activities and the availability of sunscreen and protective clothing.[202]

The literature reports significant correlations between parental use of sunscreen and use by their children,[71,203] but no such relationship has been demonstrated with other sun-protective behaviors. Some parents know the risks of skin cancer, but do not realize that children are at risk.[67,68] Some parents believe a suntan is a sign of good health; others use sunscreen on their children as their only or preferred skin cancer prevention measure,[59] even when other methods (e.g., shade, clothing) are available. Sometimes parents apply sunscreen on their children incorrectly and inconsistently[50,204,205] (e.g., only after a child has experienced a painful sunburn). Reports of high sunburn rates among youth[49,58] highlight the need for better education of parents and caregivers about appropriate sun-protective behaviors.

Effectiveness. The team's search identified 16 reports (23 intervention arms)[87,95,140–142,144,146,149–151,200,206–210] that evaluated the effectiveness of interventions to prevent UV exposure or skin cancer, directed to parents or caregivers. Information about the disposition of the reports is provided in Table 9. Details of the nine qualifying reports are available at *www.thecommunityguide.org/cancer*.

The reviewed reports used numerous activities and evaluated a variety of outcomes in one or both parents (all nine reports)[141,144,146,149,150,206,207,209,210] and their children (eight studies).[141,144,146,149,150,207,209,210] (No reports evaluated outcomes among other caregivers.) Three reports[141,144,146] involved interactive sun-protection activities (stories, games, puzzles, stamps, arts and crafts) and environmental supports (e.g., providing sunscreen, shade, and signage); two[207,210] relied on educational materials or presentations; one[149] presented a UV exposure-reduction curriculum at poolside, provided home-based activities for parents and their children, and measured degree of tanness using a colorimeter; one[206] targeted new mothers, who were given sun-protective guidelines, postcard reminders, sunscreen samples, baby sun hats, and sun umbrellas; one[150] used point-of-purchase prompts and discount coupons for children's hats and sunscreen; and one[209] combined focused behavioral strategies with community-wide publicity campaigns to change attitudes and behaviors of parents and their children.

Five intervention arms from four reports[141,146,206,207,209] examined changes in parental UV exposure. Fourteen arms from eight reports[141,144,146,149,150,207,209,210] examined changes in children's sun-protective behaviors (using sunscreen; seeking shade; wearing a hat, shirt, or other protective clothing; and composite sun-protective behaviors). Nine arms from four reports[150,206,207,209] examined changes in children's UV exposure, and one report[146] examined changes in incidence of children's sunburn. Five arms from three reports[141,144,210] examined changes in parental knowledge; five arms from three reports[141,207,210] examined changes in parental attitudes or beliefs; and one report[150] examined changes in parental intentions. Three arms from two reports[211] examined changes in children's attitudes or beliefs, and four arms from three reports[141,144,146] examined changes in parent-reported, sun-protection measures and environmental supports (provision of sunscreen and portable shade structures) at outdoor recreational centers or swimming pools.

The reviewed reports demonstrated insufficient evidence of effectiveness of the intervention on parental sun-protective behavior,[141,146,207] parental UV exposure,[141,206,207,209] children's sun-protective behavior,[141,144,146,149,150,207,209,210] children's UV exposure,[150,206,207,209] and incidence of children's sunburn[146] because there were too few reports (parental UV exposure[206,207,209] and incidence of children's sunburn[146]), or results were inconsistent (parental sun-protective behavior,[141,146,207] children's sun-protective behavior,[141,144,146,149,150,207,209,210] and children's UV exposure[150,206,207,209]).

Effects of the intervention on parental knowledge,[141,144,210] parental attitudes or beliefs,[141,207,210] and parental intentions were inconsistent.[150] Three arms from two reports[209,210] demonstrated desirable and consistent effects of the intervention on children's attitudes or beliefs (median relative difference, 67.6%).

Applicability. Evidence about applicability was not assessed for this intervention because effectiveness was not established.

Other positive or negative effects. The systematic review development team identified other potential effects of interventions aimed at parents or caregivers, and further evaluation is needed to determine the likelihood of their occurrence. Interventions for parents or caregivers may not only reduce risk of overexposure to UV radiation based on over-reliance on sunscreen use by the parent or caregiver, but the intervention may also reduce reliance on sunscreen for the children under their care. Additionally, a reduction in UV exposure among this population may be associated with reductions in cataract formation. Potential negative effects of the intervention include vitamin D deficiency and reductions in outdoor physical activity.

Economic efficiency. Economic evidence was not collected for this intervention because effectiveness was not established.

Barriers to implementation. Evidence about barriers to implementation of this intervention was not collected because effectiveness was not established.

Conclusion. According to *Community Guide* rules of evidence,[64] available reports provide insufficient evidence to determine the effectiveness of interventions for parents or caregivers in preventing UV exposure or skin cancer. Evidence was insufficient because of too few reports or inconsistent evidence.

The reviewed reports demonstrate that the intervention led to improvements in children's attitudes or beliefs, as well as sun-safety measures and environmental supports at outdoor recreational centers and swimming pools. Because changes in reported policies did not necessarily translate into changes in UV exposure or behavior, these are not recommendation outcomes (see methods in Appendix A).

Community-Wide Multicomponent Programs, Including Comprehensive Community-Wide Interventions

The team defined **community-wide multicomponent programs** as those that used combinations of individual-directed strategies, mass media campaigns, and environmental and policy changes in an integrated effort in a defined geographic area (city, state, province, or country). Such programs may also incorporate setting-specific strategies within the larger program. They are usually delivered with a defined theme, name, logo, and set of messages.[80,187] The team included studies in this review if they occurred in a defined geographic area, and had at least two components and two settings. The team defined **comprehensive community-wide interventions** as being multilevel (i.e., those that include multiple individual-directed, setting-specific, and community-wide components), addressing a substantial proportion of the population in a defined area, and lasting longer than 1 year.

Multicomponent sun-protection programs aim to achieve behavioral changes among the population of a defined geographic area (e.g., counties, states, countries). Some are relatively modest efforts, such as combining a setting-specific program with a community-wide mass media or small media effort, whereas others are multilevel and comprehensive, involving entire communities, schools, workplaces, healthcare and recreation settings, mass media, and other organizations. In addition to education, these programs may also include significant efforts to institute sun-protection policies and structural supports. Programs like these have been in place for 2 decades in Australia, with the longest-standing and most commonly cited ones being

Table 10. Interventions in community-wide multicomponent and comprehensive community-wide settings: information about reports

	Number
Reports meeting inclusion criteria	35[79–82,94,187,188,209,212–238]
Reports excluded, limited quality of execution	5[224,228,229,232,234]
Reports on the same study	22[79,80,82,94,187,188,212–217,220,222,223,225–227,230,235,236,238]
Qualifying reports	8[81,209,218,219,221,231,233,237]
Design suitability	
Least	3[209,221,233]
Moderate	3[218,231,237]
Greatest	2[81,219]

the Slip! Slap! Slop! and SunSmart campaigns in Victoria.[187] Two U.S. programs, the SafeSun Project in New Hampshire[80,81] and the Falmouth Safe Skin Project in Massachusetts,[209] have used similar strategies on a smaller scale.

The team conducted this review to assess the effectiveness of these programs and the extent to which available evidence (which comes mostly from sustained programs in Australia, a country with high skin cancer rates) may or may not generalize to the United States, where skin cancer is a less prominent public health concern and the population includes a higher proportion of dark-skinned individuals who are at lower risk of developing skin cancer.

Effectiveness. The team's search identified 35 reports of the effectiveness of multicomponent and comprehensive community-wide interventions.[79–82,94,187,188,209,212–238] Information about the disposition of the reports is provided in Table 10. Details of the ten qualifying reports are available at *www.thecommunityguide.org/cancer*.

Of the seven studies[81,209,218,221,228,231,233] in the community-wide multicomponent programs that measured covering-up or sun-avoidance behaviors, four[218,228,231,233] showed generally positive outcomes, and three others[81,209,221] showed essentially no significant change in the **recommended** behaviors of interest (i.e., sun avoidance or covering up).

