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Behavioral Counseling to Prevent Skin Cancer: Systematic Evidence Review to Update the 2003 U.S. Preventive Services Task Force Recommendation

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Prepared by:
Oregon Evidence-based Practice Center
Center for Health Research, Kaiser Permanente
3800 North Interstate Avenue
Portland OR, 97227

Investigators:
Jennifer S. Lin, MD, MCR
Michelle Eder, PhD
Sheila Weinmann, PhD
Sarah P. Zuber, MSW
Tracy L. Beil, MS
Daphne Plaut, MLS
Kevin Lutz, MFA

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Structured Abstract

Purpose: We conducted this systematic evidence review of five key questions to assist the U.S. Preventive Services Task Force (USPSTF) in updating its 2003 recommendation on behavioral counseling to prevent skin cancer (melanoma, basal cell carcinoma, and squamous cell carcinoma).

Data Sources: We first conducted a comprehensive search for systematic reviews from 2001 until March 2008. Using three existing systematic reviews, we developed separate searches for each key question. We searched MEDLINE and the Cochrane Central Register of Controlled Trials from 2001 through December 2008 for key questions 1 to 3; from the end search dates of existing systematic reviews through December 2008 for key question 4 (if no existing systematic review was identified, we searched from 1966 through December 2008); and from 1966 through December 2008 for key question 5. We also obtained articles from outside experts and by reviewing bibliographies of relevant articles and existing systematic reviews.

Study Selection: We reviewed a total of 5,387 abstracts and 324 complete articles. There were a total of 57 unique studies included in this review: 10 examining the effectiveness and harms of counseling interventions; 32 examining the epidemiologic link between sun exposure, indoor tanning, or sunscreen use and skin cancer; and 16 examining the potential harms of sun-protective behaviors.

Data Extraction: Two investigators independently reviewed abstracts and articles against a set of a priori inclusion criteria, and also independently critically appraised each study using design-specific quality criteria based on USPSTF methods and the Newcastle-Ottawa quality criteria for cohort and case-control studies. One investigator abstracted data from included studies into evidence tables and a second investigator checked the data.

Data Synthesis: We found 10 fair- or good-quality randomized controlled trials (RCTs) that examined the impact of primary care relevant skin cancer counseling interventions on sun-protective behaviors, two of which examined community-based interventions with a component of counseling in primary care. In adults (n=6,225), primary care relevant counseling with computer support increased composite scores measuring sun-protective behaviors at 6 to 24 months. In young adults (n=563), brief appearance-focused behavioral interventions decreased normative indoor tanning behaviors at 6 months and decreased ultraviolet (UV) exposure, as objectively measured by skin pigmentation at 12 months. In young adolescents (n=819), primary care counseling with computer support, similar to those used in adults, decreased midday sun exposure and increased sunscreen use at 12 and 24 months. In parents of newborns (n=728), primary care counseling integrated into sequential well-child care visits increased composite scores measuring sun-protective behaviors at 36 months. Successful interventions ranged from single low-intensity interventions (e.g., 15-minute single session, booklet, video) to multiple in-person or phone-based counseling. No significant harms, including physical activity and sedentary behaviors, were reported in these trials.

We found mainly fair-quality cohort and case-control studies examining the relationship between sun exposure and skin cancer (11 studies for squamous cell and basal cell carcinoma, 18 studies for melanoma). We found that increasing intermittent (or recreational) sun exposure is associated

with an increased risk for squamous cell and basal cell carcinoma and melanoma. This association is more consistent in studies with the timing of intermittent sun exposure in childhood. Fewer studies examined the association of total and chronic (or occupational) sun exposure. These studies do not suggest a strong association between total or chronic sun exposure and skin cancer. However, some evidence suggests that total sun exposure in childhood is associated with an increased risk for melanoma and occupational sun exposure may be associated with a decreased risk for melanoma.

We found very few studies that examined the relationship between indoor tanning and risk for squamous cell or basal cell carcinoma, after adjusting for all important confounders. Results generally suggest no association. However, a slightly larger body of higher quality evidence suggests that "regular" or "early" use of indoor tanning devices may increase the risk for developing melanoma. Most of these studies used crude measures of indoor tanning device exposure.

Based on one fair-quality trial, regular sunscreen use may prevent squamous cell carcinoma but not basal cell carcinoma. Case-control studies that suggest sunscreen use reduces the risk for basal cell carcinoma have major limitations. Based on five fair-quality studies, sunscreen use has no clear protective or harmful effect on the risk for melanoma, although the case-control studies examining this risk have major limitations.

Few harms were found in 16 fair-quality studies examining the potential harms of sun-protective behaviors. In school-aged children (n=1,615), sun-protective behaviors do not increase risk for sedentary behaviors or increase in body mass index. Based on three good-quality trials (n=516), use of sunscreen with a higher sun protection factor can increase duration of intentional sun exposure in sun bathers. However, three other fair- to good-quality trials (n=2,520) suggest that sunscreen use in general does not appear to increase sun exposure in adults or children. In adults (n=153), sunscreen use does not lead to vitamin D deficiency. In a cohort of women living at high latitudes (n=2,016), however, those who avoided direct sun exposure were at risk for vitamin D deficiency during the winter and spring months. Four of seven fair- or good-quality studies that examined the relationship between sun exposure and risk for cancer suggest that sun exposure in predominantly white persons may be inversely related to risk for advanced breast and prostate cancer and non-Hodgkin lymphoma, after adjusting for well-established risk factors. However, none of these trials adjusted for dietary vitamin D intake or measured vitamin D status.

Limitations: The main limitations for the trial evidence supporting counseling to prevent skin cancer are the small number of trials in children and the unclear clinical significance of small changes in composite scores measuring sun-protective behaviors. Major concerns about the internal validity of the observational literature include the complex nature of measuring sun exposure and sunscreen use, inconsistent and inadequate adjustment for important confounders, and use of study designs complicated by recall bias. Results from the observational literature examining indoor tanning device use and sunscreen use may not be applicable to today's products due to changes in indoor tanning devices and sunscreens over time. Most of the counseling trials and all of the epidemiologic studies include exclusively or predominantly white populations.

Conclusions: A limited number of RCTs suggest that primary care relevant behavioral counseling can minimally increase sun protection composite scores in adults and their newborns,

decrease indoor tanning and objectively measured pigmentation in college students, and decrease midday sun exposure and increase sunscreen use in young adolescents. The clinical significance of small changes in sun protection composite scores is unclear. Many of the counseling interventions incorporated computerized support that could generate tailored feedback. Evidence, mostly from case-control studies, suggests that intermittent sun exposure, especially in childhood, is associated with an increased risk for skin cancer. Regular sunscreen use can prevent squamous cell carcinoma, but it is unclear if it can prevent basal cell carcinoma or melanoma. Therefore, behavioral counseling to promote skin cancer prevention should focus on improving multiple behaviors to reduce UV exposure and not improving sunscreen use alone. There is some evidence to suggest that regular and early use of indoor tanning devices may increase the risk for melanoma. However, sunscreen and indoor tanning technologies have changed substantially over the past 20 to 30 years.

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I. Introduction

Scope and Purpose

This report was written to support the U.S. Preventive Services Task Force (USPSTF) in updating its 2003 recommendation on counseling for skin cancer prevention. The 2003 report found a single counseling trial, in the context of a community-based educational intervention, that examined the effectiveness of increasing sun-protective behaviors.[1] Given the multimodal nature of this intervention, however, the contribution of the office-based counseling component could not be isolated. In addition to the counseling literature, the previous report also examined the association between sun-protective behaviors and melanoma. This report found that determining the efficacy of sun avoidance and use of protective clothing for the prevention of melanoma is complex. The evidence did support the hypothesis that intermittent sunburn in childhood is a preventable risk factor. However, no trials linking sun avoidance or use of protective clothing to a decrease in skin cancer incidence were identified. Finally, the report found one trial showing a modest benefit of sunscreen in preventing squamous cell carcinoma. A meta-analysis of case-control studies, however, showed that sunscreen use was not associated with an increased or decreased risk for melanoma.

The primary evidence gaps identified by the 2003 USPSTF recommendation were uncertainty about whether clinician counseling is effective in changing patient behaviors to reduce skin cancer and uncertainty about potential harms of sun-protective behaviors. Additionally, the USPSTF noted that only fair-quality evidence linked sunscreen use or use of indoor tanning to skin cancer outcomes. Therefore, this review focuses on new trial evidence for counseling interventions to prevent skin cancer conducted in primary care, and also reexamines previous trials that were not conducted in primary care but may be considered feasible for primary care adoption or represent community interventions to which primary care can refer patients.[2] The early detection of skin cancer with skin self-examination is addressed in the recently updated evidence review on skin cancer screening.[3] This review also examines the harms directly associated with counseling interventions, epidemiologic associations between key behaviors in counseling interventions (i.e., decreased sun exposure, sunlamp or tanning bed avoidance, and sunscreen use) and relevant skin cancer outcomes, and the potential harms associated with these sun-protective behaviors.

Background

Condition Definition

The three major types of skin cancer are melanoma, squamous cell carcinoma, and basal cell carcinoma.[4] There are four major subtypes of cutaneous melanoma: superficial spreading, nodular, lentigo maligna, and acral lentiginous.[1] Some melanomas are not easily classified into a single category and may have overlapping features.

Burden of Preventable Illness

Skin cancer is the most common cancer in the United States. Over 1 million persons are diagnosed annually in the United States with cutaneous malignant melanoma, squamous cell carcinoma, or basal cell carcinoma.[4] While melanoma is less common than basal cell and squamous cell carcinoma, it is also more deadly.[4] Incidence rates of melanoma have also been increasing worldwide. Age-adjusted incidence rates of melanoma among white Americans have risen from approximately 8.7 per 100,000 in 1975 to 26.4 per 100,000 in 2005.[5] An estimated 62,480 persons were expected to develop melanoma in 2008, which means 1 in 52 men and 1 in 77 women will develop this potentially lethal cancer during their lifetimes.[6] Several factors may contribute to increasing incidence rates, including increased exposure to carcinogenic factors (i.e., ultraviolet [UV] exposure), increased public awareness of the warning signs of melanoma, and increased screening by clinicians.[7-9] Mortality rates are more than 5-fold lower than incidence rates, but depend upon stage at diagnosis.[10] Five-year survival of melanoma is 99 percent if diagnosed at a localized stage, but only 65 percent or 15 percent if diagnosed at a regional or distant stage, respectively.[10]

Of the approximately 1.3 million cases of skin cancer diagnosed each year, about 800,000 to 900,000 are basal cell carcinoma, and 200,000 to 300,000 are squamous cell carcinoma.[4] While squamous cell cancer accounts for less than 0.1 percent of all cancer deaths, it does have the potential to metastasize and may account for a significant proportion of mortality from skin cancer in older persons and immunosuppressed persons.[11] In contrast, survival rates for those with basal cell carcinoma are indistinguishable from those of the general population.[11] On the basis of mortality, squamous cell and basal cell carcinoma are often not considered important problems. Because of their high and rising incidence, however, squamous cell and basal cell carcinoma pose a significant economic burden. Based on 1995 Medicare claims data, it was estimated that squamous cell and basal cell carcinoma are the fifth most costly type of malignant cancer to treat (behind lung, prostate, colon, and breast cancer), and represented approximately 4.5 percent of costs associated with management of all types of cancer.[12]

Risk Factors and High-Risk Groups

Cutaneous melanoma, basal cell carcinoma, and squamous cell carcinoma have well-known host and environmental risk factors. Skin cancer is approximately 10 times more common among Caucasians than among deeply pigmented ethnic groups. Other host factors include history of previous melanoma, family history of skin cancer, and immunosuppression.[4,13,14] Several phenotypic characteristics are associated with skin cancer risk, including hair and eye color (through correlation with skin phenotype), freckles, and tendency to sunburn.[13,15] As with other types of cancer, skin cancer incidence increases with age, but is also one of the most common types of cancer in young people.[4,13] Men are 1.5 to 3 times more likely than women to develop skin cancer, depending on age and type of skin cancer.[4,13] The role of genetic factors in the etiology of melanoma is complicated. Several genes that cause increased chromosomal sensitivity to sun damage may explain the role of family history as a risk factor for melanoma.[7] A history of melanoma in first-degree relatives is a strong predictor of melanoma, and about 10 percent of all people with melanoma have a family history of melanoma. Gene mutations have been found in anywhere from about 10 to 40 percent of families with a high rate of melanoma. In

addition, two inherited conditions, xeroderma pigmentosum and basal cell nevus syndrome, confer high risk for skin cancer.[4]

Exposure to solar UV radiation is the most important environmental risk factor for all types of skin cancer.[16] UV radiation from the sun is approximately 95% UVA and 5% UVB. In addition to sunlight, indoor tanning is a source of UV exposure. The composition of UV exposure in indoor tanning has changed over time, however, in that earlier sunlamps primarily emitted UVB radiation, and more recent tanning beds emit higher rates of UVA radiation. Sunscreens, used to protect against UV exposure, have likewise changed over time as well, in that UVA protection was not added to sunscreens until 1989. Other environmental factors include exposure to coal tar, pitch, creosote, arsenic, or radium.[4]

Intermediate outcomes of sun exposure and skin cancer, such as sunburn, acquired nevi, and actinic keratoses, have been established. Sunburn, an inflammatory response to UV radiation, is strongly related to the risk for melanoma. Studies have shown that people with a history of sunburns have double the risk for melanoma.[13,17,18] The correlation of sunburns with melanoma may be direct or may be because sunburn is a marker of both sun sensitivity and intermittent sun exposure.[13,17] Actinic keratoses, another form of skin damage caused by sun exposure, are also a confirmed risk factor for skin cancer.[11,15] At least 60 percent of squamous cell carcinoma cases arise from existing actinic keratoses.[19-21] Nevi (i.e., moles) are most likely caused by a combination of genetic and environmental factors, particularly sun exposure. The number of common and atypical nevi significantly increases the risk for melanoma.[7,13,22,23]

Current Practice

It is hypothesized that sun exposure should be more easily modifiable through behavioral intervention than many other cancer risk factors and that changes in behavior should have an impact on decreasing cancer incidence.[1] Strategies for the primary prevention of skin cancer by limiting UV exposure include avoiding midday sun, wearing protective clothing and broad-brimmed hats, applying sunscreen, and avoiding indoor tanning.[13] The American Cancer Society recommends protection from exposure to UV radiation, monthly skin self-examinations, and screening during periodic checkups.[4] The Task Force on Community Preventive Services recommends educational and policy approaches in primary schools to improve children's sun-protective "covering up" behavior.[24]

The frequency of routine primary care counseling for skin cancer prevention varies across studies. Three recent studies report rates from as low as 22 percent to as high as 76 percent. Specifically, the American Academy of Pediatrics Periodic Survey found that more than 90 percent of pediatricians believed that skin cancer is a significant public health problem, but only 22 percent reported counseling most patients in all age groups. The most common intervention named by pediatricians was advising sunscreen with a sun protection factor (SPF) of $\geq$15.[25] Another study of pediatricians in Texas found that 76 percent routinely recommend sunscreen, 53 percent routinely recommend protective clothing, and 46 percent routinely recommend limiting midday sun exposure.[26] A third study showed that primary care physicians, when confronted with a standardized patient at high risk for skin cancer, did not ask questions about skin type or sun exposure habits and only 67 percent recommended sunscreen, 7 percent discussed sunscreen types or procedures for effective use, and 13 percent counseled other skin-protective behaviors.[27]

Recent studies suggest that Americans' sun-protective behaviors must be improved. A cross-sectional study from all 50 states of 10,079 boys and girls ages 12 to18 years found that the prevalence of sunscreen use was 34 percent. Nearly 10 percent used a tanning bed during the prior year. Girls were more likely than boys to use sunscreen and much more likely than boys to report tanning bed use. Furthermore, the majority had at least one sunburn during the prior summer (83 percent), and 36 percent had three or more sunburns.[28] Among 28,235 adults participating in the 2005 National Health Interview Survey (NHIS), over 50 percent reported infrequent use of sunscreen, approximately 20 percent of adults aged 18 to 20 years reported use of an indoor tanning device in the past year, and over 40 percent of adults aged 18 to 49 years reported a sunburn during the past year.[29]

Previous USPSTF Recommendation

In October 2003, the USPSTF concluded that the evidence is insufficient to recommend for or against routine counseling by primary care clinicians to prevent skin cancer (I recommendation). At the time, the USPSTF found insufficient evidence to determine whether clinician counseling is effective in changing patient behaviors to reduce skin cancer risk. Counseling parents may increase the use of sunscreen for children, but there was little evidence to determine the effects of counseling on other preventive behaviors (such as wearing protective clothing, reducing excessive sun exposure, avoiding indoor tanning, or practicing skin self-examination) and little evidence on potential harms.