Results of comprehensive, community-wide programs were generally more positive. All three such studies showed changes in covering-up or sun-avoidance behaviors in the desired direction. These results, all from Australia, are promising, but by themselves still provide insufficient evidence to determine effectiveness due to small numbers of studies and limitations in study design and execution (two time-series studies and one before-and-after study, all with fair quality of execution). Insufficient evidence to determine effectiveness is not the same as evidence of ineffectiveness. Additional studies are needed to confirm the effectiveness of these programs and to determine whether they can be successfully applied to the U.S. population.

Studies that evaluated self-reported sunscreen use had generally demonstrated desirable effects (increased sunscreen use).[231,233,237] Many of the comprehensive community-wide studies evaluated changes in school and government policy, and changes in environment; they generally showed positive process measure outcomes (e.g., increase in number of sun-safe policies in schools or governments, increase in number of stores with available low-cost sunscreen or increase in amount of information and number of posters provided).[217,237] The effects on knowledge, attitudes, and beliefs of adults and children were inconsistent.[209,231,234]

Applicability. Because evidence was insufficient to determine effectiveness, the team has not included a full evaluation of applicability. However, it should be noted that the most promising results of the available studies are from three long-term, intensive interventions in Australia.[217,231,237] The context in which those studies occurred may differ in some important ways from the U.S. context: For example, the incidence of skin cancer is higher and thus more of a health priority in Australia, where there is less heterogeneity in skin color and thus higher skin cancer risk than in the United States, UV exposure is probably on average higher than in the United States, and in some of those studies, the mass media component was heavily subsidized. Any of these factors might affect the extent to which these results may or may not translate to the U.S. context. Additional replications in other contexts, especially in the United States, would be useful.

Other positive or negative effects. The studies included in this body of evidence did not address potential harms of reducing UV exposure, such as increases in the incidence of vitamin D deficiencies or reductions in physical activity.

Economic efficiency. Economic evidence was not collected because effectiveness of the intervention was not established.

Barriers to implementation. Evidence about barriers to implementation of this intervention was not collected because effectiveness was not established.

Conclusion. According to *Community Guide* rules of evidence,[64] evidence is insufficient to determine the effectiveness of multicomponent programs to reduce

UV exposure or increase sun-protective behaviors because of inconsistent results. Evidence was also insufficient to determine the effectiveness of comprehensive community-wide programs to reduce UV exposure or increase sun-protective behaviors because of small numbers of studies and limitations in their study design and execution.

General Research Issues

Although the effectiveness of two recommended interventions (i.e., interventions in primary schools for improving children's covering-up behaviors and interventions in recreational or tourism setting for improving adult covering-up behaviors) for reducing the risk of skin cancer has been established, important general research issues remain, some of which have been identified in previous literature.[22,65,239–242] The most important and surprising conclusion is that, despite all the issues, settings, and populations examined, little research measures key behavioral and health outcomes. The research issues are organized below by the way each individual study is scored from a design and quality perspective.[243]

Design and Analysis Considerations

Of the 85 studies reviewed for all categories, 55 used experimental designs, and many involved group-randomized trials (note that overlap may exist for reports found in more than one category). Most of the randomized controlled trials involved setting-specific interventions, whereas many of the community-wide interventions and one healthcare setting intervention used other appropriate designs, such as time-series designs ($n = 4$). The remaining 26 studies used before-and-after designs. All of the designs have important strengths and weaknesses. Studies that incorporate concurrent control groups help to control for changes over time (e.g., history, maturation) that are not attributable to the intervention. Several of the included studies demonstrated the importance of this control and showed either desirable[80] or undesirable changes (including no change)[146,192] in the control groups over time. The team's review of school-based interventions found smaller effects in those studies with greatest suitability of design, suggesting that simpler before-and-after designs may have overestimated intervention effects in that review. On the other hand, before-and-after, time-series, and similar designs have strengths as well. For example, before-and-after and time-series designs may have fewer problems with contamination and may have advantages with respect to external validity, because their populations may be less highly selected (e.g., less dependent on volunteers, less highly motivated) than the populations included in tightly controlled trials. Additional diverse approaches, in terms of study design and execution, and with attention both to internal and external validity, are certainly worth pursuing. Consistently rigorous analytic methods are needed, and future studies should control for relevant confounders, such as risk levels and weather conditions.

Description of Target Population and Context

Several reports in this area of research did not contain basic descriptions about the intervention or population. For example, many studies did not report the year(s) in which the study took place. In many instances, the distribution of the population by race and ethnicity or sun sensitivity was not described. Many of the settings could have been better described. For example, many reports did not describe the characteristics of the schools in which interventions took place (e.g., whether schools were private or public, how many students they served, and the characteristics of the students and faculty). Finally, better descriptions are needed of annual UV exposure in the places in which studies were conducted. Better descriptions of these important issues will help to assess likely applicability of the findings or to explain any variability of effects.

Description of Intervention

Several reports mentioned that their programs emphasized skin cancer prevention, but it was difficult to disentangle what the specific components were or how much emphasis there was on primary prevention (versus early detection) or on promoting use of sunscreen versus on covering-up or sun-avoidance behaviors. Further information is needed on which attributes of the interventions contribute most to intervention effectiveness or ineffectiveness (e.g., do policy components or education components contribute more to intervention effectiveness; what are the central "active ingredients" in complex interventions). Describing intervention characteristics in greater detail might also help practitioners replicate successes. If journal space limitations are a barrier to more complete and useful intervention descriptions, supplemental communication strategies might be explored (e.g., Internet publication).[48,244]

Duration of Interventions and Length of Follow-up

About two thirds of the interventions had a duration of <6 weeks, and more than half the evaluations followed subjects for <3 months. Given the seasonality of sun-protective behaviors and the importance of encouraging habitual as opposed to short-term behavior change, a longer follow-up is crucial. The trend toward multi-year interventions and longer follow-up periods is an important improvement, although limitations in re-

search resources can be an important barrier to longer-term programs and evaluations.

Intervention Quality

This is one of the most difficult attributes to assess from publications describing intervention studies.[245] Intervention quality is also very hard to conceptualize and measure. However, the following observations are offered.

An encouraging trend can be seen in increasing use of formative research and pre-testing of interventions before they are implemented.[142,150,163]

Mediating factors deserve greater attention and need to be correlated with behavior changes. For example, if the intervention is thought to work through changes in attitude, did these changes in attitude occur along with the behavior change? To date, few studies in this area of research have reported on both mediating factors and behavioral or health outcomes. A need also exists to develop measures of the effects of environmental and policy change strategies. Few interventions addressed policy or environmental changes and in those that did, the effects of the policy or environmental components could not be disentangled from other aspects of the intervention. Often, the reports measured the increase in number of policies, but did not measure changes in actual practice.

Measurement of Exposure

Few studies reported process evaluation data, which can help to assess how much of the intervention was actually implemented. Improvement in this area would be helpful, especially for interventions of longer duration and increased complexity.

Measurement of Outcomes

More behavioral and health outcomes need to be examined. The majority of intervention studies examined intermediate outcomes, such as knowledge, attitudes, and intentions, rather than actual sun-protective behaviors or health outcomes. For example, in primary school settings, only one study examined incidence of sunburn. In the secondary school setting, very few studies examined sun-protective behaviors other than sunscreen use. The pattern of examining many intermediate outcomes and few behavioral and health outcomes was generally consistent across reviews. Furthermore, many studies that did measure behaviors measured only sunscreen use. Given recent concerns about the adequacy of sunscreen as a sole protective strategy (see Sun-Protective Behaviors section for more information on sunscreens), additional behavioral and health outcomes should also be measured.

Outcomes need to be similar to evaluate effectiveness. For example, measuring protective behaviors prior to intervention, but measuring behavioral intentions after the intervention does not allow calculation of an effect.