II. Methods

Terminology

See Appendix E for definitions of terms and abbreviations.

Key Questions and Analytic Framework

We developed an analytic framework with five primary key questions (KQs) based on the previous review and a scan of new primary and secondary research conducted since the previous review (Figure 1).

KQ 1: Is there direct evidence that counseling patients in sun-protective behaviors (decreasing sun exposure, avoidance of indoor tanning, and using sunscreen) reduces intermediate outcomes (sunburns, nevi, or actinic keratoses) or skin cancer (melanoma, squamous cell carcinoma, or basal cell carcinoma)?
KQ 2: Do primary care relevant counseling interventions change sun-protective behaviors (decreasing sun exposure, avoidance of indoor tanning, and using sunscreen)?
KQ 3: Do primary care relevant counseling interventions have adverse effects?
KQ 4: Is sun exposure (intentional or unintentional), indoor tanning, or sunscreen use associated with skin cancer outcomes?
KQ 5: Are sun-protective behaviors associated with adverse effects (e.g., increased time spent in the sun, reduced physical activity, dysphoric mood, vitamin D deficiency)?

For KQ 4, we did not find studies meeting our inclusion criteria that examined a decrease in sun exposure (e.g., with use of protective clothing, avoidance of midday sun exposure) and skin cancer outcomes. Therefore, we included studies examining the relationship between sun exposure (intentional and unintentional) and skin cancer. We did not examine the association between UV exposure or sun-protective behaviors and intermediate outcomes (e.g., sunburns, nevi, or actinic keratoses). Epidemiologic links between intermediate health outcomes and skin cancer are also not reviewed in this report.

Literature Search Strategy

We searched for relevant systematic reviews published from 2001 to March 2008 in MEDLINE, Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects, and Clinical Evidence or by the National Institute for Health and Clinical Excellence, Institutes of Medicine, and Agency for Healthcare Research and Quality (AHRQ). Fifteen relevant systematic reviews, in addition to the previous evidence report, were assessed for quality and their potential for answering KQs or identifying primary research for answering KQs. We developed separate

literature searches and terms for each KQ (Appendix A Table 1) based on our assessment of the prior evidence report and the subsequent systematic review literature (Table 1).[17,22,30-42] We identified 5,387 abstracts through MEDLINE and Cochrane Central Register of Controlled Trials (search dates are provided in Table 1).

For KQs 1 to 3, we searched only for randomized and nonrandomized controlled trials. For KQs 4 and 5, we searched for observational studies and trials. The search for KQs 1 to 3 updated the prior 2002 report. The KQ 4 search began with two more recent, fair-quality systematic reviews with comprehensive literature searches examining the association between indoor tanning devices and skin cancer[30] and sunscreen use and melanoma.[31] When we did not have existing systematic reviews and the question was not systematically reviewed in the prior report, we used 1966 as our search start date. We evaluated all studies included in the previous report[1] against the inclusion and exclusion criteria for the current review. We also obtained articles from outside experts and by reviewing bibliographies of other relevant articles and existing systematic reviews. All searches were limited to articles in the English language.

Article Review and Data Abstraction

We reviewed all abstracts for potential inclusion for any of the KQs using the inclusion/exclusion criteria described in Appendix A Table 2. For KQs 1 to 3, examining the trial literature for the effectiveness and harms of behavioral counseling interventions to prevent skin cancer, we included only those counseling interventions that were conducted in primary care settings, judged to be feasible for delivery in primary care, or widely available for referral from primary care. In general, primary care relevant counseling interventions involved individual-level participant identification, a primary care practitioner or related clinical staff, and individual or small-group format with a limited number of sessions or was viewed as connected to the health care system. Behavioral counseling interventions that included an active component of community outreach, use of community members (e.g., opinion leaders, peer facilitators), use of community programs (e.g., worksite programs, school programs), use of social marketing, or use of public policy changes were not considered primary care relevant. Given the paucity of trial literature in this field, however, we also considered multimodal interventions if the intervention clearly involved primary care. We also required that trials evaluating counseling interventions be conducted in populations representative of primary care patients. Therefore, we excluded studies that exclusively enrolled participants with current or past history of malignant or premalignant skin lesions, or persons with syndromes at risk for skin cancer (e.g., persons with inherited or acquired immunodeficiency, xeroderma pigmentosum, albinism, basal cell nevus syndrome, exposure to arsenic, recessive dystrophic epidermolysis bullosa, medical exposure to psoralen or UVA treatment, familial atypical mole and melanoma syndrome, or more than 100 melanocytic nevi). We did, however, include persons at increased risk based on skin phenotype or family history of skin cancer. For KQs 1 to 3, included trials were conducted in English-speaking countries that are culturally similar to the United States.

For KQ 2, trials had to report behavioral outcomes 3 months or later after the counseling intervention. Behavioral outcomes included self-reported or directly observed measures of sun protection (e.g., limitation/avoidance of midday sun, use of sun-protective clothing, use of sunscreen, or limitation/avoidance of indoor tanning). We did not include behavioral outcomes,

including skin self-examinations, because secondary prevention was not in this review's scope and is addressed in a separate report.[3] We also excluded trials that only reported outcomes related to knowledge, attitudes, self-esteem, or ability changes (skills).

For KQs 4 and 5, we had limited a priori exclusion criteria. However, we did exclude studies that focused on populations with syndromes at risk for skin cancer, as described above. We included trials and cohort studies when available. Due to the paucity of trial and cohort studies, we also considered nested case-control studies and population-based case-control studies. We excluded cross-sectional studies that were ecologic analyses and hospital-based case-control studies, as hospital-based controls are not generally representative of the community and hospital-based cases can introduce considerable selection bias.[43,44] Outcomes for KQ 5 included potentially significant clinical harms (e.g., paradoxical increase in sun exposure, reduced physical activity, dysphoric mood, vitamin D deficiency, increased incidence of other types of cancer).

Two investigators independently screened 5,387 abstracts for potential inclusion, including all abstracts for KQs 1 to 3, and every fifth abstract (20 percent sample) for KQs 4 and 5. There were a total of four discrepancies between the two reviewers for the 480 dual-reviewed abstracts for KQs 4 and 5 (agreement of 99.2 percent). None of these four abstracts was included in the final review. Therefore, we feel confident that no relevant articles were missed by having a second investigator dual review only a subset of the abstracts.

We reviewed a total of 60 articles for KQs 1 to 3 and 264 articles for KQs 4 and 5. Two investigators independently rated all articles meeting inclusion criteria for quality assessment using the USPSTF's study-design specific quality criteria, which was supplemented by the Newcastle-Ottawa Scale for assessing cohort and case-control studies (Appendix A Table 3). The USPSTF has defined a three-category quality rating of "good," "fair," and "poor" based on these criteria. In general, a good-quality study meets all criteria well. A fair-quality study does not meet, or it is not clear that it meets, at least one criterion, but it has no known important limitation that could invalidate its results. A poor-quality study has important limitations.[2] All poor-quality studies were excluded. Case series and case reports were not included unless they addressed fatal harms. Listings of all excluded articles are included in Appendix B Tables 2–4 and Appendix C Tables 2 and 4. A flow chart of reviewed abstracts and articles is included in Appendix A Figure 1.

We found no trials for KQ 1. This review included 14 articles representing 10 unique trials for KQs 2 and 3; 56 articles representing 32 unique studies for KQ 4; and 18 articles representing 16 unique trials for KQ 5. One primary reviewer abstracted relevant information into standardized evidence tables for each included article (Appendix B Table 1 and Appendix C Tables 1 and 3). A second reviewer checked the abstracted data for accuracy and completeness.

Literature Synthesis

We found no data for KQ 1. For KQs 2 and 3, we were unable to conduct quantitative synthesis, primarily due to the heterogeneity of populations addressed and counseling intervention methods. Instead, we qualitatively synthesized our results stratified by the populations addressed: adults, young adults, adolescents, and parents and children. The Results section and corresponding summary tables reflect these qualitative summaries.

Similarly, for KQs 4 and 5, we were unable to pool estimates of associations due to the heterogeneity in measurement of exposures and outcomes. Instead, we qualitatively synthesized our results stratified by type of exposure addressed (sun exposure, indoor tanning, and sunscreen use) or type of adverse effect.

USPSTF Involvement

The authors worked with three USPSTF liaisons at key points throughout the review process to develop and refine the scope, analytic framework, and KQs; to resolve issues around the review process; and to finalize the evidence synthesis. AHRQ funded this research under a contract to support the work of the USPSTF. AHRQ had no role in study selection, quality assessment, or synthesis, although AHRQ staff provided project oversight, reviewed the draft evidence synthesis, and assisted in external review of the draft evidence synthesis. This systematic evidence review was revised based on comments from five expert reviewers.

III. Results

Key Question 1: Is There Direct Evidence That Counseling Patients in Sun-Protective Behaviors Reduces Intermediate Outcomes or Skin Cancer?

We found no trials directly examining whether behavioral counseling interventions can reduce skin cancer or intermediate outcomes (e.g., sunburns, nevi, and actinic keratoses). One trial, by Crane and colleagues, included both self-reported behavioral outcomes and number of nevi on skin examination as outcome measures. As only 38 percent of participants were examined, this study was excluded for poor quality for this KQ.[45] Another trial, by Glazebrook and colleagues, included self-reported sunburn in the composite sun-protective behavior score, but was not reported separately.[46] Both these trials are included in KQ 2.

Key Question 2: Do Primary Care Relevant Counseling Interventions Change Sun-Protective Behaviors?

We found eight unique trials examining primary care relevant counseling interventions to increase sun-protective behaviors (Table 2). Given the limited number of trials, especially in adolescents and children, we discuss two additional trials that were multimodal community-based interventions to prevent skin cancer and included primary care counseling as one component (Table 2).[47,48] One of these two trials was included in the previous review.[47] Only one trial explicitly targeted decreased use or avoidance of indoor tanning.[49]

Adults

Summary of findings. We found four fair-quality randomized controlled trials (RCTs) evaluating primary care conducted or relevant behavioral counseling interventions to prevent skin cancer in adults.[46,50-52] Three trials were conducted in the United States,[50-52] and one trial was conducted in the United Kingdom.[46] The counseling interventions conducted in the United States were coupled with in-office computer support using the transtheoretical model to generate printed stage-based, tailored feedback.[50-52] Two of these counseling interventions with computer support targeted multiple behaviors in addition to sun protection and were called "Expert System" interventions.[51,52] The trial conducted in the United Kingdom used a self-directed computer station in a primary care practice to deliver the counseling intervention.[46]

Overall, three of the four trials (n=6,225) showed that primary care relevant counseling combined with computer support can modestly impact self-reported sun-protective behaviors, as measured by composite behavior scores.[46,51,52] Populations studied included predominantly middle-aged white men and women. One trial (n=589) included only persons with high-risk skin characteristics,[46] and the other trials did not report the participants' sun sensitivity or skin type. Interventions ranged from a single low-intensity intervention (approximately one 15-minute

session) to multiple (three or four) in-person counseling or, phone sessions followed by tailored written feedback.

These trials, however, have a few important limitations. The trial by Glazebrook and colleagues had only a 6-month followup. In addition, all three trials had small but statistically significant differences in followup between the intervention and control groups. Most importantly, these three trials all showed a difference in composite scores measuring self-reported sun protection behaviors. The differences in these scores, though statistically significant, were small, and it is unclear if these small differences would translate into clinically meaningful behavior change to prevent skin cancer. In addition, the true feasibility and cost of implementing the in-office computer support to generate individual tailored feedback in primary care is not clear.

One trial conducted among siblings of patients with melanoma (n=494) failed to show any statistically significant changes in sun-protective behaviors at 12 months in those receiving individual telephone counseling (four 15-minute sessions) conducted by a health educator with computer support and tailored printed materials, compared with those receiving usual care.[50] This trial used different outcome measures than the other trials (i.e., percent tanned by the end of last summer, routine use of sunscreen with SPF 15 or higher). It is unclear if the nonsignificant findings are a result of trial design issues (e.g., choice of study population, number of participants, choice of outcome measures) or due to lack of efficacy of the intervention itself. Additionally, this trial had low followup at 12 months (approximately 64 percent).

Additional study details. One fair-quality trial randomly assigned 10 primary care practices in Nottinghamshire, United Kingdom, to have a computer workstation that delivered a brief 10- to 15-minute self-directed counseling session, called the "Skinsafe" program.[46] This Skinsafe intervention, based on the health belief model, was organized into eight sections, designed to be completed in a single session, to inform users about the dangers of excessive sun exposure, sun-protective behaviors, skin characteristics that are at risk for developing skin cancer, early signs of melanoma, how to reduce risk for melanoma, and how to check skin for suspicious lesions. Across the 10 sites, 589 persons with "high-risk" skin characteristics (mean age, 38 years; mostly women) were either given a prescription for the Skinsafe program or received usual care. Persons at the five primary care practices in the intervention group had statistically significantly higher sun-protection behavior scores at 6-month followup (mean difference, 0.33 [95% CI, 0.09–0.57]).

Two fair-quality trials by Prochaska and colleagues randomly assigned adults at risk for sun exposure, as defined by their stage of change in the transtheoretical model, to receive telephone-based counseling and written survey assessments with tailored, mailed feedback using computerized support (the Expert System intervention).[51,52] The Expert System intervention, based on the transtheoretical model, is designed to use computerized support to deliver stage-based, tailored communications to inform persons about how to reduce sun exposure by limiting sun exposure to 15 minutes a day or always using SPF 15 or higher sunscreen. While the duration of the phone or written assessments were not described, they were administered at 0, 6, 12, and 24 months, followed by a three- to five-page tailored, mailed feedback at 0, 6, and 12 months. In the 2005 trial, adults from 79 different nonhospital-based primary care practices (n=5,407) who were age 45 years on average, about 30 percent male, and overwhelmingly white were randomly assigned to receive the Expert System intervention or assessment only.[51] Among the subset of individuals (n=3,834) who were at risk for sun exposure (defined as being in the precontemplation, contemplation, or preparation stage of change), those in the intervention group

had a very small, but statistically significant, increase in sun avoidance and sunscreen use behaviors at 12 and 24 months, as measured by a four-item Sun Protection Scale. In the 2004 trial, the participants (n=2,460), while similar in age, sex, and race distribution to the 2005 trial, were recruited through schools (parents of children in the ninth grade).[52] Among the subset of parents (n=1,802) at risk for sun exposure, those in the intervention group had a very small, but statistically significant, difference in sunscreen use at 12 and 24 months using the same four-item Sun Protection Scale, but not sun avoidance.

The final trial in adults was a fair-quality cluster RCT among siblings of melanoma patients identified through dermatologists at teaching hospitals in the Boston area.[50] These siblings (n=494) were approximately 47 percent male and 100 percent white, and 85 percent had "fair" skin. Siblings were randomly assigned to receive either usual care or four sessions of telephone-based counseling by a health educator with computer-generated tailored materials at 0, 1, 3, and 5 months. At 6- and 12-month followup, there were no statistically significant differences between the intervention and control groups in tanning behavior (as measured by percent tanned by the end of last summer) or in routine sunscreen use.

Young Adults

Summary of findings. We found two fair-quality RCTs evaluating primary care relevant behavioral counseling interventions to prevent skin cancer in young adults in college.[49,53] Both of these trials used "appearance-based" behavioral interventions that emphasized the photoaging effects of UV exposure and cultural norms regarding tanning and appearing tan instead of a primarily "health-based" message about skin cancer prevention. In one RCT, young university women who self-reported an intention to tan indoors (n=430) received either a professionally produced booklet with an appearance-focused approach aimed at reducing indoor tanning or were assigned to a control group of assessment only. This intervention appeared to statistically significantly reduce the normative increases in indoor tanning during the 3 months of heaviest use, by over 35 percent at 6-month followup.[49] In another RCT (n=133), mostly female college students were randomly assigned to view a brief video with or without a UV facial photo or to a control group of assessment only. At 12 months, the persons who viewed the video had a "moderate" decrease in objectively measured skin pigmentation.[53] The change in pigmentation was judged "moderate" based on the authors' report of the Cohen d statistic.

Both these trials, however, have a few important limitations. The trial by Hillhouse and colleagues had only a 6-month followup and was conducted among young women who self-identified with the intention to indoor tan. The trial by Mahler and colleagues had a fairly small number of participants randomly assigned to four different intervention groups, in a two-by-two factorial design. Followup was only 63 percent for the results reported, and results were not reported with a true control group. It appears that the UV facial photo, however, did not have an intervention effect, and the authors of the paper state that none of the primary analyses indicated any significant interaction between the video and UV photo interventions. Finally, participants in the Mahler study received course credit for their participation in the trial.

Additional study details. One fair-quality RCT conducted in two U.S. universities randomly assigned young women (n=430) to receive either a professionally produced booklet with an appearance-focused message aimed at reducing indoor tanning or assessment only.[49] This booklet had five sections addressing the history of tanning and the context for tanning norms,

analysis of tanning and image norms, effects of UV radiation on skin, effects of indoor tanning, and indoor tanning guidelines. Women were age 19 years on average and selected based on a self-reported intention to tan indoors. Approximately one third of the participants had fair or medium skin type. At 6 months, with over 90 percent followup, women in the intervention group had statistically significantly less than normative increases in indoor tanning during the 3 months of heaviest use, by over 35 percent (6.8 events vs. 10.9 events over past 3 months; $p<0.001$).

One fair-quality trial RCT in a Southern California university randomly assigned participants (n=133) in a two-by-two factorial design to receive either a brief video session, a UV facial photo, both, or assessment only.[53] The interventions included an 11-minute videotaped slideshow on photoaging of the skin due to UV exposure and effective practices for reducing photoaging, a UV facial photograph using a modified instant camera, and a natural-light instant photograph. Participants were about 80 percent female, 45 percent white, and had a mean age of 20 years. This trial evaluated both self-reported behaviors and objectively measured skin pigmentation using skin reflectance spectrophotometry. At 12 months, the trial had 80 percent followup for self-reported behavior outcomes and 70 percent followup for spectrophotometry readings, but only 63 percent had followup at both 5 and 12 months and were therefore included in the final results. Results were reported for the video groups versus no video groups. Since the UV facial photo is not necessarily primary care feasible and the photo intervention did not appear to have a significant effect on self-reported or objectively measured outcomes, it is not discussed further (see Appendix B Table 1 for details). At 12 months, those persons who received the video session had lighter pigmentation as measured by one of two skin reflectance measures. This change was statistically significant, and based on the reported Cohen d statistic, was considered "moderate." There did not appear to be any statistically significant difference between the groups in the self-reported eight-item composite measure of sun-protective behaviors.

Children and Adolescents

Summary of findings. We found only two fair-quality RCTs evaluating primary care relevant behavioral counseling interventions to prevent skin cancer in children and adolescents.[45,54] Participants in both these trials were predominantly white. In one trial (n=819), young adolescents who were randomly assigned to brief counseling by their primary care providers coupled with an Expert System intervention had both higher self-reported composite sun protection scores and greater likelihood of avoiding or limiting midday sun exposure or using sunscreen on the face or sun-exposed areas at 24 months. The other cluster RCT was conducted in a large managed-care organization in which parents of newborns (n=728) received either usual care or sun protection counseling integrated into four sequential well-child care visits, at the discretion of the primary care provider.[45] Patients randomly assigned to receive the intervention had small but statistically significant higher self-reported composite sun protection scores at 36 months compared with those in control practices. However, the clinical significance of these higher scores is unclear, given the very small numerical differences and the lack of statistically significant differences in each of the seven sun-protection questions (with the exception of "shade use") that contributed to the composite score.

Because we found only two trials in children and adolescents, we discuss two additional fair-quality trials in adolescents and children that primarily examined community-based interventions to prevent skin cancer but included a counseling component conducted in primary care.[47,48] One of these trials was included in the prior report.[47] Both of these trials show that multimodal

community-based interventions to promote sun-protective behaviors in predominantly white neighborhoods and delivered through primary care practices, schools and/or day care centers, recreational facilities, and other community venues can improve directly observed and self-reported sun-protective behaviors in grade school and middle school children over 2 years of followup. Although these two trials were well-conducted community-level interventions, both trials followed the communities', rather than the individuals', behaviors, so the children and adolescents observed at baseline were not the same individuals at followup. Additionally, given the design of the intervention, it is impossible to determine the relative effect of each component, such as counseling in primary care.

Additional study details. The only fair-quality trial in adolescents was conducted in children aged 11 to 15 years attending one of six San Diego primary care clinics.[54] Participants (n=819) were age 13 years on average, 47 percent male, and 58 percent white, with 25 percent reporting high sun sensitivity (based on ability to tan, skin and hair color). Patients were randomly assigned to receive either a "Sun Smart" or physical activity and diet intervention, both using an Expert System intervention. The interventions consisted of brief counseling by primary care providers, interactive computer sessions, telephone assessments at 3, 6, 15, and 18 months, printed tailored feedback, mailed information, and sunscreen samples. The control group was matched in intensity, but did not receive the 2- to 3-minute primary care counseling. At 24 months, adolescents receiving sun protection counseling appeared to be approximately 5 to 10 percent (exact numbers not reported) more likely to report "always" or "often" avoiding midday sun exposure, limiting midday sun exposure, using sunscreen on face, and using sunscreen on sun-exposed areas. However, there were no significant differences between the two groups in self-report of wearing a shirt or staying in the shade.

The only fair-quality trial in younger children was conducted in parents and infants attending one of 14 primary care clinics part of a large managed-care organization in Colorado.[45] The majority of parents (n=728) were aged 30 to 39 years, nearly all were female, and about 76 percent were white, with the majority (75 percent) self-reporting fair to medium white skin. Parents and infants were randomly assigned to receive sun protection promotion at four consecutive well-child visits (at ages 2, 6, 18, and 36 months) or to usual care visits. The intervention included counseling at the discretion of the provider and packets of information, as well as a sun hat, sunglasses, and sunscreen samples. Although the intervention group had a small but statistically significant improvement in the seven-item Sun Protection Practice score at 36 months, these behavior changes were not significant when looked at individually (e.g., clothing use, midday sun avoidance, limiting time in sun, hat use, sunglasses use, sunscreen use). The measure "use of shade" was statistically significantly increased by 7 percent among the intervention group at 24 months (p=0.04), but was no longer statistically significant at the end of the trial (p=0.06).

Two fair-quality cluster RCTs evaluated a multicomponent community-based intervention, "SunSafe," which included some counseling in primary care.[47,48] The SunSafe intervention included training primary care clinicians to incorporate sun protection messages into well visits, as well as providing patient education materials to supplement sun-protection curriculum delivered through schools, recreational areas/facilities, and other community venues. One trial targeted adolescents entering sixth through eighth grade at beaches and swimming pools in geographically distinct towns in New Hampshire and Vermont.[48] Cross-sections of the adolescent population were assessed at baseline (n=797) and at 1 (n=637) and 2 years (n=493). Participants at baseline and followup did not represent a single cohort. Participants at baseline

were in sixth grade, approximately 45 percent male, and mostly white. As compared with adolescents in schools and communities without the SunSafe intervention, adolescents in the intervention communities were observed to have a greater percentage of body surface area protected at 24 months (66.1 vs. 56.8 percent; $p<0.01$) and more frequently reported sunscreen use (47.0 vs. 13.8 percent; $p<0.001$). The other trial targeted children aged 2 to 9 years and their caregivers visiting beaches in 10 geographically distinct towns in New Hampshire.[47] Cross-sections of the communities were assessed at baseline (n=865) and 12 months (n=1,065). Participants were about one half male and overwhelmingly white. There was no statistically significant difference in observed sun-protective behaviors (use of sun-protective behaviors or protection by shade) between children in the intervention and control communities at 12 months. As compared with children in communities without the SunSafe intervention, those children in the intervention communities reported using sunscreen more frequently at 12 months (approximately 17 percent difference; $p=0.011$).

Key Question 3: Do Primary Care Relevant Counseling Interventions Have Adverse Effects?

Of the 10 trials examining primary care relevant counseling interventions to prevent skin cancer, we found no evidence for a paradoxical decrease in sun-protective behaviors. In one trial, the skin cancer counseling intervention was an attention control intervention for a physical activity and diet counseling intervention.[54-56] In this trial, adolescent girls and boys (n=395) with a mean age of 13 years received skin cancer counseling in a primary care practice. There was no clinically or statistically significant effect on self-reported measures of sedentary behaviors (mean hours per day), 7-day physical activity recall (moderate and vigorous activity, mean minutes per week), or number of days per week active (refer to Appendix B Table 1 for more details).

Key Question 4: Is Sun Exposure, Indoor Tanning, or Sunscreen Use Associated With Skin Cancer Outcomes?

In total, we found 56 articles representing 32 unique fair- or good-quality studies that evaluated the association of sun exposure, indoor tanning, or sunscreen use with skin cancer, the majority of which were case-control studies. We did not find any studies meeting our inclusion criteria that examined the association between a decrease in an individual's sun exposure (e.g., due to protective clothing or avoidance of midday sun exposure) and skin cancer outcomes. Therefore, in this KQ, we discuss the relationship between sun exposure and skin cancer outcomes. We found only one good-quality trial, the Nambour Skin Cancer Prevention Trial,[57-61] which was reported in multiple publications and included in the prior report.[1] We found seven fair- or good-quality cohort studies, one of which was a cohort derived from the Nambour Skin Cancer Prevention Trial. We included 25 fair- or good-quality population-based case-control studies,

two of which were nested case-control studies. In this section, we discuss the results for each exposure (sun exposure, indoor tanning, and sunscreen use) separately. Sun exposure is discussed by type of exposure: "intermittent," which includes predominantly measures of recreational sun exposure; "chronic," which includes occupational measures or weekday measures of sun exposure; or "total," which includes cumulative estimates of sun exposure. However, it is important to note that measures of sun exposure within these categories vary greatly between studies. In addition, when possible, we categorized exposures by timing: in childhood (generally before age 19 or 20 years), in the recent past (ranging from past 5 to 20 years), or over the entire lifetime. Given the considerable heterogeneity in study characteristics and measurement of exposure variables, we did not attempt a quantitative summary of results. The reported odds and risk ratios are to illustrate a general estimate of the magnitude of association (e.g., between the highest and lowest risk groups). However, odds and risk ratios should not be compared between studies, because they used very different measures of exposure and choice of reference groups. Individual study details, including quality assessment, are available in Tables 3–5 and Appendix C Table 1.

Sun Exposure

Summary of findings. Based on 11 primarily fair-quality cohort and case-control studies, increasing intermittent (or recreational) sun exposure in childhood and over one's lifetime is associated with an increased risk for both squamous cell and basal cell carcinoma (range OR, 1.27 to 3.86). The evidence is more consistent for intermittent sun exposure in childhood leading to an increased risk for squamous cell and basal cell carcinoma than in adulthood (range OR, 1.42 to 3.86). While there are fewer studies that examined the association of total (or cumulative) and chronic (or occupational) sun exposure, existing studies did not suggest a strong association between total or chronic sun exposure and squamous cell or basal cell carcinoma.

There were 18 fair-quality studies examining the association between sun exposure and melanoma. Based on mainly case-control studies, it appears that both total and chronic sun exposure are not strongly associated with melanoma. However, some evidence suggests that total sun exposure in childhood is associated with an increased risk for melanoma (range OR, 1.81 to 4.4), and occupational sun exposure may be associated with a decreased risk for melanoma. Case-control studies examining the risk for melanoma and intermittent sun exposure are inconsistent, but some studies suggest that increasing recreational sun exposure increases the risk for melanoma (range OR, 1.3 to 5.0). However, the evidence is more consistent for recreational sun exposure in childhood leading to an increased risk for melanoma than in adulthood (range OR, 1.7 to 3.5).

Measures of intermittent, chronic, and total sun exposure, delineation of levels of exposure, and reference groups for each measure varied largely between studies, making it difficult to make comparisons across studies. We did not quantitatively pool risk estimates.

Study details. A total of five fair- or good-quality cohort studies and six fair- or good-quality case-control studies examined the association between sun exposure and squamous cell or basal cell carcinoma, using different measures of total (or cumulative) sun exposure, intermittent (or recreational) sun exposure, and chronic (or occupational) sun exposure (Table 3).