Measurement of specific sun-protective behaviors is important. Many of the studies reported composite behaviors and did not allow measurement of the effect of the intervention on a specific sun-protective behavior. Other studies concentrated on only one behavior: improvement in sunscreen use. More interventions with a greater focus on covering up and sun avoidance, and a decreased emphasis on sunscreen use are needed. Given recent research findings on the effectiveness of sunscreens, more detailed research on sunscreen use is needed. Are higher SPF sunscreens being used? Does sunscreen use extend the amount of time out in the sun? How do different sun-protective behaviors interact (e.g., does seeking shade make wearing sunscreen or a hat unnecessary)? Also, the distinction between intentional sun exposure (to achieve a biological response, such as a tan) and unintentional sun exposure (no specific intention to acquire a tan or to stay out in the sun, but rather a result of daily activities such as work or sports) has not been well studied. It has been reported that intention may affect sun-protective behavior and thus might affect intervention effectiveness.[50]

The adequacy of the sun-protective behaviors is usually not accounted for in self-report measures or parent-reported measures (for their children), although new tools may enable us to improve the validity of self-reports.[168] Most studies rely on self-reporting of behaviors and their presumed determinants. Self-report is particularly vulnerable to social-desirability bias. A few studies have used multiple self-report measures (e.g., both surveys and diaries), and have examined the relative merits of each for assessing behavior.[140,141,246] Studies in nonschool settings have more often (but still rarely) used third-party observations of behaviors, visual inspection, and occasionally, physical measures.[246] However, observations may not reflect adoption of a "habit" but rather only a moment in time.[150] Physical measures using erythema meters, spectrophotometers,[246] colorimeters,[247] and polysulphone dosimeters[248] are useful, but may be impractical in large trials, and measures of tanness may not be valid in nonwhite populations.

None of these measurement strategies is without challenges, and additional triangulation using multiple strategies might be useful. Also, further work is needed to increase consistency between at least a core set of behavior change measures that can be used to compare and contrast study results. Lack of consistency makes it very difficult to compare and contrast results across studies. In addition, measures should be developed that make the public health importance (or lack thereof) of observed changes easier to discern (e.g., small average changes in Likert-like scales are very hard to interpret).

Addressing this concern of a lack of consistency in measurement, in 1998 a Canadian National Workshop on measurements of sun-related behaviors developed a consensus on a standard set of measures for program evaluation and for monitoring of sun exposure and protective behaviors.[249] The workshop summarized that sun-related behaviors are different from other health behaviors such as nutrition and tobacco in the following ways:

- Sun exposure varies substantially seasonally and geographically, and collection measures must be sensitive to such external influences.
- Sun-related behaviors require individuals to interpret and respond to their risk according to a complex set of environmental and physiological clues.
- Comprehensive sun protection requires individuals to undertake a set of behaviors. Therefore, research must account for a set of behavioral outcomes rather than a single indicator.
- A number of nonbehavioral factors influence individual risk, including phenotype, occupation, and age.

Additionally, the workshop identified several issues related to data collection and measurement unique to sun-related behaviors:

- Most research relied on self-reported behaviors by youth and adults and proxy reports for children. More objective data collection tools (e.g., daylight exposure monitors) might be useful to validate self-reported measures.
- Operational definitions of sun-related variables have varied substantially across published studies.
- Recall periods also vary substantially. Some studies assess behavior over a long period of time and some over a short period of time (such as last weekend).

The workshop concluded with six essential core items to include for future behavioral surveillance surveys and smaller evaluation projects. These items included measurement of sunburn, sun exposure, phenotype, and five separate sun-protective behaviors.

Theory, Conceptual Models, and Evidence for Planning Interventions

Like other types of health promotion efforts, skin cancer prevention programs are most likely to succeed when they are based on a clear understanding of the targeted health behaviors and their environmental context. Theories about why people do or do not engage in sun-protective behaviors, and data about a given target audience (e.g., about a particular population's barriers to and facilitators of sun protection) are often helpful in guiding the search for promising and suitable interventions.[250] Conceptual models of program characteristics and outcomes of interest, such as the analytic frameworks developed for these reviews, might also be helpful for program planning. Population-wide surveys have been used to examine the distribution of behaviors and their determinants, and can contribute to the design of strategies to increase sun-protective behaviors. Other formative research methods, such as focus groups, have also been used to develop targeted skin cancer prevention programs, and have been especially useful when working with understudied audiences in new locations, such as multiethnic Hawaii.[142]

Although few evaluation reports describe the theoretical bases of interventions to prevent skin cancer, many of the more recent publications specify one or more of the theories that have guided their programs. These have included learning theory,[83] theories of message framing and fear arousal,[87,133,138,208] applied behavioral analysis,[148] stages of change,[155] social cognitive theory,[145,146] and ecologic approaches.[187] Theories that suggest both individual-directed and environmental strategies are most compatible with multicomponent and community-wide interventions. People who engage in the planning of skin cancer prevention programs—whether for community health improvement or for scientific evaluation—should identify and examine their assumptions and, in turn, build on the theories, models, and local context underlying their approaches to improve sun-protective behaviors in their communities and target audiences.

An important area of inquiry in the arena of behavioral research to reduce UV exposure concerns the relative effectiveness of various messages. Three studies[123,132,134] in a secondary school setting reported a theory base for message development, but only one[134] gave sufficient detail to replicate message testing. These studies, which for the most part were not conducted as widely distributed interventions, were useful to guide the development of messages used in setting-specific interventions to reduce UV exposure. Some persuasion theories directed researchers to build messages that tested cognitive features, such as inductive or deductive logic about sun-protective behaviors or benefits of tanning.[132] Other theories directed researchers to craft messages with emotional features, such as humor or fear.[134] The small number of available studies and their diversity preclude overall conclusions.

Research to improve the use of message-development theories of message development, especially in terms of instruments and message templates, could benefit interventions to increase sun-protective behaviors. In all studies, messages were assumed, rather than tested, to possess the characteristics that they were intended to have. Although differences in opinion exist as to what constitutes a message development study and a study in which the message is the intervention, either type of study could benefit by including a control group

to rule out chance having as much to do with an outcome as the message.

Research Needs and Work in Progress

The field of behavior change for skin cancer prevention has progressed significantly in the past decade, but important areas for further advancement exist. As outlined above, these include design, measurement, better description of interventions, development of a better understanding of how environmental and policy interventions work, and studies in multiethnic populations. The use of new communication technology and international collaborations can make significant contributions in these areas. The team hopes that the availability of systematic reviews that identify both progress to date and the remaining gaps will help to reduce the gaps in available research.

Specific Research Issues

Although most of the research gaps described above were general, and could explain why most setting-specific categories did not produce sufficient evidence to determine effectiveness, a few research issues were specific to the setting or target group.

Interventions for Secondary Schools

More studies are needed to examine sun-protective behaviors of adolescents and young adults, and to determine what kind of approach might work best in this population, especially given the low baseline prevalence of sun-protective behaviors.

Interventions in Occupational Settings

Studies that target the most common outdoor occupational workers—mail carriers, agricultural workers, landscapers, horticulturists, foresters, construction workers, telephone line workers, commercial fishery workers, land surveyors and mappers, oil field workers, amusement park attendants, and athletes—are needed.

Interventions in Healthcare Settings

Almost all studies in this category examined the counseling behavior of the provider and not the patient. More studies that examine the behavioral or health outcome of the end user—the patient—are needed. In this small subset of studies, the provider was most often a physician or a physician-in-training, but studies examining the role of the nonphysician provider would help identify if counseling skills to change behavior might be better suited for providers with the time and skills, such as a nurse or a health educator. Additionally, more studies are needed to examine healthcare system studies oriented directly to patients.

Interventions for Parents and Caregivers

Studies are needed to examine the effect of interventions on nonparental caregivers, as it is becoming increasingly common for children to be cared for by nonparental caregivers while both parents are at work outside the home.

Interventions in Multicomponent Community Settings

Approaches to better define the "active ingredients" (i.e., the most important components that contribute to the success of these interventions) would be helpful, as would determining the applicability of these interventions to the U.S. population.

Summary: Findings of the Task Force on Community Preventive Services

The Task Force recommends two interventions to improve sun-avoidance or covering-up behaviors: educational and policy interventions in primary schools, and programs for adults in outdoor recreational or tourism settings. These Task Force recommendations represent tested interventions that promote decreased UV exposure at the community level. They can be used for planning interventions to promote UV protection or to evaluate existing programs. The other interventions that were reviewed, but for which evidence was insufficient to determine effectiveness, may also prove useful in providing a broader taxonomy of interventions that might be tried in communities and in promoting additional testing and evaluation.