None of the three case-control studies that examined total sun exposure showed a statistically significant association between total sun exposure and squamous cell or basal cell carcinoma,[62-64]

even after adjusting for skin phenotype.[62,63] None of the two cohort studies (n=3,612)[61,65] or three case-control studies[62,64,66] that examined chronic or occupational sun exposure showed a statistically significant association between occupational sun exposure and squamous cell or basal cell carcinoma. All but two of these studies adjusted for skin phenotype.[61,64]

The largest number of studies examined intermittent or recreational sun exposure and the risk for squamous cell or basal cell carcinoma (five cohort and six case-control studies)(Table 3). Of the cohort studies, the largest three were conducted in the United States (Nurses' Health Study: n=107,900 for squamous cell carcinoma, n=73,366 for basal cell carcinoma; Health Professionals Study: n=44,591).[67-69] These studies suggest that women who report not spending regular time outdoors in the summer are at decreased risk for squamous cell (RR, 0.7 [CI, 0.4–1.1]) and basal cell carcinoma (RR, 0.73 [CI, 0.59–0.90]),[67,68] and men who had frequent sun exposure in the summer as a teenager are at increased risk for basal cell carcinoma (range RR, 1.30 to 1.42).[69] In two smaller cohort studies from Australia (n=3,612), recreational sun exposure, measured as mainly indoors, indoors and outdoors, or mainly outdoors, was not significantly associated with risk for squamous cell or basal cell carcinoma.[61,65] Five of the six case-control studies adjusted for skin phenotype.[62,63,66,70,71] In these studies, increasing recreational sun exposure in childhood increased risk for basal cell carcinoma (range OR, 1.82 to 2.6),[62,70] but the association between lifetime increase in recreational sun exposure and squamous cell or basal cell carcinoma was not as consistent.[62,63,66,70,71] The largest case-control study, nested within the Nurses' Health Study, suggests an increase in squamous cell (OR, 2.15 [CI, 1.45–3.19]) and basal cell carcinoma (OR, 2.05 [CI, 1.38–3.06]) with the highest categorization of lifetime recreational sun exposure.[71] A smaller case-control study also suggests an increased risk for basal cell carcinoma with increasing recreational sun exposure;[62] however, the other case-control studies do not.[63,66,70] Only one study stratified results by skin type. This study showed an interaction between sun exposure and basal cell carcinoma, with a higher risk seen in those persons with a lesser ability to tan.[62]

One fair-quality cohort study and 17 fair- or good-quality case-control studies examined the association between sun exposure and melanoma, using different measures of total, intermittent, and chronic sun exposure. Six case-control studies included some measure of total sun exposure, either in childhood, in the recent past, or over the lifetime.[72-77] These studies showed mixed results, with two studies finding a statistically significant association between total lifetime sun exposure and melanoma (range OR, 2.20 to 2.63).[73,74] The other four studies did not find this association.[72,75-77] One study that presented results stratified by skin type suggests that those who tan easily have a decreased risk for melanoma with increasing total lifetime sun exposure.[72] All three studies that examined total sun exposure in childhood showed a statistically significant association between increasing sun exposure and melanoma (range OR, 1.81 to 4.4).[74,76,77] Eight case-control studies included some measure of chronic or occupational sun exposure.[72,73,75,76,78-81] Two of these studies suggest that occupational sun exposure is associated with an increased risk for melanoma. Both of these studies, however, used crude measures of occupational sun exposure (yes/no, none/sometimes/often).[78,79] The confidence intervals in one of these studies, though statistically significant, were extremely wide due to the very small number of cases.[78] In contrast, five of the remaining six studies suggest that occupational sun exposure is inversely associated with melanoma risk.[72,73,75,76,80]

One fair-quality cohort study and 13 fair-quality case-control studies examined the association between intermittent or recreational sun exposure and melanoma. A large (n=106,379) fair-

quality cohort study from Norway and Sweden showed no significant association between frequency of sunbathing vacations in childhood or as an adult and risk for melanoma.[82] Of the eight case-control studies that examined lifetime recreational sun exposure,[71,73,75,79,83-86] five studies showed that increasing recreational sun exposure was associated with melanoma risk (range OR, 1.3 to 5.0);[71,73,75,79,84] all but one adjusted for skin phenotype.[84] Only one of these studies presented results stratified by skin type, which suggested an interaction between a lesser ability to tan and an increased risk for melanoma.[71] Of the three case-control studies that did not show a statistically significant association between lifetime recreational sun exposure and melanoma risk, two from Sweden used a crude dichotomous measure of recreational sun exposure, and one from Denmark lost statistical significance after adjusting for important confounders including skin phenotype. All three case-control studies that examined recreational sun exposure during childhood suggest that increasing sunbathing behavior in childhood is associated with an increased risk for melanoma (range OR, 1.7 to 3.5).[81,84,87] Only one study presented results stratified by skin type, which suggested an interaction between a lesser ability to tan and an increased risk for melanoma.[87]

Indoor Tanning

Summary of findings. We found very few studies that examined the relationship between exposure to indoor tanning devices and risk for squamous cell and basal cell carcinoma, after adjusting for all important confounders. Results generally suggest no association. However, a slightly larger body of higher-quality evidence suggests that "regular" or "early" use of indoor tanning devices may increase the risk for developing melanoma (range OR, 1.55 to 2.3). Most of these studies used crude measures of indoor tanning exposure.

Study details. We found only five fair-quality case-control studies that examined the association between indoor tanning and the risk for squamous cell or basal cell carcinoma (Table 4).[64,66,70,71,88] Two of these studies were conducted in Canada during the early 1980s. The remaining studies were conducted in the 1990s. Four of the five studies used only a crude dichotomous measure (ever/never) of indoor tanning, and none of these studies found a statistically significant association between ever and never use.[64,66,70,71] Three of these studies adjusted for both skin phenotype and sun exposure.[66,70,71] One fair-quality case-control study that was slightly larger and had a slightly higher proportion of exposed individuals showed a statistically significant association between indoor tanning and risk for squamous cell or basal cell carcinoma, with greater risk for those who reported early first use (before age 20 years).[88] However, this study only adjusted for skin phenotype and did not adjust for sun exposure.

We found one fair-quality cohort study and 10 fair-quality case-control studies that examined the association between indoor tanning and melanoma.[71,79,80,82,83,85,86,89-92] The cohort study, derived from the Norwegian-Swedish Women's Lifestyle and Health Cohort Study, found that women who reported solarium use one time or more per month during ages 10 to 39 years had an increased risk for melanoma (RR, 1.55 [CI, 1.04–2.32]), after adjusting for important confounders including skin phenotype and intermittent sun exposure.[82] Of the 10 case-control studies, three studies were conducted in the early to mid1980s.[80,83,90] Only one of the 10 case-control studies conducted a separate analysis for sunlamps (used mostly pre-1980 and with higher UVB content) and tanning beds (used mostly post-1980 and with higher UVA content).[92] Five of the 10 studies did not find any association between ever or never use of indoor tanning and melanoma.[79,80,83,89,91] Only one of these studies adjusted for both skin phenotype and some

measure of sun exposure.[89] This study by Chen and colleagues also examined measures of total sunlamp use and age at first use, but did not find any statistically significant association between these measures and melanoma. Of the four studies that found a statistically significant association between indoor tanning exposure and melanoma, only two adjusted for both skin phenotype and some measure of sun exposure,[71,85] while one adjusted for skin phenotype and number of sunburns[85] and one adjusted for only skin phenotype.[90] These studies suggest that regular or higher frequency indoor tanning or use at a younger age may increase risk for melanoma. The one study that examined sunlamp and tanning bed exposure separately found a statistically significant trend (p=0.02) for frequent sunlamp use (≥6 times) and melanoma risk (OR, 1.54 [CI, 0.93–2.57]), but not for frequent tanning bed use (≥10 times) and melanoma risk (OR, 1.25 [CI, 0.79–1.98]).[92] However, the study investigators stated that while no association with tanning bed use was found, sufficient lag time may not have elapsed to assess a potential effect, given the more recent use of tanning beds.

Sunscreen Use

Summary of findings. Based on one trial, regular sunscreen use may prevent squamous cell carcinoma (RR, 0.65 [CI, 0.45–0.94]). It is unclear whether regular sunscreen use prevents basal cell carcinoma; case-control studies that suggest sunscreen use reduces the risk for basal cell carcinoma have major limitations. Based on five fair-quality studies, sunscreen use has no clear protective or harmful effect on the risk for melanoma. However, the case-control studies examining this risk have major limitations.

Study details. We found one RCT (n=1,621) examining whether regular sunscreen use can prevent squamous cell or basal cell carcinoma (Table 5).[57-59] Based on this trial, individuals randomly assigned to regular sunscreen use had a decreased risk for squamous cell carcinoma after 8 years of followup (RR, 0.65 [CI, 0.45–0.94]). No statistically significant decrease in risk was seen for basal cell carcinoma. Although this was a good-quality RCT, at 8 years a substantial proportion of participants had only passive followup with pathology records. Two fair-quality cohort studies (n=181,266) derived from the Nurses' Health Study did not show a decrease in squamous cell or basal cell carcinoma risk with sunscreen use after adjusting for skin phenotype and sun exposure.[67,68] However, both of these studies used only a crude dichotomous measure of sunscreen use. While two fair-quality case-control studies suggest a protective effect of sunscreen for basal cell carcinoma, both used crude measures of sunscreen use, and neither study adjusted for sun exposure.[62,64]

We found one fair-quality cohort study and four fair-quality case-control studies that examined the association between sunscreen use and melanoma.[79,80,85,86,93] One cohort study (n=178,155) and one case-control study found no significant association between a crude dichotomous measure of sunscreen use and risk for melanoma.[79,93] Three case-control studies found a statistically significant association between sunscreen use and melanoma, but were inconsistent. One study found a protective effect for women who reported always using sunscreen compared with women who reported sometimes or never using sunscreen, after adjusting for skin phenotype and sunburn but not sun exposure.[80] Two studies in Sweden found a statistically significant harmful effect of sunscreen, such that persons who reported always or almost always using sunscreen were at increased risk for melanoma, after adjusting for both skin phenotype and sun exposure.[85,86]

Key Question 5: Are Sun-Protective Behaviors Associated With Adverse Effects?

We found 16 fair- or good-quality studies that directly examined the potential harms of sun-protective behaviors (Table 6).[94-107] Of these, one fair-quality trial examined whether adherence to sun-protective behaviors in children reduces physical activity;[94] six fair- or good-quality trials examined whether sunscreen use leads to increased sun exposure;[95-97,108-110] two fair-quality studies examined the effect of sun exposure or sunscreen on vitamin D levels;[98,99] and seven fair- or good-quality studies examined the relationship between sun exposure and risk for breast cancer, colon cancer, prostate cancer, or lymphoma. We found no studies that examined the effect of sun-protective behaviors on mood (for individual study details, refer to Appendix C Table 3).

Reduced Physical Activity

Limited trial evidence suggests that there is no increased risk for sedentary behaviors or increase in body mass index (BMI) in children who reduced their amount of midday sun exposure. Based on one fair-quality cluster nonrandomized trial (n=1,615) in Australia, grade school children who received a 4-year sun protection curriculum beginning at age 6 years had the same mean BMI at 4- and 6-year followup as children receiving a standard health education curriculum.[94] In addition, there was no difference in self-reported total time spent outdoors between the children in the intervention and control schools. Although the counseling intervention in this trial was not primary care relevant, this study does show that children who practice sun-protective behavior as a result of school-based education do not decrease the total time spent outdoors or show an increase in BMI. This trial's findings are consistent with those observed in the sun protection counseling arm of the trial by Norman and colleagues, which found no difference in self-reported measures of sedentary behavior or physical activity in adolescents before and 12 months after counseling.[54]

Increased Sun Exposure

Two good-quality trials suggest that use of higher SPF (SPF 30) sunscreen increases intentional sun exposure, although not risk for sunburn, in young adult sunbathers. However, based on two other trials in adults and two fair-quality trials in children, sunscreen use in general does not appear to increase sun exposure. We found two small but good-quality double-blind RCTs (n=149) conducted in Europe that examined whether sunscreen use encourages longer sun exposure in healthy student volunteers on vacation.[95,96] In these trials, persons randomly assigned to higher SPF sunscreen (SPF 30) had increased self-reported sun exposure from sunbathing (approximately 19 to 25 percent) compared with those using SPF 10 sunscreen. However, there was no significant difference in sunburns between the two groups, and the greatest differences in total number of sunbathing hours was in those who did not have sunburns. Another similarly designed fair-quality RCT (n=367) conducted in France was designed to determine whether higher SPF sunscreens have an impact on sun exposure behavior and to determine the impact of actual versus perceived SPF protection.[97] Adults in this trial were randomly assigned into one of three arms: SPF 12 sunscreen labeled as "basic protection," SPF 40 sunscreen labeled as "basic

protection," or SPF 40 sunscreen labeled as "high protection." Adults blinded to SPF who received SPF 40 sunscreen did not have increased sun exposure from sunbathing, but did have an increase in sunburns compared with those who received SPF 12 sunscreen (14 percent vs. 24 percent, respectively; p=0.06). However, this is complicated by the fact that persons who received SPF 12 sunscreen labeled as "basic protection" used three times as much sunscreen on average compared with those who received SPF 40 sunscreen. In addition, there was no difference in self-reported sun bathing or sunburns between the adults who received SPF 40 sunscreen labeled as "basic" or "high" protection. Allocation concealment may have been threatened in this trial, and in addition, patients in this trial, compared with the other two trials by Autier and colleagues, were older (mean age, 39 years) and generally spent fewer hours sunbathing (13 to 14 hours/week vs. approximately 2.5 to 3 hours/day). The largest trial (n=1,621), the Nambour Skin Cancer Prevention Trial, randomly assigned persons (mean age, 49 years) to receive SPF 15 sunscreen or placebo sunscreen and did not find any difference at 4.5 years in self-reported time spent outdoors or ambient UV exposure, as measured by polysulphone badges worn by a random subset of participants (n=175).[57,108] Two fair-quality trials in grade school and nursery school children (n=2,345) did not find any difference at 3 years in self-reported time spent outdoors or time spent on sunny vacations between those students who received high SPF sunscreen or no sunscreen.[109,110]

Vitamin D Deficiency

Due to the inclusion criteria for this review, we only found two studies examining sun-protective behaviors and possible harms of vitamin D deficiency (see the Discussion section for additional information). In one fair-quality trial, sunscreen use did not significantly decrease vitamin D levels or cause vitamin D deficiency.[98] In a fair-quality cohort study, vitamin D levels were greatly influenced by sun exposure, and women living at high latitudes who avoided direct sun exposure were at increased risk for vitamin D deficiency during the winter and spring months.[99] A placebo-controlled RCT in Australia investigated whether regular sunscreen use in adults put individuals at risk for vitamin D deficiency.[98] Participants (n=153) were randomly assigned to SPF 17 sunscreen or placebo cream over the summer. At 7 months there was no statistically significant change in 25-hydroxyvitamin D3 levels between the two groups. More importantly, no one in the sunscreen group developed vitamin D deficiency. A cohort study nested within a multicenter RCT in Denmark (Danish Osteoporosis Prevention Study) assessed the prevalence of vitamin D deficiency in perimenopausal women and the relative influences of sun exposure and vitamin D intake on measured levels of 25-hydroxyvitamin D3.[99] Healthy Danish women (n=2,016) were interviewed to determine their sun exposure and sunbed use and were given diet records to determine their vitamin D intake. Overall, only 7 percent of the population had vitamin D deficiency (3 percent during the summer through autumn and 11 percent during the winter through spring). However, those avoiding direct sunshine and not taking vitamin D supplements were at increased risk for vitamin D deficiency compared with those who had occasional or regular sun exposure (32.8 percent vs. 17.6 percent and 9.8 percent, respectively). Although the data are not reported, the authors state that "most of the women with low serum 25-hydroxyvitamin D3 values were only deficient for part of the year." According to the study authors, no cutaneous vitamin D production occurs from October to April at Denmark's latitude, thus the maintenance of vitamin D is dependent on vitamin D intake and stores built up during the previous summer.

Increased Cancer Risk

Sun exposure, through the production of vitamin D, may be protective against some types of cancer. Based on a sparse body of fair- or good-quality cohort and case-control studies, it appears that sun exposure in lighter pigmented persons may be inversely related to risk for advanced breast and prostate cancer after adjusting for well-established risk factors, and that intermittent sun exposure may be inversely related to risk for nonHodgkin lymphoma. None of these studies adjusted for vitamin D intake or measured vitamin D status. We did not identify any studies examining the association between reduction in sun exposure and risk for developing cancer other than skin cancer.