The Task Force reviews and recommendations identify promising strategies for reducing UV exposure using the interventions that have been proven effective. Because sun-protective behaviors are not practiced often enough, and because the incidence of skin cancer is increasing, interventions for which evidence is currently insufficient deserve more research attention, while interventions that have been proven effective merit increased attention to diffusion, dissemination, replication, and implementation. These reviews by themselves do not provide advice about implementation of effective programs, but the referenced articles provide additional detail for those with an interest, and additional implementation advice is also available elsewhere.[61,65,244,251–253]

Many of the recommended interventions had small to moderate behavior change scores. Readers should keep in mind that the interventions were targeted to populations rather than single individuals. Small changes in behavior in large populations can result in substantial public health benefits.

The reviews on which the recommendations are based also provide a starting point for improving the

quality and usefulness of existing research. As might have been predicted in this emerging area of research, many questions about these interventions remain to be answered. The team hopes that the documentation of evidence gaps in these reviews will help to improve the next generation of research.

Using These Recommendations

Choosing interventions that are well matched to local needs and capabilities, and then carefully implementing those interventions, are vital steps for increasing UV protection. In setting priorities for the selection of interventions to meet local objectives, recommendations and other evidence provided in the *Community Guide* should be considered along with such local information as skin cancer incidence, skin cancer mortality, prevalence of sun-protective behaviors, latitude, UV index averages, resource availability, administrative structures, and economic and social environments of organizations and practitioners.

An assessment of the community is essential to deciding how, when, and where to focus skin cancer prevention efforts. Some of the most important issues to consider are priorities, place, population, and practices. Establishing skin cancer prevention as a priority is a challenge in various settings. Skin cancer is but one of many health topics that merit attention, and for certain communities, skin cancer prevention may not be as high priority as other cancers or other diseases. In warmer climates, children spend more time outdoors year-round, whereas in colder climates, outdoor activities are much more limited by the weather. Snow-belt states and rainy regions may afford less opportunity for outdoor recreation, but may want to invest in education about UV exposure during winter sports seasons, when sunshine is prevalent, and for residents who travel to sunnier regions. Population characteristics in a community, such as relevant age group, gender distribution, skin phototype, and socioeconomic status can guide program planning. Although light-skinned people are at a higher risk for skin cancer, darker-skinned people also need to take precautions when exposed to UV radiation. All of these factors can affect the attitudes, ability, and behaviors of the community to take sun-protective precautions. Awareness of the existing practices for sun exposure and sun protection among community members helps define the challenge in achieving optimal sun-safety practices.

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Points of view are those of the Task Force on Community Preventive Services and do not necessarily reflect those of the Centers for Disease Control and Prevention.

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Appendix A

Methods

In the *Community Guide*, evidence is summarized on (1) effectiveness of interventions; (2) applicability of evidence data (i.e., the extent to which available effectiveness data might apply to diverse population segments and settings); (3) positive or negative effects of the intervention other than those assessed for the purpose of determining effectiveness, including positive or negative health and nonhealth outcomes; (4) economic impact; and (5) barriers to implementation of interventions. When evidence is insufficient to determine the effectiveness of the intervention on a specific outcome, information about applicability, economics, or barriers to implementation is not included, unless there is an issue of particular interest.

The following process was used to review evidence systematically, and translate that evidence into the conclusions reached in this article involved the following steps:

- Forming a systematic review development team
- Developing a conceptual approach to organizing, grouping, and selecting interventions
- Selecting interventions to evaluate
- Searching for and retrieving evidence
- Assessing the quality of and abstracting information from each study
- Assessing the quality of and drawing conclusions about the body of evidence of effectiveness
- Translating the evidence of effectiveness into recommendations
- Considering data on applicability, other effects, economic impact, and barriers to implementation
- Identifying and summarizing research gaps

This section summarizes how these methods were used in developing the reviews of interventions to reduce exposure to UV radiation. The reviews were produced by the systematic review development team and a multidisciplinary team of specialists and consultants representing a variety of perspectives on cancer prevention.

Search for Evidence

Electronic searches for literature were conducted in MEDLINE, PsycINFO, and CINAHL (nursing and allied health). The team also reviewed the references listed in all retrieved articles, and consulted with experts on the systematic review development team and elsewhere, including seeking published and unpublished articles in a sun protection listserve sponsored by the Environmental Protection Agency. The team included journal articles and governmental reports. The initial literature search on the topic was conducted in 1999, and the search was updated monthly until June 2000. The MEDLINE search strategy is shown in Table A1.

To be included, identified studies had to:

- Evaluate a specified population-based intervention for the prevention of skin cancer
- Be published in English from 1966 to June 2000
- Involve primary prevention of skin cancer (i.e., studies promoting screening were excluded because the effectiveness of screening is uncertain according to the USPSTF (see *www.ahrq.gov/clinic/uspstf/uspsskca.htm*)
- Evaluate effectiveness and assess at least one of the outcomes specified on the team's analytic frameworks and/or provide information on one or more of the following domains: applicability, other effects (i.e., harms or side effects), economic evaluation, or barriers to intervention implementation
- Be conducted in an established market economy*
- Be a primary study rather than, for example, a guideline or review

Studies of effectiveness or applicability also required that the study compare a group of people who had been exposed to the intervention with a group of people who had not been exposed or who had been less exposed. (The comparisons could be concurrent or in the same group over time. Studies in the other domains could be with or without a comparison.)

*Established market economies as defined by the World Bank are Andorra, Australia, Austria, Belgium, Bermuda, Canada, Channel Islands, Denmark, Faeroe Islands, Finland, France, Germany, Gibraltar, Greece, Greenland, Holy See, Iceland, Ireland, Isle of Man, Italy, Japan, Liechtenstein, Luxembourg, Monaco, the Netherlands, New Zealand, Norway, Portugal, San Marino, Spain, St. Pierre and Miquelon, Sweden, Switzerland, the United Kingdom, and the United States.

Table A1. Search strategy for *Community Guide* skin cancer review

1	skin neoplasms/or skin cancer.tw.
2	melanoma/
3	carcinoma, basal cell/or carcinoma, squamous cell/
4	nevus/or nevi.tw.
5	keratosis/
6	actinic keratoses.tw.
7	(sun damage or photodamage).tw. or skin aging/
8	solar keratoses.tw.
9	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8
10	primary prevention/or prevention.mp. [mp = title, abstract, registry number word, mesh subject heading]
11	pc.fs.
12	knowledge/or knowledge, attitudes, practice/or knowledge.mp. [mp = title, abstract, registry number word, mesh subject heading]
13	awareness/or awareness.mp. [mp = title, abstract, registry number word, mesh subject heading]
14	(attitude or attitude or attitudes).mp. [mp = title, abstract, registry number word, mesh subject heading]
15	public policy/or policy.mp. [mp = title, abstract, registry number word, mesh subject heading]
16	health promotion/or health education/
17	behavior/or behavior:.mp. [mp = title, abstract, registry number word, mesh subject heading]
18	10 or 11 or 12 or 13 or 14 or 15 or 16 or 17
19	9 and 18
20	19 not screen:.tw,hw.
21	19 and screen:.tw,hw. and primary prevention.mp. [mp = title; abstract, registry number word, mesh subject heading]
22	20 or 21
23	(sunburn: or suntan: or tanning).mp. [mp = title, abstract, registry number word, mesh subject heading]
24	ultraviolet rays/or ultraviolet radiation.mp. [mp = title, abstract, registry number word, mesh subject heading]
25	(sun exposur: or sun protect: or sun safety or solar protect: or solar exposur:).mp. [mp = title, abstract, registry number word, mesh subject heading]
26	sunlight/or protective clothing/or protective clothing.mp. [mp = title, abstract, registry number word, mesh subject heading]
27	sunscreening agents/
28	23 or 24 or 25 or 26 or 27
29	18 and 28
30	29 not screen:.tw,hw.
31	29 and screen:.tw,hw. and primary prevention.mp. [mp = title, abstract, registry number word, mesh subject heading]
32	30 or 31
33	22 or 32
34	limit 33 to English language
35	limit 34 to human

Abstraction and Evaluation of Studies

Each study that met the inclusion criteria was read by reviewers who used a standardized abstraction form to record information from the study.[1] Any disagreements between the reviewers were reconciled by consensus among the review team members.