Breast cancer. Two observational studies, one fair-quality retrospective cohort study and one good-quality case-control study, examined the possible protective role of sun exposure in relation to breast cancer.[100,107] The analytic cohort was derived from the NHANES I Epidemiologic Follow-up Study, and included women ages 25 to 74 years with adequate followup and available dietary and dermatologic data.[100] There was a nonstatistically significant trend of decreasing risk for breast cancer in relation to increasing levels of combined recreational and occupational sun exposure (p=0.06), after adjusting for age, education, age at menarche, age at menopause, BMI, frequency of alcohol consumption, and physical activity. This trend was most prominent within a stratified analysis across region of residence, although statistical significance of these trends was not reported. However, adjustment for dietary vitamin D intake appeared to attenuate this trend (p=0.08). While none of the analyses adjusted for skin type, the analytic cohort was restricted to white women. In a large, well-done case-control study by the same group of investigators, the associations between sun exposure, vitamin D receptor gene polymorphism, and breast cancer risk were examined in a multiethnic population in California.[107] Using either measures of observed skin pigmentation or a sun exposure index, increasing sun exposure was statistically significantly associated with a decreased risk for advanced breast cancer. In persons with the lightest skin type (by tertile), the highest sun exposure groups (by quartile) had an adjusted relative risk reduction of 0.53 (CI, 0.31–0.91) based on a sun exposure index (p=0.01). The analysis adjusted for age, race, education, family history of breast cancer, personal history of benign breast disease, number of full-term pregnancies, breastfeeding, height, alcohol consumption, BMI, menopausal status, and history of hormone therapy use. This magnitude of risk reduction and trend in risk reduction was not observed in persons with medium- or dark-skin type or with localized breast cancer.

Prostate cancer. We found one fair-quality study designed to evaluate the association between sun exposure and prostate cancer.[105] This case-control study was conducted by the same group of investigators and was similar in design and methodology to the previously well-done case-control study on breast cancer risk.[107] However, this case-control analysis was limited to white persons because there was insufficient data to permit race-specific analyses. The findings in this case-control study were similar to those of the breast cancer study, with a statistically significant inverse trend between sun exposure (using both observed skin pigmentation and a sun exposure index) and risk for advanced prostate cancer. In nonHispanic whites, the highest sun exposure groups (by quintile) had an adjusted relative risk reduction of 0.51 (CI, 0.33–0.80) based on a sun exposure index (p=0.02). The analysis adjusted for age, family history of prostate cancer, and month of pigmentation measurement. However, there was no statistically significant trend between self-reported measures of lifetime outdoor activities or lifetime outdoor jobs and risk for advanced prostate cancer.

Colon cancer. We found only one fair-quality case-control study designed to evaluate the association between sun exposure and colon cancer.[101] In this study, participants who were identified through a large health maintenance organization across three regions in the United States were interviewed to assess dietary intake and calcium and vitamin D intake, as well as sun exposure. Neither sun exposure nor dietary vitamin D intake were statistically significantly associated with risk for colon cancer after adjusting for age, BMI, family history of colon cancer, aspirin and/or nonsteroidal anti-inflammatory drug use, energy intake, long-term vigorous activity, fiber, and calcium. None of the analyses adjusted for skin type, although approximately 91 percent of the population was white.

NonHodgkin lymphoma. Three fair-quality case-control studies examined the association between sun exposure and nonHodgkin lymphoma. The largest case-control study, conducted in Denmark and Sweden, assessed the association between UV exposure (sun and sunbed/lamps) and lymphoma (both nonHodgkin lymphoma and Hodgkin lymphoma).[104] Cases and controls were identified through national population registries and were interviewed by telephone to determine host factors, sun exposure and sunbed/lamp use, and self-reported skin cancer. Cases with other hematologic malignancy or immunosupression (from organ transplantation or HIV) were excluded. After adjusting for age, sex, country, and skin type, increasing sun exposure (as measured by self-reported sunbathing, sunny vacations, or sunburn history) was statistically significantly associated with decreasing risk for nonHodgkin lymphoma. In addition, increasing indoor tanning use was also statistically significantly associated with decreasing risk for nonHodgkin lymphoma. Similar, albeit weaker, trends were found for Hodgkin lymphoma. Another case-control study conducted in Australia found a similar statistically significant association between self-reported measures of nonoccupational sun exposure (by quartile), as measured by sun exposure on nonworking days and vacation sun exposure, and risk for nonHodgkin lymphoma after adjusting for age, sex, state, and skin type.[102,103] However, sun exposure on working days or lifetime occupational sun exposure was not significantly associated with risk for nonHodgkin lymphoma. Neither of these two studies assessed or adjusted for dietary vitamin D intake. The third case-control study, conducted in four geographic areas in the United States, was designed to examine the association between sun exposure or dietary vitamin D intake and nonHodgkin lymphoma in a predominately white population.[106] This study used in-person interviews and mailed questionnaires to ascertain sun exposure and dietary intake, and had noticeably lower response rates than the other two case-control studies. In this study, there was no statistically significant association between midday sun exposure, use of sunlamps or sunbeds, or history of blistering sunburns and risk for nonHodgkin lymphoma, after adjusting for age, sex, ethnicity, and state (latitude). Other than a measure of "blistering sunburns," this study did not report on intermittent versus chronic sun exposure. This study assessed, but did not adjust for, dietary vitamin D intake, presumably because the study did not find a statistically significant association between dietary vitamin D and risk for nonHodgkin lymphoma. In addition, this study adjusted for ethnicity but not skin type.

Melanoma. As discussed in KQ 4, five fair-quality studies, one cohort and four case-control, examined the association between sunscreen use and risk for melanoma. Of these, two of the case-control studies conducted in Sweden found a statistically significant harmful effect of sunscreen, such that persons who reported always or almost always using sunscreen were at increased risk for melanoma, after adjusting for both skin phenotype and sun exposure.[85,86]

IV. Discussion

Summary of Findings

In 2003, the USPSTF concluded that there was insufficient evidence to recommend for or against routine counseling by primary care clinicians to prevent skin cancer. At the time of this recommendation, only a single trial that evaluated primary care skin cancer counseling was available, and this was part of a larger community-based intervention. Therefore, the contribution of office-based counseling could not be isolated. In addition, there was uncertainty about potential harms of counseling to encourage sun-protective behaviors, and limited evidence examining the effect of sunscreen or indoor tanning use on skin cancer risk. We summarize our findings according to the evidence gaps identified by the 2003 USPSTF recommendation.

Effectiveness of Counseling to Promote Sun-Protective Behaviors

Although we did not find any studies examining whether counseling interventions could reduce skin cancer or intermediate outcomes (e.g., sunburns, nevi, or actinic keratoses), we found 10 fair- or good-quality RCTs that examined the impact of primary care relevant skin cancer counseling interventions on sun-protective behaviors. In two of these trials, however, the counseling delivered through primary care was a small part of a much larger coordinated multimodal, community-based intervention, and thus will not be discussed further.

In adults (n=6,225), primary care relevant counseling with computer support can increase composite scores measuring sun-protective behaviors at 6 to 24 months. In young adults (n=563), brief appearance-focused behavioral interventions can decrease normative indoor tanning behaviors at 6 months, and decrease UV exposure, as objectively measured by skin pigmentation, at 12 months. In young adolescents (n=819), primary care counseling with computer support, similar to that used in adults, can decrease midday sun exposure and increase sunscreen use at 12 and 24 months. In parents of newborns (n=728), primary care counseling integrated into sequential well-child care visits can increase composite scores measuring sun-protective behaviors at 36 months. It is important to note that the trials in adults only reported composite sun protection scores and not changes in individual behavior. It is unclear if the small, but statistically significant, differences in composite scores of self-reported sun-protective behaviors translate into clinically meaningful behavior change that will prevent skin cancer. All but one trial used self-reported behavioral outcomes and therefore could be affected by social desirability bias. However, it appears that self-reported skin cancer risk behaviors are subject to minimal social desirability bias.[111]

Most of these trials were conducted in exclusively or predominantly white populations. Only one trial in young adolescents and one trial in college students reported inclusion of a sizeable nonwhite population. However, this restriction is reasonable, given the much higher incidence of skin cancer in white persons. In addition, one trial in the United Kingdom included only persons with “high-risk” skin characteristics (e.g., red hair, multiple nevi, history of sunburn as a child, freckling, family history of melanoma, or fair sun-sensitive skin),[46] and one trial included only young women who expressed intention to indoor tan.[49] Three trials used a low-intensity

intervention: a single 15-minute self-directed session on a computer workstation "prescribed" by their primary care provider, an appearance-focused booklet aimed at decreasing indoor tanning, or an appearance-focused video on the effects of photoaging on skin. The remaining trials examined high-intensity counseling interventions with about four sessions (either in person or by telephone), many of which included computerized support. Although all trials reported the theoretical underpinnings of the intervention, they are described in varying detail. As such, it is often unclear if the intervention was guided by theory only or empirical data as well (see Appendix B Table 1 for details on intervention theory).

Harms of Counseling and Practicing Sun-Protective Behaviors

Overall, we found little evidence that sun-protective counseling or practicing sun-protective behaviors causes significant harms. Of the 10 trials examining the effectiveness of counseling interventions to improve sun-protective behaviors, we found no evidence that primary care relevant counseling interventions or community-based interventions involving primary care counseling paradoxically decrease sun-protective behavior. In addition, based on two trials, there is no evidence to suggest that sun-protective behavioral counseling in children or adolescents negatively impacts physical activity or BMI.[54,94]

Based on limited but good-quality trial evidence, it appears that higher SPF sunscreen use can increase intentional sun exposure in young adults on sunbathing vacations compared with lower SPF sunscreen use (but not sunburns). However, other fair- to good-quality trial evidence suggests that sunscreen use in general does not appear to increase sun exposure in adults or children. Two case-control studies suggest an increased risk for melanoma with sunscreen use, although other studies found no association or a protective effect. However, these studies have major methodological limitations, including the use of very crude measures of sunscreen use and lack of adequate adjustment for confounding by indication.

Due to the inclusion criteria for this review, we only included two studies examining sun-protective behaviors and possible harms of vitamin D deficiency. From one fair-quality trial, it appears that regular sunscreen use does not lead to vitamin D deficiency.[98] One cohort study suggests that vitamin D levels are greatly influenced by sun exposure and that women living at high latitudes may be at risk for vitamin D deficiency during the winter and spring months.[99] However, the study investigators state that "most of the women with low serum 25-hydroxyvitamin D3 were only deficient for part of the year." A recent full report on vitamin D and cancer from the World Health Organization International Agency for Research on Cancer includes a detailed discussion of the complex relationship between serum 25-hydroxyvitamin D levels and sun exposure, and the multiple variables that potentially affect endogenous vitamin D production.[112] Cutaneous vitamin D synthesis, however, varies significantly among individuals. In general, this synthesis happens relatively quickly, and prolonged sun exposure does not result in continuous increases in vitamin D synthesis, so that maximum vitamin D synthesis occurs at suberthemogenic UV doses.[112] According to best estimates, during sunny summer days at approximately 40 degrees latitude, a fair-skinned person could achieve maximum cutaneous vitamin D synthesis with 5 to 10 minutes midday sun exposure to the face and forearms a few times a week. Longer exposure, approximately 30 minutes, is needed for darker-skinned persons or with less-intense sun exposure (e.g., cloudy days).[112] In addition, this report recognizes the importance of exogenous vitamin D found in diet, and that fortified foods and supplements are important sources of vitamin D in the winter when skin synthesis of vitamin D is insufficient.[112]

Finally, it has been hypothesized that vitamin D production may be protective against certain types of cancer through vitamin D receptor-dependent or independent mechanisms. The few case-control studies published on this topic suggest that sun exposure and intermittent sun exposure in lighter pigmented persons may be inversely related to risk for advanced breast cancer, prostate cancer, and nonHodgkin lymphoma. However, this literature is very sparse, and the case-control studies have important methodological limitations, including the adequate measurement of sun exposure and lack of adjustment for vitamin D intake. Furthermore, none of the studies directly assessed vitamin D status, and the relationship between sun exposure and vitamin D status is not direct. Given the limited number of published studies, it is likely that this body of literature is significantly affected by publication bias.[112]

Association Between Sun Exposure, Sunscreen Use, or Indoor Tanning and Skin Cancer

We did not find any studies meeting our inclusion criteria that examined whether a change in sun exposure (e.g., due to protective clothing or avoidance of midday sun) resulted in a decrease in skin cancer outcomes. We found mainly fair-quality cohort and case-control studies examining the relationship between sun exposure and skin cancer (11 studies for squamous cell and basal cell carcinoma, 18 studies for melanoma). We found that increasing intermittent (or recreational) sun exposure is associated with an increased risk for squamous cell and basal cell carcinoma (range OR, 1.27 to 3.86). Case-control studies examining the risk for melanoma with intermittent sun exposure are inconsistent, but some studies suggest that increasing recreational sun exposure increases the risk for melanoma (range OR, 1.3 to 5.0). However, the evidence is more consistent for intermittent sun exposure in childhood leading to an increased risk for both melanoma and squamous cell and basal cell carcinoma. Fewer studies examined the association of total or chronic (or occupational) sun exposure. These studies do not suggest a strong association between total or chronic sun exposure and skin cancer. However, some evidence suggests that total sun exposure in childhood is associated with an increased risk for melanoma and occupational sun exposure may be associated with a decreased risk for melanoma. Our findings are consistent with a fair-quality systematic review by Gandini and colleagues that found a positive association for intermittent sun exposure and an inverse association for high levels of occupational or chronic sun exposure.[17] Unlike our review, the meta-analysis by Gandini and colleagues included both population-based and nonpopulation-based case-control studies.

We found very limited evidence (a limited number of studies using crude measures of indoor tanning exposure) that exposure to indoor tanning devices may increase the risk for squamous cell and basal cell carcinoma, after adjusting for all important confounders. Results generally suggest no association. However, a slightly larger body of higher quality evidence suggests that "regular" or "early" use of indoor tanning may increase the risk for developing melanoma (range OR, 1.55 to 2.3). Most of these studies used crude measures of indoor tanning exposure. The one study that examined sunlamp (earlier technology) and tanning bed (more recent technology) exposure separately found a statistically significant trend ($p=0.02$) for frequent sunlamp use ($\geq$6 times) and melanoma risk (OR, 1.54 [CI, 0.93–2.57]), but not for frequent tanning bed use ($\geq$10 times) and melanoma risk (OR, 1.25 [CI, 0.79–1.98]).[92] However, the study investigators state that although no association with tanning bed use was found, sufficient lag time may not have elapsed to assess a potential effect, given the more recent use of tanning beds. Our findings are consistent with a fair-quality systematic review and meta-analysis by the International Agency

for Research on Cancer on artificial UV light and skin cancer that found evidence to suggest that first use of indoor tanning equipment before age 35 years increases risk for melanoma.[30] This review estimated the risk for melanoma at 1.15 (CI, 1.00–1.31) based on "ever use" in 19 studies, and at 1.75 (CI, 1.35–2.26) based on first exposure during youth in 7 studies. The risk for squamous cell carcinoma, based on "ever use" in three studies, was 2.25 (CI, 1.08–4.70), and not significant for basal cell carcinoma. Unlike our review, the meta-analysis included both population-based and nonpopulation-based case-control studies.

Based on one fair-quality trial, regular sunscreen use may prevent squamous cell carcinoma (RR, 0.65 [CI, 0.45–0.94]) but not basal cell carcinoma. Case-control studies that suggest sunscreen use reduces the risk for basal cell carcinoma have major limitations. Based on one fair-quality cohort (n=178,155) and four fair-quality case-control studies, there is no clear protective or harmful effect of sunscreen use on the risk for melanoma. This finding is consistent with a fair-quality systematic review and meta-analysis by Dennis and colleagues that found no association between melanoma and sunscreen use.[31] This meta-analysis, however, did not report any sensitivity analyses. The primary research, nonrandomized studies examining sunscreen use, included in both our report and the meta-analysis by Dennis and colleagues, have major methodological limitations, including the use of very crude measures of sunscreen use and lack of adequate adjustment for confounding by indication.