Assessing the Suitability of Study Design

Design suitability was assessed for every identified study.[2] The team's study design classifications, chosen to ensure consistency in the review process, sometimes differ from the classification or nomenclature used in the original studies. Studies with good or fair quality of execution, and any level of design suitability, were included in the body of evidence for the purpose of assessing effectiveness.

Assessing the Quality and Summarizing the Body of Evidence of Effectiveness

Quality of study execution was systematically assessed using *Community Guide* methods and its abstraction form.[1,2] Some studies had more than one separate intervention arm, (i.e., distinct interventions that were compared with each other and/or a control). Under these circumstances the team treated distinct "arms" as independent interventions for the purposes of this review.

Criteria for assessing the strength of evidence on effectiveness in the *Community Guide* have been published elsewhere.[2] Generally, by *Community Guide* standards, the minimal number of studies sufficient to draw a conclusion about a given intervention outcome is as follows:

- One study of greatest design suitability and good execution and sufficient effect size, or
- Three studies of greatest or moderate design suitability and good or fair execution with sufficient and consistent effect size, or
- Five studies of greatest, moderate or lowest design suitability and good or fair execution with sufficient and consistent effect size.

The team abstracted information from the studies about the outcomes of interest specific to the intervention under evaluation. Unless otherwise noted, the team represented the results of each study as a point estimate for the relative change in the outcome of interest associated with the intervention. The team calculated absolute and relative effect sizes as shown in Table A2. When the team had to make choices between effect measures, it used the last available measure both before and after the intervention in calculating effect sizes.

The team reported the effect of the intervention as beneficial, when the intervention is associated with a change in an outcome in the desired direction (i.e., an increase in sunscreen use or a decrease in exposure to peak sun) and as undesirable when an effect went in the opposite direction.

When the team decided that a summary effect measure was feasible and useful, it reported the median and interquartile range to show effect sizes from multiple studies. The team also noted whether zero was included within the upper and the lower interquartile range. Interquartile ranges including zero suggest that the results are inconsistent in direction; interquartile ranges not including zero suggest that the results are generally consistent in direction.

In some cases, the team had to select among several possible effect measures for inclusion in its summary measures of effectiveness. When available, the team included measures adjusted for potential confounders in multivariate analysis rather than crude effect measures. No studies were excluded from the evaluation strictly on the basis of an insufficient follow-up period. If the intervention program had

Table A2. Summary effect measures

	Before-and-after only design	Study with comparison group (RCT, cohort design, nonrandomized trial)
Absolute effect measure	Post–pre	$\Delta I - \Delta C$
Relative effect measure	(Post–pre)/pre × 100	$\Delta I/I_{pre} - \Delta C/C_{pre}$

C, control; I, intervention; RCT, randomized controlled trial.

multiple evaluations at different follow-up points, the team chose the evaluation at the longest follow-up period.

In evaluating the body of evidence, the team assessed size and consistency of reported effects and attempted, if possible, to explain any inconsistency. The team also assessed whether there were common threats to validity in the body of evidence that either weakened or strengthened the conclusions. The team summarized the strength of the body of evidence on the basis of the number of available studies, the strength of their design and execution, and the size and consistency of reported effects, as described in detail elsewhere. When the number of studies and their design and execution quality were sufficient by *Community Guide* standards to draw a conclusion on effectiveness, the results were summarized both graphically and statistically.

It is critical to note that when the team concludes that evidence is insufficient to determine the effectiveness of the intervention on a given outcome, it means that it is not yet known what effect, if any, the intervention has on that outcome. It does not mean that the intervention has no effect on the outcome.

Other Effects

The *Community Guide* reviews of UV protection interventions systematically assessed the effects of the intervention on other outcomes that were identified as other harms or benefits of the intervention in the analytic frameworks. The team also notes other harms or benefits if they were mentioned in the studies reviewed.

Economic Evaluations

Economic evaluations were conducted only there is sufficient or strong evidence of effectiveness of the interventions. Methods used in economic evaluations are described elsewhere.[3] The standard abstraction form used for economic abstraction is available at *www.thecommunityguide.org/methods/econ-abs-form.pdf*.

Summarizing Barriers to Implementation of Interventions

Barriers to implementation are summarized only if there is sufficient or strong evidence of effectiveness of the intervention.

Summarizing Research Gaps

Systematic reviews in the *Community Guide* identify existing information on which to base public health decisions about implementing interventions. An important additional benefit of these reviews is identification of areas in which information is lacking or of poor quality. To summarize these research gaps, remaining research questions for each intervention evaluated were first identified. Where evidence of effectiveness of an intervention was sufficient or strong, remaining questions about effectiveness, applicability, other effects, economic consequences, and barriers were summarized. Where evidence of effectiveness of an intervention was insufficient, only remaining questions about effectiveness and other effects were summarized. Applicability issues were summarized only if they affected the assessment of effectiveness. In general, the *Community Guide* has made the argument that it is premature to identify research gaps in economic evaluations or barriers before effectiveness is demonstrated. For each category of evidence, issues that emerged from the review were identified, based on the informed judgment of the team. Several factors influenced that judgment. When a conclusion was drawn about evidence, the team decided if additional issues remained. Specifically, if effectiveness was demonstrated by using some but not all outcomes, the team did not necessarily identify gaps in all of the other possible outcomes as important evidence gaps. If the available evidence was thought to be generalizable, the team did not necessarily list all subpopulations or settings where studies had not been done as research gaps. Within each body of evidence, the team considered whether there were general methods issues that would improve future studies in that area.

References for Appendix

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Appendix B

Table B1. Summary evidence table: interventions in primary schools

Author, year, location, study design, design suitability, study quality	Follow-up interval; *n;* limitations	Demographics: age, gender, race/ethnicity, SES	Intervention	Results: summary effect measures (behavioral and health outcomes only), *p* value, within or between groups
Bastuji-Garin (1999)[88] France Before-and-after study Least suitable Good quality	F/U: 3 months from end of I *n*=203 Limitations: Neither the content nor the intensity of the education were described in detail; no description of the sampling frame for the schools or eligibility criteria; volunteer samples of schools may have selected for staff with an interest in the subject and biased results away from the null; single interviewer not blinded; intervention may have changed self-reports rather than actual behavior; unrelated time trends may have contributed to apparent positive effects	Mean age: 9.2y Female: 50.5% Race/ethnicity: NR SES: Upper middle class	Interactive sun-awareness program consisting of individual journals prepared by the children, and a skit and poster, or interactive game to integrate material of each sun awareness topic; weekly packet provided a different topic each week for 4 weeks	**Child health outcomes and sun-protective behaviors** (single items) Children reporting that their skin never sunburns: Absolute change: +20.0 Relative change: +42.7% ($p<0.001$, within) Children reporting that they always wear a hat Absolute change: +9.9 Relative change: +41.6% ($p=0.01$, within) Children reporting that they always wear a t-shirt: Absolute change: +2.5 Relative change: +5.3% ($p=0.01$, within) Children reporting that they avoid sunny hours Absolute change: +10.8 Relative change: +16.4% ($p=0.02$, within) Children reporting that they always wear sunscreen: Absolute change: +9.4 Relative change: +37% ($p=0.03$, within)
Buller (1994)[92] Arizona RCT Greatest suitability Good quality	F/U: Immediately following end of I *n*=139 Limitations: Limited demographic information on study population; no description of schools; convenience sample of schools; self-reported outcome measures; group design but individual analyses may have resulted in overestimated effect	Mean age: NR (4th–6th graders) Female: NR Race/ethnicity: NR SES: NR	I: Classroom curriculum for 4th–6th graders, consisting of skin cancer and UV protection education, lesson plans, inclass activities, take-home activities, newsletter, and dissemination suggestions for involving entire school C: No intervention	Children wear protective clothing in summer (single item; range 1–3): Absolute change: 0.37 Relative change: +27.6% ($p<0.05$, between) Children wear sunscreen in winter (single item; range 1–3): Absolute change: 0.18 Relative change: +13.55% ($p<0.05$, between)

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Table B1. Continued

Author, year, location, study design, design suitability, study quality	Follow-up interval; *n;* limitations	Demographics: age, gender, race/ethnicity, SES	Intervention	Results: summary effect measures (behavioral and health outcomes only), *p* value, within or between groups
Buller (1999)[90] Arizona RCT Greatest suitability Good quality	F/U: 2 months from B/L *n*=159 Limitations: No descriptions of schools; convenience sample of volunteer schools and classrooms; children smart self-reported outcome measures; no comparison of groups at B/L	Mean age: NR (range: 9–11y)+ Female: 53.7% Race/ethnicity: 57% white; 36% other (mainly Hispanic); 7% NR SES: NR	I-1: CD-ROM sun safety game and interactive activities, modified for grades 4 and 5, with children earning points on each activity I-2: Sun safety curriculum only, sun safety game and activities I-3: Sun-safety curriculum + CD-ROM C: No intervention	**Child composite sun-protective behaviors** (mean score, 13 items, 3-point scale): I-1: Absolute change: +0.07 Relative change: +3.5% I-2: Absolute change: +0.14 Relative change: 7.3% I-3: Absolute change: +14 Relative change: 7.2% Overall p=0.074
Buller (1996)[89] Arizona RCT Greatest suitability Good quality	F/U: 2 months from B/L *n*=447 Limitations: Low participation rates; childrens' reports of own and of parents' behavior; group design and individual analyses may have overestimated significance	Mean age: range 8–10y Female: 49% Race/ethnicity: 63.7% white; 10.4% Hispanic; 2.8% African American; 15.6% other; 7.4% NR SES: NR	I: Multidisciplinary curriculum on sun properties, composition of the skin, historic attitudes to tanning, and strategies to reduce sun exposure; included lesson materials in-class and take-home activities, workbook, key term glossary, quick review, and newsletter C: No intervention	Children wear protective clothing in summer (mean score, 3-point-scale): Absolute change: +0.07 Relative change: +4.9% (p=0.43, between) Children lay in sun to tan (mean score, 3-point scale): Absolute change: −0.11 Relative change: +4.4% (p=0.11, between) Children play early or late when outside (mean score, 3-point scale) Absolute change: +0.12 Relative change: −6.3% (p = 0.27, between) Child composite sun-protective behavior (13 items, 3-point scale): Absolute change: +0.02 Relative change: +1.0% (p=0.51, between) Children wear sunscreen in summer (mean score, 2-item scale, 3-point scale): Absolute change: +0.04 Relative change: +1.8% (p > 0.05, between)

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Table B1. Continued

Author, year, location, study design, design suitability, study quality	Follow-up interval; *n;* limitations	Demographics: age, gender, race/ethnicity, SES	Intervention	Results: summary effect measures (behavioral and health outcomes only), *p* value, within or between groups
Girgis (1993)[97] Australia RCT Greatest suitability Good quality	F/U: 8 months from end of I *n*=648 Limitations: Secular time	Mean age: 10y Female: 53% Race/ethnicity: NR SES: father-NR (53%); 32.6% low income; 15.3% high income	I-1: Standard: 30-minute didactic lecture focusing on dissemination of information; included posters and sunscreen samples I-2: Intensive: Skin Safe skin-protection program incorporated into teachers' curriculum, consisting of cooperative learning techniques, student participation, problem-based strategies to promote awareness of problems and potential solutions associated with solar exposure, encouragement of students to develop responsibility for their own welfare by critically examining and improving their own environment C: No intervention	**Child composite sun-protective behaviors** (odds ratio using intervention groups as variable): I-1: Absolute change: −0.15 Relative change: −15.0% I-2: Absolute change: +2.06 Relative change: +206.0% Overall p value < 0.001
Gooderham (1999)[98] Canada Before-and-after study Least suitable Good quality	F/U: 1 month from B/L *n*=216 Limitations: Nonvalidated self-reported outcome measures; before-and-after study design with questionable use of analysis of variance statistical testing; potential for test–retest bias away from the null	Mean age: NR Range: (9–10y) Female: 47% Race/ethnicity: 90% white; 3% American Indian or Alaskan Native; 2% Asian; 2% East Indian; 1% African American; 2% other	Sun-awareness education program consisting of two 1-hour presentations, sun-awareness activity booklet, sun-safety workbook, take-home educational materials, and incentives	Child sun-protective behaviors (3-point scale): Always wear a long-sleeved shirt: Absolute change: +3.0 Relative change: +100.0% (p<0.001, within) Always wear long pants: Absolute change: +7.0 Relative change: +175.0% (p<0.001, within) Always wear hat when outside: Absolute change: +16.0 Relative change: +69.6% (p<0.001, within) Always wear sunscreen when outdoors in summer: Absolute change: +13.0 Relative change: +31.7% (p<0.001, within)

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Table B1. Continued

Author, year, location, study design, design suitability, study quality	Follow-up interval; *n;* limitations	Demographics: age, gender, race/ethnicity, SES	Intervention	Results: summary effect measures (behavioral and health outcomes only), *p* value, within or between groups
Hoffman (1999)[100] Florida Nonrandomized trial Greatest suitability Good quality	F/U: 2 weeks from end of I *n*=181 Limitations: School size not described; convenience sample of schools; no validation of assessment tool; self-reported outcome measures	Mean age: NR (5th graders) Female: 52% Race/ethnicity: 81% white; 9% African American; 2% Hispanic; 8% other SES: based on Hollingshead 1975—0% strata 1; 6.5% strata 2; 17% strata 3; 38% strata 4; 37% strata 5	I: Lecture and interactive intervention given to 5th-grade science classes to relay information on sun's effect on the skin, evaluate students' risks inherent in sun exposure, and promote change toward sunscreen use; included 10-minute ACS video, proper sunscreen application, student-produced videotaped commercials emphasizing UV exposure dangers and methods to reduce, homework assignments, and brochures for parents C: No intervention	Sunscreen use (visual analog scale, mean score): Absolute change: +17.6 Relative change: +148.7%
Homung (2000)[101] North Carolina RCT Greatest suitability Good quality	F/U: 7 months from end of I *n*=192 Limitations: Extremely limited description of standard didactic presentation; no description of actual provision of the intervention; group rather than individual interaction with CD-ROM may have limited individual participation; no validation of behavioral measures	Mean age: 8.5 y Female: 44% Race/ethnicity: NR SES: NR	I-1: CD-ROM sun-safety game and interactive activities, modified for grades 3 and 4, supplemented by AAD pamphlets and information sheet I-2: Standard didactic sun safety curriculum	**Child composite behavior** (shade and sunscreen use) (100 point): I-1: Absolute change: −0.6 Relative change: −1.4% (*p*-value NR, between) I-2: Absolute change: −3.8 Relative change: −7.3% (*p*-value NR, between)

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Table B1. Continued

Author, year, location, study design, design suitability, study quality	Follow-up interval; *n;* limitations	Demographics: age, gender, race/ethnicity, SES	Intervention	Results: summary effect measures (behavioral and health outcomes only), *p* value, within or between groups
Milne (2000)[107] Australia Nonrandomized trial Greatest suitability Good quality	F/U: 1.5y from B/L *n* = 1386 Limitations: Reliance on self-reported outcome measures	Mean age: 6 Female: 48.2% Race/ethnicity: 9.7% Southern European ancestry: 90.3% other SES: parents—59.3% high school or less; 40.6% tertiary education	I-1: Moderate group received "Kidskin" curricula comprised of developmentally appropriate, learner-centered skill and outcome based materials, classroom and home-based activities, and guidelines for providing a sun-protective school environment I-2: High intervention group received same intervention as the Moderate group and were also mailed program materials over the summer holidays, offered low-cost sun protective swimwear, and were actively assisted to introduce and formalize policies to provide a sun-protective school environment C: Regional standard Western Australian Health Education curricula	**Child sun-protective behaviors or assessments:** Time spent outdoors during peak UV hours (adjusted mean): I-1: Absolute change: −4.3 Relative change: −8.3% I-2: Absolute change: −6.1 Relative change: −21.6% (p = 0.01, between) Covered back entire time: I-1: Absolute change: +14.3 Relative change: +24.6% I-2: Absolute change: +9.1 Relative change: +17.5% (p = 0.001; between) Wore hat entire time: I-1: Absolute change: −0.3 Relative change: −1.4% I-2: Absolute change: −3.3 Relative change: −6.3% (p = 0.6, between) Wore protective swimwear: I-1: Absolute change: +20.2 Relative change: +30.1% I-2: Absolute change: +5.9 Relative change: +11.3% (p = 0.0005, between) Use shade more than half the time: I-1: Absolute change: +10.2 Relative change: +31.2%