Limitations

Given the purview of the USPSTF and the scope of our evidence report, we did not review community-based behavioral interventions to promote sun-protective behaviors (e.g., those conducted in schools, recreational, or occupational settings or media campaigns), as these were not considered feasible to implement in primary care or referable from primary care. However, interested readers can refer to the Task Force on Community Preventive Service's recommendations and evidence report on interventions to prevent skin cancer.[24,113,114]

There are two major limitations in the body of evidence evaluating the effectiveness of primary care relevant counseling to prevent skin cancer. The first limitation is the generalizability of the interventions to current primary care practice. Based on rigorous trial evidence, many of the effective counseling interventions to promote sun-protective behaviors incorporated computerized support providing tailored patient education. This type of computerized support is not necessarily widely available, and the implementation of this type of support would require additional effort and cost. It is also unclear if this type of support is essential to the effectiveness of the interventions. Only one trial specifically evaluated counseling to reduce indoor tanning, and none of the trials using composite behavior scores included indoor tanning. Both trials in young adults used "appearance-focused" behavioral interventions. It is possible that different counseling messages will be effective in differently aged populations. Second, many of the counseling trials used composite sun behavior scores. It is unclear if these small changes in scores represent meaningful changes in sun-protection behavior that would reduce skin cancer or even prevent a number of sunburns. In addition, only two trials addressed skin cancer prevention counseling in children and adolescents, which based on the epidemiological evidence, is the ideal time to intervene on sun-protective behaviors. Although most of the counseling trials were conducted in predominantly white populations, this is not really a limitation for this body of

literature, as white persons represent a higher risk population. One counseling trial in young adolescents and one trial in college students included a sizeable proportion of nonwhite participants. However, given that practically all of the epidemiologic studies included exclusively or predominantly white individuals, it is unclear if sun-protective behavior counseling will have similar benefits in nonwhite populations, especially given the lower incidence of skin cancer in nonwhite populations.

The epidemiological evidence examining skin cancer risk with sun exposure, indoor tanning, and sunscreen use has numerous limitations. The internal validity of the observational literature is threatened by the complex and variable nature of measuring sun exposure and sunscreen use, omission of adjustment for important confounders in many studies, and problems with recall bias for determining true exposure in case-control studies. The literature as a whole may also be influenced by publication bias. The generalizability of the observational literature addressing indoor tanning and sunscreen use is limited by the inclusion of outdated indoor tanning devices and sunscreen formulations.

Even though we limited our included studies to fair- or good-quality cohort and population-based case-control studies, this body of evidence had some consistent limitations in internal validity. Most of the cohort studies (and all of the large cohort studies) included were derived from larger cohort studies that were not primarily designed to address skin cancer-related behaviors, and therefore use fairly crude measures of exposure. In addition, a few of these cohort studies were not true inception cohort studies, meaning the cohorts were defined by those persons who answered relevant questions and did not have missing data. Even narrowing our inclusion criteria to population-based case-control studies, it is possible that cases were not necessarily representative of the whole spectrum of the examined disease in the general population. For example, many case-control studies were interview studies that excluded cases of death. This means that cases with the most aggressive cancer or advanced disease were likely underrepresented. Case-control studies often reported different ways of calculating participation rates; therefore, comparison of participation rates across studies is difficult, although we excluded studies reporting extremely poor participation rates. Also, some case-control studies excluded different types of melanoma, again making comparisons across studies difficult. In addition, melanoma research is now beginning to distinguish among types of melanoma by somatic gene mutations, and is finding differences in risk factors for the different types of melanoma. Evidence to suggest that melanomas at different body sites are associated with distinct patterns of sun exposure support this hypothesis.[115] However, we did not examine cross-sectional studies or studies without true controls, and we did not include selected studies that may elucidate this association. One included case-control study presented site-specific melanoma outcomes; however, associations between different measures of sun exposure and site-specific melanoma outcomes did not seem to differ in this study (Appendix C Table 1).[73]

Perhaps the biggest limitation in interpreting this body of evidence is the complexity and variability in the measurement of sun exposure and important confounders, particularly for sun exposure and sunscreen use. Sun exposure is extremely complex to measure, even when broken down into total, intermittent, and chronic sun exposure. There was a large amount of heterogeneity in the actual measurement of sun exposure between studies, the categorization of levels of exposure, and the choice of reference groups. Sun-exposure measurement was defined differently, was assessed differently (e.g., objectively measured pigmentation, interview, questionnaire), and was often used in different periods of life. Complexity of measurement

ranged from sun exposure indexes accounting for some aspect of measured ambient UV exposure, to cumulative hours to very broad categories (e.g., mainly indoors, indoors and outdoors, or mainly outdoors). In general, the measurement of indoor tanning or sunscreen use was crude. Measurement of sunscreen use rarely included important details, such as SPF, amount, frequency and duration, and year, as sunscreen formulations have changed over time. Likewise, measurement of indoor tanning use rarely included important details, such as rationale or motivation of use, frequency and duration, and year, as indoor tanning devices have changed over time as well.

Adjustment for important confounders and stratification to examine effect modification also varied across studies; however, studies examining sun exposure generally adjusted for age, sex, and some measure of skin phenotype or sun sensitivity. Although some studies did not adjust for sun sensitivity (i.e., skin type, ability to tan, or susceptibility to burn), most adjusted for some measure of skin phenotype in general (e.g., skin color, hair/eye color). Only four studies presented results stratified by skin phenotype, and these studies suggest an interaction between skin phenotype and skin cancer.[36,71,87,116] Therefore, simply adjusting for skin type as a confounder in logistic regression may not be adequate to understand the effect of sun exposure in at-risk (e.g., poor tanners) populations. Lack of adequate adjustment and lack of stratification for skin phenotype or sun sensitivity may be an explanation for the lack of association or the inverse association reported with occupational sun exposure, as persons at low risk for skin cancer due to skin pigmentation are over-represented in outdoor workers. In addition, though most studies examining indoor tanning and sunscreen use adjusted for age, sex, and skin phenotype, not all adjusted for sun exposure. For sunscreen use, confounding by indication is extremely important and was generally not well adjusted for. Some studies also may have over-adjusted for confounding, such as adjusting for nevi, freckling, or sunburn history, as these are likely intermediate steps in carcinogenesis or surrogates for sun exposure.

The retrospective assessment of sun exposure, and in some cases important confounders, is subject to significant recall bias. This recall bias may have been less of a problem in earlier studies, such as in the 1980s when there was less public knowledge about the potential harms of UV exposure. As a corollary, assessment of past exposure, especially in childhood or the distant past, are subject to imprecision. Therefore, since most of this evidence is case-control studies, it is subject to these limitations.

Given these numerous limitations, we caution against lending much confidence to quantitative risk estimates. Given the extreme heterogeneity in the measurement of exposure, confounders, and, in some instances, outcomes (i.e., types of skin cancer), we did not attempt quantitative synthesis of risk estimates. It is also important to consider that, even though the epidemiological literature may show a statistically significant association trend in risk (e.g., from the lowest to highest percentile), people might not change their behavior to this degree (e.g., from that of the highest to that of the lowest percentile), so the estimates presented in the epidemiological literature are intended to describe primarily the strength of an observed association and dose response, important criteria for causality. These limitations also apply to the case-control studies examining the association between sun exposure and cancer other than skin cancer.

While it is also likely that this body of literature is subject to publication bias, the direction of bias may not be consistent. For example, studies showing a positive association between sun exposure and melanoma might be more likely to be published, while studies showing a positive association between sunscreen use and melanoma might be less likely to be published.

In addition to the limitations in the internal validity of this body of evidence, there are also important limitations in the generalizability of associations observed for indoor tanning and sunscreen use, both of which have changed in the recent past. Indoor tanning devices before 1980 had higher UVB content, and after 1980 had higher UVA content.[92] Furthermore, modern tanning beds have undergone technological advances to enrich UVB that allow shorter duration of exposure. However, in practice, the proportion of UVB output of indoor tanning devices varies.[30] Therefore, the potential harm of indoor tanning has changed during the period of all of the included studies, and adolescent or early adulthood sunbed exposure in observational studies may not be generalizable to the current exposure from indoor tanning devices. Likewise, sunscreen formulations have also changed drastically over time. SPF was introduced in 1978 and protection for UVA was not added until 1989, and UV sun exposure is approximately 5% UVB and 95% UVA.[30] In addition, sunscreen formulations have also improved over time, offering higher level SPF and water resistance.

Due to the scope of this report, we did not examine the evidence between sun exposure, indoor tanning, or sunscreen use and outcomes other than skin cancer (e.g., nevi, premalignant lesions, or evidence of photoaging of the skin). We acknowledge that, therefore, we may have missed other potentially informative bodies of literature for skin cancer prevention. Due to the scope of our report and our inclusion criteria, our report does not discuss key bodies of literature on the relationship of sun exposure and vitamin D, and vitamin D and cancer risk. Interested readers should refer to the recent report by the International Agency for Research on Cancer.[112]

Emerging Issues and Future Research

More primary care relevant counseling trials to promote sun-protective behaviors, including those that address indoor tanning, are needed, especially in children, adolescents, and young adults. Trials of low-intensity interventions, such as the 15-minute self-administered computer session or an appearance-focused video or booklet, should be replicated in other populations. In addition to using self-reported measures of avoidance of midday sun, use of protective clothing, and use of sunscreen, trials should also consistently include measures of indoor tanning and sunburns. Trials using composite behavioral scores would be strengthened if they also provided the proportion of individuals whose behavior changed as recommended. In 2005, the National Cancer Institute and the Emory Prevention Research Center convened a workshop for skin cancer prevention investigators in the United States to develop a consensus-based set of core measures to assess UV exposure, sun-protective behaviors, and nonsolar tanning behavior.[117,118] These measures should be used consistently so as to understand their validity and reliability across different settings and populations. In addition to using these consensus-based self-reported measures, objective measures, such as dosimeters or visual observation of participant behavior, would also strengthen this body of literature.

More studies, and better designed studies, that examine the potential effect of sunscreen use and decreased sun exposure on vitamin D and other diseases hypothesized to be affected by vitamin D (e.g., cancer, autoimmune disease, bone-related disease) are needed. Trial evidence suggests that sunscreen is effective in reducing risk for squamous cell carcinoma, but it is unclear if regular sunscreen use prevents basal cell carcinoma or melanoma. However, nonrandomized studies examining sunscreen use have serious methodological limitations. It is therefore

important to determine if the increase in recreational sun exposure, even if it does not increase risk for sunburns, has clinically important sequelae. Currently, the epidemiologic literature supporting an association between sun exposure and breast and prostate cancer and nonHodgkin lymphoma is sparse and has serious methodological limitations. Therefore, more studies are needed that account for the measurement of sun exposure, adjustment for important confounders, and direct assessment of vitamin D levels, if possible. Currently, there is no evidence to suggest that sun-protective behavior messages aimed at reducing prolonged or intense sun exposure and sunburns cause significant harm, such as vitamin D deficiency or increasing risk for cancer. In addition, more studies with more detailed assessment of sunscreen and indoor tanning use are needed. It is important that these studies consistently adjust for both important host and environmental factors. Survey instruments to assess these types of exposure need to be reliable and validated. The body of evidence would be strengthened if studies used the same or comparable measurements to facilitate comparison across studies. It will likely take decades to see a potential protective effective of regular sunscreen use on melanoma risk or the potential harms of current tanning beds. Therefore, studies evaluating current sunscreen formulations will continue to be necessary over time.

Conclusions

A limited number of RCTs suggest that primary care relevant behavioral counseling can minimally increase composite scores measuring self-reported sun-protective behaviors in adults and their newborns, decrease self-reported indoor tanning use and objectively measured pigmentation in college students, and decrease self-reported midday sun exposure and increase sunscreen use in young adolescents. The clinical significance of small changes in sun protection composite scores is unclear. Many of the counseling interventions incorporated computerized support that could generate tailored feedback.

Primary care counseling to prevent skin cancer and the practice of sun-protective behaviors to limit intense or prolonged sun exposure do not appear to have significant harms, but methodologically rigorous studies examining the potential harms of vitamin D deficiency are lacking. There is evidence, mostly from case-control studies, to suggest that intermittent sun exposure, especially in childhood or adolescence, may increase risk for all types of skin cancer. Regular sunscreen use can decrease the incidence of squamous cell carcinoma, but it is unclear if it can prevent basal cell carcinoma or melanoma. Based on a limited number of studies, it appears that regular and early use of indoor tanning may increase the risk for melanoma. These risks, however, may not apply to current devices, since tanning devices have changed significantly over the past 20 to 30 years. Therefore, behavioral counseling to promote skin cancer prevention should focus on improving multiple behaviors to reduce UV exposure and not improving sunscreen use alone.

One counseling trial in young adolescents and one trial in college students included a sizeable proportion of nonwhite participants. However, given that practically all of the epidemiologic studies included exclusively or predominantly white persons, it is unclear if sun-protective behavior counseling will have similar benefits in nonwhite populations, especially given the lower incidence of skin cancer in nonwhite populations.

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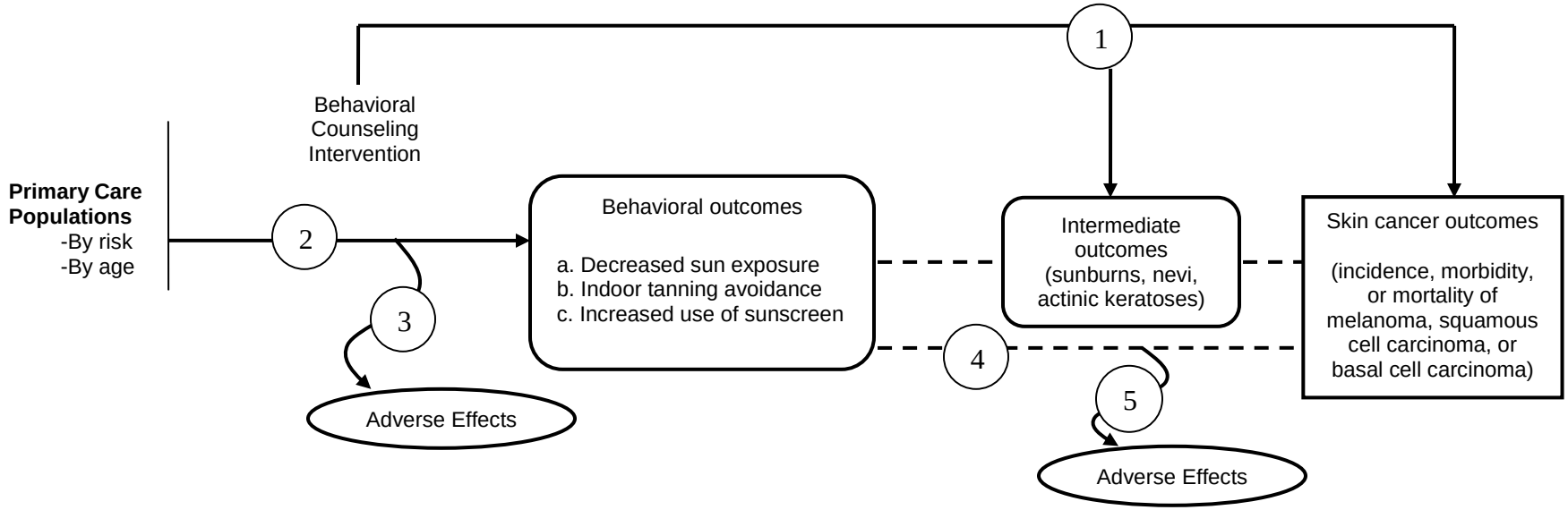
Figure 1. Analytic Framework and Key Questions



Key Questions

1. Is there direct evidence that counseling patients on sun-protective behaviors (decreasing sun exposure, avoidance of indoor tanning, and using sunscreen) reduces intermediate outcomes (sunburns, nevi, or actinic keratoses) or skin cancer (melanoma or squamous cell or basal cell carcinoma) ?
2. Does primary care relevant counseling change sun-protective behaviors (decreasing sun exposure, avoidance of indoor tanning, and using sunscreen)?
3. Do primary care relevant counseling interventions have adverse effects?
4. Is sun exposure (intentional or unintentional), indoor tanning, or sunscreen use associated with skin cancer outcomes?
5. Are sun-protective behaviors associated with adverse effects (increased time spent in the sun, reduced physical activity, dysphoric mood, or vitamin D deficiency)?