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Table B1. Continued

Author, year, location, study design, design suitability, study quality	Follow-up interval; *n;* limitations	Demographics: age, gender, race/ethnicity, SES	Intervention	Results: summary effect measures (behavioral and health outcomes only), *p* value, within or between groups
				I-2: Absolute change: +5.3 Relative change: +10.2% (p=0.09, between) Composite observed sun exposure to face: I-1: Absolute change: −1.0 Relative change: +1.9% I-2: Absolute change: −3.1 Relative change: +26.1% (p=0.006, between) Composite observed sun exposure to forearm: I-1: Absolute change: −1.3 Relative change: +2.5% I-2: Absolute change: −4.5 Relative change: +23.6% (p=0.008, between) Composite observed sun exposure to back: I-1: Absolute change: −9.5 Relative change: +18.3% I-2: Absolute change: −14.0 Relative change: +33.6% (p=0.002, between)

AAD, American Academy of Dermatology; ACS, American Cancer Society; B/L, baseline; C, comparison; F/U, follow-up; I, intervention; *n,* sample size; NR, not reported; RCT, randomized control trial; SES, socioeconomic status; UV, ultraviolet; y, year(s).

Appendix C

Table C1. Summary evidence table: interventions in recreational/tourism settings

Author, year; location; study design; design suitability; study quality	Follow-up interval; *n;* limitations	Demographics: age, gender, race/ethnicity, SES	Intervention	Results: summary effect measures (behavioral and health outcomes only), *p* value, within or between groups
Dey (1995)[139] England RCT Greatest suitability Fair quality	F/U: 0–21 days from end of I *n*=2385 Limitations: Limited description of intervention (# questions and scoring); self-reported outcome measures; no stratification of UV exposure by site; no assessment of confounding	Mean age: 32.5 y Female: 52.5% Race/ethnicity: NR SES: NR	I: Leaflet "If you worship the sun, don't sacrifice your skin" by the Health Education Authority placed in seat-back pockets for airline passengers C: No leaflet	**Percentage of adults with self-reported incidence of severe sunburn** (flight length assumed to correspond with duration of vacation): Absolute change: All flights: −0.9% (p=0.38, between) Short flight: −0.8% (p=0.60, between)
Glanz (2000)[143,144] Hawaii RCT Greatest suitability Good quality	F/U: 3 months from end of I *n*=285 Limitations: Self-reported outcome measures	Mean age: parents: 38y; children: 7 y Female: 86% Race/ethnicity: 79% Hawaiian or other SES: Most parents were married, had some college education, and >$20K annual household income	I-1: Education arm: staff training, on-site activities, take-home booklets, behavior-monitoring boards, and incentives I-2: Education/environment arm: same as education arm plus provision of sunscreen and promotion of sun-safe environments C: Condensed educational program after second survey	**Child sun-protection habits** (score range 1–4, "rarely or never" to "always"): Sunscreen use: I-1: Absolute change: +0.08 Relative change: +40.0% (p<0.05, within) I-2: Absolute change: +0.05 Relative change: +25.0% (p>0.05), within) No significant difference between groups Seek shade I-1: Absolute change +0.15 I-2: Absolute change +0.0 (NR, between) Relative changes not applicable Wear a hat: I-1: Absolute change: −0.05 Relative change: −33.0% (NR, within) I-2: Absolute change: −0.10 Relative change: −67.0% (NR, within)

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Table C1. Continued

Author, year; location; study design; design suitability; study quality	Follow-up interval; *n;* limitations	Demographics: age, gender, race/ethnicity, SES	Intervention	Results: summary effect measures (behavioral and health outcomes only), *p* value, within or between groups
				Wear a shirt: I-1: Absolute change +0.03 Relative change: +9.0% (NR, within) I-2: Absolute change: +0.38 Relative change: +136.0% (NR, within) Composite sun-protective habits index (average score; required responses for at least three behaviors): I-1: Absolute change: +0.05 Relative change: +100.0% ($p<0.01$, within) I-2: Absolute change: +0.10 Relative change: +200.0% ($p<0.01$, within) No significant differences between groups
Glanz (2002)[146] Massachusetts and Hawaii RCT Greatest suitability Good quality	F/U: 8 weeks from B/L *n*=842 Limitations: Reliance on brief self-report measures	Mean age: parents: NR; children: 6.5y Female: 47% Race/ethnicity: Hawaii: 27% white; Massachusetts: 90% white SES: Hawaii: 55% with household income >$50K Massachusetts: 85% with household income >$50K	I: Sun-protection: staff-training; parent and children sun-safety lessons, interactive activities, providing sunscreen, shade, and signage, and sun-safe environment promotion C: Injury prevention: lessons and activities on bicycle and rollerblading safety, fire safety, traffic and walking safety, poisoning and choking prevention, and playground safety	The following were measured from possible scores ranging from 1 to 4, "rarely or never" to "always": **Child sun-protection habits** Sunscreen use: Absolute change: +0.14 Relative change: +4.53 ($p=0.05$, between) Wear a hat: Absolute change: +0.10 Relative change: +3.92 ($p=0.28$, between) Seek shade: Absolute change: +0.17 Relative change: +8.13 ($p=0.01$, between) Composite sun-protection habits index (required responses for at least three behaviors):

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Table C1. Continued

Author, year; location; study design; design suitability; study quality	Follow-up interval; *n;* limitations	Demographics: age, gender, race/ethnicity, SES	Intervention	Results: summary effect measures (behavioral and health outcomes only), *p* value, within or between groups
				Absolute change: +0.10 Relative change: +4.45 (*p*=0.03, between) Children's incidence of sunburn (moderate/high-risk children): Absolute change: +0.22 Relative change: +41.16 (*p*=0.04, between) **Adult sun-protection habits** Use sunscreen: Absolute change: +0.21 Relative change: +8.45 (*p*=0.01, between) Wear hat: Absolute change: +0.23 Relative change: +11.15 (*p*=0.01, between) Seek shade: Absolute change: +0.09 Relative change: +3.63 (*p*=0.24, between) Composite sun-protection habits index (required responses for at least three behaviors): Absolute change: +0.11 Relative change: +4.38 (*p*=0.95, between)

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Table C1. Continued

Author, year; location; study design; design suitability; study quality	Follow-up interval; *n;* limitations	Demographics: age, gender, race/ethnicity, SES	Intervention	Results: summary effect measures (behavioral and health outcomes only), *p* value, within or between groups
Glanz (1998)[141] Hawaii Before-and-after study Least suitable Fair quality	F/U: 4 weeks from B/L *n*=154 Limitations: Limited demographic information on parents; no description of sample selection; self-reported outcome measures	Mean age: parents: NR; children: 7 y; staff: 20 y Female: 66.7% Race/ethnicity: Parents—white or Asian/Pacific Islanders % NR; Staff—4% white; 42% Hawaiian; 27% Asian/Pacific Islander; 27% mixed SES: parents—well-educated; middle or upper income Staff: 56% attended or graduated college; 81% never married	Staff training, group activities, take-home booklets, incentives for children and staff, providing sunscreen, and promotion of sun-safe environments and policies; children received interactive booklets, with stories, games, and puzzles to be completed with parents; parents received additional educational brochures and surveys to complete; delivered by recreation leaders for c.u. 4 weeks	**Adult (parents) sun-protection behaviors** (stratified from composite scores; range of scores: 5–20) Sunscreen use: Absolute change: +0.03 Relative change: +4.1% (NR, within) Seek shade: Absolute change: +0.12 Relative change: +26.3% (NR, within) Composite sun protection habits index: Absolute change: +0.7 Relative change: +5.5% ($p<0.05$, within) **Child sun-protection behaviors** (stratified from composite scores; range of scores: 5–20) Sunscreen use: Absolute change: +0.07 Relative change: +9.8% (NR, within) Seek shade: Absolute change: +0.15 Relative change: +63.8% (NR, within) Composite sun-protection habits index: Absolute change: +1.6 Relative change: +15.4% ($p<0.01$, within)
Lombard (1991)[148] Virginia Before-and-after study Least suitable Fair quality	F/U: Average 1 month from B/L *n*=NR (total 600 members) Limitations: Year study performed not reported; no description of age, race/ethnicity, or gender of study population; convenience sample of two swimming pools; no reporting of screening criteria; no statistical testing; no assessment of confounding	Mean age: NR Female: NR Race/ethnicity: NR SES: primarily middle to upper class	Peer leader modeling by lifeguards, informational posters and fliers, posted feedback, posted goals, free sunscreen and commitment raffle; at two swimming pools with approximately 300 members each; for average of 25 days	**Percentage of adults with the following sun-protection behaviors:** Seek shade: Absolute change: Pool A: +20.1 Pool B: +3.8 Relative change: Pool A: +187.9% (NR, within) Pool B: +62.3% (NR, within) Wear a hat:

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Table C1. Continued

Author, year; location; study design; design suitability; study quality	Follow-up interval; *n;* limitations	Demographics: age, gender, race/ethnicity, SES	Intervention	Results: summary effect measures (behavioral and health outcomes only), *p* value, within or between groups
				Absolute change: Pool A: +9.5 Pool B: +1.3 Relative change: Pool A: +69.9% (NR, within) Pool B: +9.9% (NR, within) Wear a shirt: Absolute change: Pool A: +2.7 Pool B: +1.8 Relative change: Pool A: +13.8% (NR, within) Pool B: +11.9% (NR, within) **Percentage of children with the following sun-protection behaviors:** Seek shade: Absolute change: Pool A: +35.3 Pool B: +25.6 Relative change: Pool A: +353.0% (NR, within) Pool B: +164.1% (NR, within) Wear a hat: Absolute change: Pool A: +1.8 Pool B: +3.4 Relative change: Pool A: +60.0% (NR, within) Pool B: +91.9% (NR, within) Wear a shirt: Absolute change: Pool A: +10.6 Pool B: +13.7 Relative change: Pool A: +50.5% (NR, within) Pool B: +60.6% (NR, within)

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Table C1. Continued

Author, year; location; study design; design suitability; study quality	Follow-up interval; *n;* limitations	Demographics: age, gender, race/ethnicity, SES	Intervention	Results: summary effect measures (behavioral and health outcomes only), *p* value, within or between groups
Mayer (2001)[150] San Diego CA Nonrandomized trial Greatest suitability Fair quality	F/U: Immediately following end of I *n*=17,245 Limitations: No description of study population or setting; no reporting of percentage of daily visitors included in sampling frame; exposure to intervention based on self-reports; observed hat use at exit may not reflect hat use during visit; and nonequivalent comparison group design may have compromised internal validity (intervention site was closer to the coast than comparison site and had somewhat cooler temperatures); no control for potential for participants to visit both sites and thus contaminate groups	Mean age: NR Female: NR Race/ethnicity: NR SES: NR	I: Parent visitors of San Diego Zoo provided with tip sheets, stamp activity sheet for children, discount coupons for hats and sunscreen in zoo gift shops, point-of-purchase prompts, sun-safety signs in restrooms; at exhibits, and at stroller rental, and aerial tram loading areas, and thematically relevant children's arts and crafts activities C: Evaluation only	**Observed hat use at site exit:** I vs C × site: Winter: OR=1.84 (p=0.01, between) Summer: OR=0.90 (p=0.46, between)
Mayer (1997)[149] San Diego CA RCT Greatest suitability Fair quality	F/U: Average 2.5 weeks from B/L *n*=169 Limitations: All measures except colorimeter were self-reports by parents; no comparison of respondents and nonrespondents	Mean age: 7.6 y Female: 49.7% Race/ethnicity: 79.8% white SES: (annual income) <$30K 15% $30–49K 18% $50–69K 26% $70–90K 22% >$90K 20% reported by parents	I: UV reduction curriculum presented at poolside by YMCA aquatics instructors and home-based activities for children and their parents; tanness-associated skin color dimensions assessed with a colorimeter; general and specific daily solar-protection behaviors of children	Use sunscreen: (all values adjusted for age and gender) Child colorimeter values (higher values indicate more tan): Absolute change: +0.4 Relative change: +2.8% (p=0.084, between) Childrens' sun-protection habits (5-point scale ranging from "never" to "always"): Absolute change: +0.03 Relative change: +0.82% (p=0.44, between) Wear a hat: Absolute change: +0.70 Relative change: +31.2% (p=0.049, between) Composite sun-protection habits (sum of scores; possible scores, 0 to 16; higher score indicates more protection): Absolute change: +0.16 Relative change: +1.11% (p=0.15, between)

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Table C1. Continued

Author, year; location; study design; design suitability; study quality	Follow-up interval; *n;* limitations	Demographics: age, gender, race/ethnicity, SES	Intervention	Results: summary effect measures (behavioral and health outcomes only), *p* value, within or between groups
Segan (1999)[153] Australia RCT Greatest suitability Fair quality	F/U: Immediately after end of I *n*=373 Limitations: Intervention exposure based on self-reports; no analysis of respondents vs nonrespondents	Mean age: 33y Female: 64% Race/ethnicity: NR SES: NR	I: Full-color, culturally relevant, six-page fold-out educational brochure "The SunSmart Holiday Guide: How to enjoy your holiday in the sun without getting burnt," pre-holiday questionnaire that assessed length and destination of holiday, reasons for holiday, skin type, demographics, sun tanning aspirations, dichotomous measures of whether a hat and sunscreen were packed, and sun protection intentions, and a post-holiday questionnaire that assessed frequency and location, and extent and severity of sunburn, reasons for sunburn, composite sunburn and sun-protection measures, measure of suntan acquired, and number of days outside and frequency of sun protection behaviors between 10 A.M. and 2 P.M. C: Pre- and post-holiday questionnaires only	**Adult sun-protection behavior scores** (5-point scale; 1 = never, 5 = always): Use sunscreen: Absolute change: −0.03 (p=0.72, between) Relative change: NR Seek shade: Absolute change: −0.09 (p=0.33, between) Relative change: NR Wear clothes covering most of body: Absolute change: −0.13 (p=0.25, between) Relative change: NR Composite sun-protection behaviors: Absolute change: −0.04 (p=0.47, between) Relative change: NR **Adult incidence of self-reported sunburn** 63% reported sunburn during intervention 37% reported severe sunburn

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Table C1. Continued

Author, year; location; study design; design suitability; study quality	Follow-up interval; *n;* limitations	Demographics: age, gender, race/ethnicity, SES	Intervention	Results: summary effect measures (behavioral and health outcomes only), *p* value, within or between groups
Weinstock (2002)[155] Rhode Island RCT Greatest suitability Fair quality	F/U: 24 months from B/L *n*=1449 Limitations: self-reported outcomes measured by questionnaires that were not validated; no analysis of respondents	Mean age: 33y Female: 61% Race/ethnicity: 94% white SES: 88% with high school education	I: Initial assessment using nine-item sun behavior–protection index and stage of change questionnaire; educational pamphlet, sun sensitivity assessment and feedback, SPF-15 sunscreen, instant sun damage imaging photographs, followed up by three- to four-page feedback reports, mailed 2, 12, and 24 months from B/L, matched to individual stage of change (reports included suggestions on reducing unprotected UV exposure) C: Initial assessment using sun-protection index and stage of change	**Adult sun-protection behavior scores** (5-point scale; 1 = never, 5 = always): Use sunscreen: Absolute change: +0.17 Relative change: +5.6% (p=0.002, between) Wear a hat: Absolute change: +0.16 Relative change: +7.6% (p=0.016, between) Avoid the sun: Absolute change: +0.12 Relative change: +4.5% (p=0.002, between) Composite sun-protection behaviors: Absolute change: +0.15 Relative change: +5.3% (p=0.001, between)

ACS, American Cancer Society; B/L, baseline; C, comparison; F/U, follow-up; I, intervention; K, thousand; *n*, sample size; NR, not reported; RCT, randomized control trial; SES, socioeconomic status; SPF, sun-protection factor; UV, ultraviolet; y, year(s).