Table 1. Search Strategies for Key Questions Based on Existing Systematic Reviews Identified

Key Question(s)	Outcome of interest	Primary existing systematic review used	Other systematic review(s) used to locate primary research	Search dates*
KQ 1–3	N/A	Helfand 2003[1]	Saraiya 2004[119]	2001 through Dec 2008
KQ 4a Sun exposure	Melanoma	Helfand 2003[1]	Gandini 2005[17]	2001 through Dec 2008
	Squamous cell or basal cell carcinoma	None	None	1966 through Dec 2008
KQ 4b Indoor tanning	Melanoma, squamous cell and basal cell carcinoma	IARC 2006[30]	Gallagher 2005[34]	2005 through Dec 2008
KQ 4c Sunscreen use	Melanoma	Dennis 2003[31]	Huncharek 2002[120] Gefeller 2002[121]	2002 through Dec 2008
	Squamous cell or basal cell carcinoma	None	None	1966 through Dec 2008
KQ 5	N/A	None	Helfand 2003[1] Grant 2007[122] Autier 2007[123]	1966 through Dec 2008

*Start date for search is 1 year prior to the end search date used in the primary existing systematic review used.

Abbreviations: KQ=key question; N/A=not applicable; none=no SER located; IARC=International Agency for Research on Cancer

Table 2. Effectiveness of Primary Care Feasible Counseling to Increase Sun-Protective Behaviors

Trial, Design, Quality	Setting, Population, Characteristics	Intervention	Efficacy
Adults			
Glazebrook 2006[46] Cluster RCT by practice Fair	PC practices in UK **N:** 589 **Age:** mean 38 yrs **Male:** 20% **Risk:** 100% with high risk characteristic, not specified	**IG:** "Skinsafe program": single 10- to15-min session using a self-directed computer workstation in the practice **CG:** Usual care, details not given	**Mean score on Sun Protection Behavior Scale at 6 months** *Pre-, post- (complete case analysis), post- (missing values imputed)* IG: 4.60 (SD, 1.82), 5.70 (SD, 1.51), 5.36 (SD, 1.72) CG: 4.66 (SD, 1.55), 5.30 (SD, 1.57), 5.06 (SD, 1.59) Complete case analysis: p=0.007 Missing values imputed: p=0.004 *Mean difference between IG and CG p value* Complete case analysis: 0.33 (95% CI, 0.09–0.57) Missing values at follow-up replaced by baseline values: 0.30 (95% CI, 0.10–0.51)
Geller 2006[50] Cluster RCT by sibling relationship Fair	Home-based, patients recruited from dermatologists in US **N:** 494 **Age:** 58% 18–50 yrs **Male:** 47% **Risk:** 85% fair skin type, 100% white	**IG:** Four 10- to 15-min telephone sessions with health educator and computer-generated tailored materials **CG:** Usual care	**% tanned by end of last summer at 12 months** IG: 25.7 CG: 35.6 Adjusted OR, 0.72 (95% CI, 0.47–1.09) **% routinely use sunscreen with SPF 15+ at 12 months** IG: 67.4 CG: 66.1 Adjusted OR, 0.96 (95% CI, 0.67–1.38)
Prochaska 2005[51] RCT Fair	Home-based, patients recruited from PC practices in US **N:** 5407, subset of 3834 at risk for sun exposure **Age:** mean 45 yrs **Male:** 30% **Risk:** sun sensitivity NR, 96.7% white	**IG:** Four telephone sessions of unknown duration and written survey assessments with computer-generated tailored materials **CG:** Assessment only	**Mean score on Sun Avoidance Subscale of Sun Protection Behavior Scale at baseline, 12 months, and 24 months** IG: 12.7 (SD, 3.6), 13.5 (SD, 3.5), 13.7 (SD, 3.5) CG: 12.4 (SD, 3.7), 12.9 (SD, 3.6), 12.9 (SD, 3.6) p<0.005 **Mean score on Sunscreen Use Subscale of Sun Protection Behavior Scale at baseline, 12 months, and 24 months** IG: 8.6 (SD, 3.9), 9.8 (SD, 3.8), 10.0 (SD, 3.9) CG: 8.5 (SD, 3.9), 8.9 (SD, 3.9), 9.2 (SD, 3.9) p<0.0001
Prochaska 2004[124] RCT Fair	Home-based, patients recruited from schools in US **N:** 2460, subset of 1802 at risk for sun exposure **Age:** mean 42 yrs **Male:** 25% **Risk:** Sun sensitivity NR, 92% white	**IG:** Four telephone sessions of unknown duration and written survey assessments with computer-generated tailored materials **CG:** Assessment only	**Mean score on Sun Avoidance Subscale of Sun Protection Behavior Scale at baseline, 12 months, and 24 months** IG: 12.65 (SD, 3.86), 13.71 (SD, 3.52), 13.99 (SD, 3.39) CG: 12.60 (SD, 3.90), 13.22 (SD, 3.64), 13.35 (SD, 3.73) p>0.05 **Mean score on Sunscreen Use Subscale of Sun Protection Behavior Scale at baseline, 12 months, and 24 months** IG: 8.32 (SD, 4.00), 9.96 (SD, 3.87), 10.21 (SD, 3.94) CG: 8.16 (SD, 3.99), 9.29 (SD, 3.98), 9.18 (SD, 3.82) p<0.05

Table 2. Effectiveness of Primary Care Feasible Counseling to Increase Sun-Protective Behaviors

Trial, Design, Quality	Setting, Population, Characteristics	Intervention	Efficacy
Young adults			
Hillhouse 2008[49] RCT Fair	Universities (2) in US **N:** 430 **Age:** mean 19 yrs **Male:** 0% **Risk:** Self-reported intention to indoor tan, approximately 1/3 fair skin	**IG:** Professionally produced booklet with appearance-focused intervention to reduce indoor tanning **CG:** Assessment only, details not given	**Indoor tanning in past 3 months** *Mean at baseline, 6 months* IG: 4.67 (SE, 0.60), 6.80 (SE, 0.93) CG: 4.48 (SE, 0.55), 10.90 (SE, 0.93) p<0.001
Mahler 2007[53] RCT Fair	University in US **N:** 133 **Age:** mean 20 yrs **Male:** 20% **Risk:** Sun sensitivity NR, 45% white	**IG:** Appearance-focused intervention with UV facial photo, 11-min videotape with photoaging information, or both **CG:** Assessment only, details not given	**Skin color using skin reflectance spectrophotometry at 12 months** *(b* higher is more tan; L* higher is lighter; L* scale results in figure, exact numbers NR)* **Video (n=38)** / **No video (n=46)** / **p** Higher exposure site, b* scale: 0.82 (0.28) / 0.90 (0.25) / NS Lower exposure site, b* scale: 0.32 (0.28) / 0.39 (0.25) / NS Higher exposure site, L* scale: ~ 1.6 (NR) / ~ -0.6 (NR) / sig Lower exposure site, L* scale: ~ 2.3 (NR) / ~ 0.9 (NR) / sig **Sun exposure z-score, adjusted for baseline** Intentional exposure: -0.12(0.16) / 0.10 (0.14) / NS Incidental exposure: -0.23 (0.16) / 0.28 (0.15) / sig **Sun Protection Behavior Scale z-score, adjusted for baseline** Sun protection index: -0.02 (0.10) / -0.07 (0.09) / NS
Adolescents			
Norman 2007[54] Patrick 2006[55] Rosenberg 2007[56] RCT Fair	PC practices in US **N:** 819 **Age:** mean 13 yrs **Male:** 46% **Risk:** 25% high sun sensitvity, 58.4% white	**IG:** Two 20-min interactive computer sessions with computer-generated tailored materials, four follow-up telephone sessions of unknown duration, and 2–3 min counseling by primary care providers **CG:** Attention control on physical activity and diet intervention, except no brief counseling by primary care providers	**Sun Protection Behavior Scale score at 6, 12, and 24 months** Adjusted sample means: IG with statistically significant increase in sun protection scores compared with CG, with trajectory of scores flattening (but still statistically significant) between 12 and 24 months *(results in figure, exact numbers NR)* **Sun protection behaviors at 24 months** *(results in figure, exact numbers NR)* % response "often" or "always" / IG / CG / p Wear a shirt? ~84 ~85 NS Stay in shade? ~44 ~45 NS Avoid sun exposure midday? ~40 ~30 p<0.05 Limit sun exposure midday? ~38 ~31 p<0.05 Use sunscreen? ~55 ~48 p<0.05 Use sunscreen on face? ~62 ~48 p<0.05 Use sunscreen on all sun exposed areas? ~56 ~40 p<0.05

Table 2. Effectiveness of Primary Care Feasible Counseling to Increase Sun-Protective Behaviors

Trial, Design, Quality	Setting, Population, Characteristics	Intervention	Efficacy
Olson 2007[48] Cluster RCT by school	Geographically distinct towns in US **N:** 797 **Age:** 98% in 6th grade **Male:** 43% **Risk:** 28% usually or always burn; 94% white	**IG:** Multimodal education with individual counseling during well visits (PC practices), classroom curriculum and group activities (schools), announcements and team policies (athletic and recreational facilities), posted information (community venues) **CG:** No intervention	**Body surface area covered (by direct observation and interview)** Adjusted mean percentage* at baseline and 24 months IG: 71.8 (SE, 1.6), 66.1 (SE, 1.5) CG: 73.7 (SE, 1.4), 56.8 (SE, 2.3) p<0.01 *Adjusted for sex, skin reaction to sun, UV level, year of observation, and temperature **% any sunscreen use at baseline, 12 months, and 24 months** IG: 58.0, 47.0, 47.0 CG: 65.8, 59.6, 13.8 p <0.05, p<0.01, p<0.001
Children and their parents			
Crane 2006[45] Cluster RCT by practice Fair	PC practices in US **N:** 728 **Age:** 30% of parents aged 20–29 yrs, 59% aged 30–39 yrs **Male (parents):** 100% **Risk:** 40% of parents with painful burn, no to light tan; 76% parents white	**IG:** Assessment and counseling by PC providers at 4 well-child visits and written information for parents **CG:** Usual care	**Sun protection behaviors at 12, 24, and 36 months** *% response "frequently" or "always"* Clothing use? IG: 51.0, 38.4, 24.2; p=0.22 CG: 43.8, 32.4, 25.5 Midday sun avoidance? IG: 70.6, 63.2, 64.2; p=0.14 CG: 64.9, 62.0, 59.0 Limit time in sun? IG: 48.9, 38.1, 32.1; p=0.97 CG: 47.5, 35.4, 34.3 Shade use? IG: 90.0, 79.2, 72.6; p=0.03 CG: 87.3, 71.9, 65.2 Hat use? IG: 61.9, 61.9, 57.3; p=0.08 CG: 60.8, 56.1, 47.4 Sunglasses use? IG: 5.2, 24.2, 39.4; p=0.22 CG: 8.3, 22.3, 29.9 Sunscreen use? IG: 90.0, 92.4, 94.2; p=0.46 CG: 87.9, 92.2, 93.1 **Sun protection practice score at 12, 24, and 36 months** IG: 18.55, 18.52, 18.18; p=0.04 CG: 18.40, 18.05, 17.71

Table 2. Effectiveness of Primary Care Feasible Counseling to Increase Sun-Protective Behaviors

Trial, Design, Quality	Setting, Population, Characteristics	Intervention	Efficacy
Dietrich 1998[47] Dietrich 2000[125] Grant-Petersson 1999[126] Cluster RCT by town Fair	Geographically distinct towns in US **N:** 865 **Age:** 38% aged <5 yrs **Male:** 52% **Risk**: 54% burn easily, implied 99% white	**IG:** Multimodal education with individual counseling during well child and illness visits (PC practices), classroom curriculum (schools and day care centers), posted information and sunscreen (beach areas) **CG:** No intervention	**Sun-protective behaviors at baseline and 12 months*** *Any protective clothing (by observation)* IG: 0.30, 0.24 CG: 0.26, 0.18 Difference of change (IG-CG): 0.02; p=0.78 *Protection by shade (by observation)* IG: 0.14, 0.14 CG: 0.18, 0.24 Difference of change (IG-CG): -0.06; p=0.38 *Sunscreen used on ≥1 body area (self report)* IG: 0.57, 0.75 CG: 0.65, 0.66 Difference of change (IG-CG): 0.17; p=0.011 *Protection on ≥1 body area by sunscreen, clothes, and/or shade (self report)* IG: 0.78, 0.87 CG: 0.85, 0.80 Difference of change (IG-CG): 0.13; p=0.029 *Protection on all 3 body areas by any means (self report)* IG: 0.53, 0.74 CG: 0.66, 0.72 Difference of change (IG-CG): 0.15; p=0.18 *All values corrected by age, sex, ease with which child burns, and weather conditions at time of interview

RCT=randomized controlled trial; N=number; IG=intervention group; CG=control group; UK=United Kingdom; US=United States; PC=primary care; CI=confidence interval; SD=standard deviation; SE=standard error; OR=odds ratio; NR=not reported; UV=ultraviolet; SPF=sun protection factor; NS=not significant; sig=significant

Table 3. Association Between Sun Exposure and Skin Cancer

Study reference, USPSTF quality rating	Design, Setting, Population	Total Sun Exposure (RR or OR)*	Intermittent Sun Exposure (RR or OR [95% CI])*	ChronicSun Exposure (RR or OR)*	Adjustments reported
Squamous cell or basal cell carcinoma					
Grodstein 1995[67] Nurses' Health Study Good	Cohort US (11 states) n=107,900	NR	*SCC, regular time outdoors in summer* Yes (use sunscreen): reference Yes (no sunscreen): 0.9 (0.6-1.2) No: 0.7 (0.4-1.1)	NR	Age; smoking; region; natural hair color; reaction to sun; lifetime # of sunburns
Hunter 1990[68] Nurses' Health Study Fair	Analytic cohort US (11 states) n=73,366	NR	*BCC, regular time spent outdoors in summer (at least 8 hrs/wk)* Yes (use sunscreen): reference Yes (no sunscreen): 0.70 (0.60-0.82) No: 0.73 (0.59-0.90)	NR	Age; time period; region; time spent outdoors in summer and sunscreen use; hair color; childhood tendency to burn; lifetime # of severe and painful sun-burns on face and arms
van Dam 1999[69] Health Professionals Follow-up Study Fair	Cohort US (multistate) n=44,591	NR	*BCC, frequency outdoors in swimsuit as teenager in summer* <1 time/wk: reference 1 time/wk: 1.30 (1.14-1.47) 2 times/wk: 1.34 (1.19-1.52) Several times/wk: 1.36 (1.22-1.52) Daily: 1.42 (1.24-1.63)	NR	Age; time period; hair color; eye color; skin reaction to sun; ancestry; BMI; region of residence
Green 1996[65] Nambour Skin Cancer Study Fair	Cohort Queensland Australia N=2,095	NR	**Leisure exposure** *SCC* Mainly indoors: reference Indoors/outdoors: 0.81 (0.37-1.80) Mainly outdoors: 1.29 (0.66-2.52) *BCC* Mainly indoors: reference Indoors/outdoors: 0.93 (0.63-1.37) Mainly outdoors: 0.85 (0.59-1.21)	**Occupational exposure** *SCC* Mainly indoors: reference Indoors/outdoors: 0.82 (0.47-1.43) Mainly outdoors: 1.37 (0.80-2.34) *BCC* Mainly indoors: reference Indoors/outdoors: 1.07 (0.79-1.46) Mainly outdoors: 1.25 (0.88-1.78)	Age; sex; skin color
Neale 2007[61] Fair	Cohort from Nambour Skin Cancer Trial Queensland Australia N=1,517	NR	**Leisure exposure** *BCC (head, trunk respectively)* Mainly indoors: reference Indoors/outdoors: 0.93 (0.64-1.35); 1.15 (0.62-2.12) Mainly outdoors: 0.99 (0.60-1.63); 0.84 (0.32-2.17)	**Occupational exposure** *BCC (head, trunk respectively)* Mainly indoors: reference Indoors/outdoors: 0.95 (0.60-1.49); 1.07 (0.60-1.93) Mainly outdoors: 0.86 (0.53-1.40); 1.12 (0.60-2.11)	Age; sex
Vlajinac 2000[127] Fair	Case-control Yugoslavia Cases n=200 Controls n=399	NR	**BCC** *# of vacations at seaside before age 10* NS; OR not reported *Average # wks per year spent at seaside* 0: reference 1-6: NR 7+: 1.81 (1.24-2.64)	NR	NR

Table 3. Association Between Sun Exposure and Skin Cancer

Study reference, USPSTF quality rating	Design, Setting, Population	Total Sun Exposure (RR or OR)*	Intermittent Sun Exposure (RR or OR [95% CI])*	ChronicSun Exposure (RR or OR)*	Adjustments reported
Han 2006[71] Nurses' Health Study Fair	Nested case-control US (11 states) SCC n=275 BCC n=283 Control n=804	NR	**Total lifetime sun exposure while wearing bathing suit (tertile)** *SCC* Low: reference Intermediate: 1.28 (0.85-1.93) High: 2.15 (1.45-3.19) *BCC* Low: reference Intermediate: 1.71 (1.14-2.56) High: 2.05 (1.38-3.06)	NR	Age; constitutional susceptibility; family history of skin cancer; # of lifetime severe sunburns which blistered; sunlamp use or tanning salon attendance; geographic region
Rosso 1999[64] Fair	Case-control Valais, Switzerland Cases n=146 Controls n=144	*SCC, total # lifetime hrs* <5,000: reference -64,200: 1.78 (0.18-17.67) 64,200+:1.42 (0.53-3.85) *BCC, total # lifetime hrs* <5,000: reference -15,800: 1.09 (0.62-1.92) -64,200: 0.99 (0.35-2.79) 64,200+: 0.70 (0.20-2.39)	**Lifetime hrs at beach on vacation** *SCC* Never: reference 2,260+: 0.78 (0.26-2.40) *BCC* Never: reference <300: 1.46 (0.52-4.07) -1,140: 1.39 (0.72-2.66) -2,260: 0.92 (0.44-1.91) 2,260+: 1.20 (0.61-2.34)	**Lifetime hrs of outdoor work** *SCC* Never: reference -47,900: 1.84 (0.30-11.09) -77,200: 2.02 (0.60-6.78) 77,200+: 1.88 (0.30-11.70) *BCC* Never: reference -12,000: 0.98 (0.58-1.66) -47,900: 1.30 (0.69-2.46) -77,200: 0.78 (0.52-1.19) 77,200+: 0.90 (0.51-1.59)	Age; sex
Kricker 1991[62] Kricker 1995[36] Kricker 1995[116] English 1998[63] English 1998[33] Fair	Case-control Western Australia n=248 (23 w/ BCC + SCC) BCC n=226 SCC n=45 Control n=1,015 BCC control n=1,021 (6 w/SCC) SCC control n=1,064 (49 w/BCC)	**BCC** *Total hrs (thousands) sun exposure 9am to 5pm, whole wk* 0-40.5: reference 40.5-56.4: 0.99 (0.61-1.58) 56.4-81.6: 1.42 (0.86-2.35) 81.6+: 0.77 (0.43-1.40) *Total hrs (thousands) sun exposure 9am to 5pm, whole wk, age ≥15* 0-14.7: reference 14.8-27.7: 1.25 (0.79-1.97) 27.8-49.3: 1.17 (0.72-1.90) 49.4+: 0.86 (0.50-1.51) *Total ambient sunlight in accumulated global radiance (mWh cm-2 X 105)* 0-8.8: reference 8.8-10.1: 1.32 (0.69-2.55) 10.1-11.4: 1.72 (0.72-4.09) 11.4+: 2.18 (0.82-5.82) **SCC** *Total ambient sunlight in*	**BCC** *Intermittent sun exposure, ages 15-19* 0-40%: reference 41-58%: 1.49 (0.88-2.52) 59-99%: 1.82 (1.01-3.28) 100%: 3.86 (1.93-7.75) *Lifetime hrs sun exposure on holiday* 0-602: reference 602-2268: 1.65 (1.01-2.70) 2268-3794: 1.68 (1.00-2.80)3794+: 1.85 (1.09-3.13) *Lifetime frequency of sunbathing* None: reference 1-200: 1.57 (0.98-2.51) 201-700: 1.08 (0.68-1.72) 701-9000: 1.02 (0.63-1.64) **SCC** *Total hrs sun exposure on nonworking days* 0-4,999: reference 5,000-8,499: 2.0 (0.89-4.4) 8,500-13,999: 1.9 (0.86-4.2) 14,000+: 1.3 (0.57-2.9) *Lifetime hrs sun exposure on holidays* <600: reference 600-2,268: 0.89 (0.44-1.8)	**BCC** NR **SCC** *Total hrs sun exposure on working days* 0-11,499: reference 11,500-19,999: 0.93 (0.42-2.1) 20,000-32,999: 1.7 (0.81-3.8) 33,000+: 1.3 (0.58-2.8)	Age; sex; ability to tan; total sun exposure (for recreational sun exposure)

Table 3. Association Between Sun Exposure and Skin Cancer

Study reference, USPSTF quality rating	Design, Setting, Population	Total Sun Exposure (RR or OR)*	Intermittent Sun Exposure (RR or OR [95% CI])*	ChronicSun Exposure (RR or OR)*	Adjustments reported
		accumulated global radiance (mWh cm-2 X 105) <8.8410: reference 8.8410-10.1399: 1.4 (0.51-3.6) 10.1400-11.4509: 2.7 (0.84-8.6) 11.4510+: 2.3 (0.62-8.3)	2,269-3,793: 1.0 (0.51-2.1) 3,794+: 0.93 (0.44-1.9)		
Gallagher 1995[66] Bajdik 1996[128] Fair	Case-control Alberta, Canada Cases n=180 Controls n=406	NR	**SCC** *Mean recreational sun exposure per year, ages 0-19* <100/y WBE, <3.8 h/wk summer: reference 100-199/y WBE, 3.8-7.4 h/wk summer: 1.2 (0.6-2.5) 200-332/y WBE, 7.5-12.4 h/wk summer: 1.1 (0.5-2.6) 333+/y WBE, 12.5+ h/wk summer: 1.6 (0.6-4.5) *Mean recreational sun exposure per year, lifetime* <75/y WBE, <2.8 h/wk summer: reference 75-149/y WBE, 2.8-5.5 h/wk summer: 0.6 (0.3-1.1) 150-224/y WBE, 5.6-8.4 h/wk summer: 0.8 (0.3-1.8) 225+/y WBE, 8.5+ h/wk summer: 0.3 (0.1-0.9) **BCC** *Mean recreational sun exposure per year, ages 0-19* <100/y WBE, <3.8 h/wk summer: reference 100-199/y WBE, 3.8-7.4 h/wk summer: 1.1 (0.6-2.0) 200-332/y WBE, 7.5-12.4 h/wk summer: 1.4 (0.7-3.0) 333+/y WBE, 12.5+ h/wk summer: 2.6 (1.1-6.5) *Mean recreational sun exposure per year, lifetime* <75/y WBE, <2.8 h/wk summer: reference 75-149/y WBE, 2.8-5.5 h/wk summer: 0.9 (0.5-1.7) 150-224/y WBE, 5.6-8.4 h/wk summer: 0.6 (0.3-1.3) 225+/y WBE, 8.5+ h/wk summer: 0.4 (0.2-1.0)	**SCC** NR **BCC** *Mean lifetime occupational sun exposure per year* <15/y WBE, <3.5 h/wk summer: reference 15-59/y WBE, 3.5-13.9 h/wk summer: 1.0 (0.6-1.8) 60-104/y WBE, 14.0-24.9 h/wk summer: 1.3 (0.8-2.3) 105+/y WBE, 25+ h/wk summer: 1.4 (0.8-2.4)	Mother's ethnic origin; hair color; skin color

Table 3. Association Between Sun Exposure and Skin Cancer

Study reference, USPSTF quality rating	Design, Setting, Population	Total Sun Exposure (RR or OR)*	Intermittent Sun Exposure (RR or OR [95% CI])*	ChronicSun Exposure (RR or OR)*	Adjustments reported
Melanoma					
Veierod 2003[82] Norwegian-Swedish Women's Lifestyle and Health Cohort Study Fair	Cohort Norway & Sweden N=106,379	NR	*Annual wks on sunbathing vacation, ages 10-19* 0: reference 1 wk/yr: 1.21 (0.80-1.83) 2-3 wks/yr: 1.09 (0.71-1.65) ≥4 wks/yr: 1.67 (1.01-2.74) *Annual wks on sunbathing vacation, ages 10-39* 0: reference ≥1 wk/yr: 1.56 (0.95-2.56)	NR	Age; region of residence; hair color
Weinstock 1991[87] Nurses' Health Study Fair	Nested case-control US (multistate) Cases n=130 Controls n=300	NR	*Annual frequency of swimsuit use outdoors, ages 15-20, by skin type* <u>Sun resistant*</u> 0-10: reference 11-30: 0.6 (0.2-1.4) ≥31: 0.3 (0.1-0.8) <u>Sun sensitive**</u> 0-10: reference 11-30: 1.2 (0.6-2.6) ≥31: 3.5 (1.3-9.3) *A priori sun sensitivity score <0.5 **A priori sun sensitivity score ≥0.5	NR	NR
Han 2006[71] Nurses' Health Study Fair	Nested case-control US (11 states) Melanoma n=200 Controls n=804		*Total lifetime sun exposure while wearing a bathing suit (tertile)* Low: reference Intermediate: 1.20 (0.73-1.97) High: 2.37 (1.51-3.73)	NR	Age; constitutional susceptibility; family history of skin cancer; # of lifetime severe sunburns which blistered; sunlamp use or tanning salon attendance; geographic region
White 1994[72] Fair	Case-control Washington, US Cases n= 256 Controls n=273	*Avg yearly sun exposure (hrs), previous 10 yrs* 0: reference 1-201: 1.16 (0.72-1.87) 202-499: 0.80 (0.45-1.42) 500-2,880: 0.88 (0.47-1.64)	NR	*Lifetime occupational sun exposure* None: reference <50%: 0.89 (0.60-1.32) ≥50%: 0.64 (0.33-1.23)	Age; sex; education
Osterlind 1988[83] Osterlind 1988[129] Fair	Case-control East Denmark Cases n= 474 Controls	NR	*Sunbathing habits, adjusted for sex, nevi, freckles and hair color* Never: reference At some time: 1.6 (1.1-2.4) 1-9 years: 1.9 (0.9-3.9) 10-24 years: 1.6 (1.1-2.5)	NR	Sex; nevi; freckles and hair color; history of sunbathing and sunburning

Table 3. Association Between Sun Exposure and Skin Cancer

Study reference, USPSTF quality rating	Design, Setting, Population	Total Sun Exposure (RR or OR)*	Intermittent Sun Exposure (RR or OR [95% CI])*	ChronicSun Exposure (RR or OR)*	Adjustments reported
	n=926		25-39 years: 1.7 (1.1-2.5) 40+ years: 1.9 (1.3-2.9) *Vacations spent in sun, adjusted for history of sunbathing and sunburning* Never: reference Sunny: 1.0 (0.8-1.3) Very sunny: 1.4 (1.0-2.1)		
Berwick 1996[73] Lea 2007[130] Chen 1996[131] Fair	Case-control Connecticut, US Cases n=650 Controls n=549	*Total lifetime sun exposure, adjusted for skin self-exam; total nevi; family history; skin cancer; skin type; eye color; hair color; freckles; ever severely sunburned* Light: reference Moderate: 1.26 (0.69-2.29) Heavy: 2.20 (1.21-4.01) Very heavy: 2.63 (1.25-5.54)	*Total recreational sun exposure index (by body site), adjusted for sex; age; skin color; # of nevi on arms; skin type* Head/neck Upper limb Lower limb Trunk Level 1 reference reference reference reference Level 2 1.5 (0.7-3.3) 0.9 (0.4-1.8) 1.0 (0.5-2.2) 1.7 (1.0-2.9) Level 3 1.0 (0.7-2.1) 1.0 (0.5-2.0) 1.2 (0.6-2.7) 1.4 (0.7-2.2) Level 4 2.6 (1.2-5.6) 2.4 (1.2-4.8) 2.7 (1.2-5.8) 2.7 (1.6-4.5) *# vacations, age 0-15* 0: reference 1-14: 1.1 (0.8-1.7) 15-90: 0.9 (0.5-1.4)	*Total yrs in outdoor jobs (by body site)* Head/neck Upper limb Lower limb Trunk 0 reference reference reference reference <5 0.8 (0.4-1.5) 0.7 (0.4-1.4) 0.7 (0.3-1.3) 0.7 (0.5-1.1) 5+ 0.5 (0.2-1.1) 0.6 (0.2-1.1) 0.3 (0.1-0.9) 0.9 (0.6-1.3)	Sex; age; skin self-exam; total nevi; family history skin cancer; skin type; eye color; hair color; freckles; ever severely sunburned
Walter 1999[90] Walter 1990[132] Fair	Case-control Ontario, Canada Cases n=583 Controls n=608	NR	*Beach vacation, past 5 yrs* No: reference Yes: 1.04 (0.82-1.32)	NR	Age; sex; reaction to initial summer sun exposure
Green 1985[77] Green 1986[133] Fair	Case-control Queensland, Australia Cases n=183 (excludes lentigo maligna) Controls n=183	*Total lifetime # hrs of sun exposure, adjusted for age, nevi on arms, hair color, and sunburn propensity* <2,000: reference 2,000-100,000: 3.2 (0.9-12.4) >100,000: 5.3 (0.9-30.8) *Total # hrs sun exposure, adjusted for age and nevi on arms* Lifetime <2000: reference 2000-: 2.3 (1.0-5.1)	*Recreational hrs on beach, adjusted for nevi on arms and age* Lifetime 0: reference 1-: 0.6 (0.2-1.4) 500-: 0.3 (0.1-0.8) 5000-: 1.3 (0.4-4.3) Ages 10-19 0: reference 1-: 1.1 (0.6-2.0) 500-: 0.8 (0.4-1.9)	NR	Age; nevi on the arms; hair color; and sunburn propensity

Table 3. Association Between Sun Exposure and Skin Cancer

Study reference, USPSTF quality rating	Design, Setting, Population	Total Sun Exposure (RR or OR)*	Intermittent Sun Exposure (RR or OR [95% CI])*	ChronicSun Exposure (RR or OR)*	Adjustments reported
		50,000-: 1.7 (0.4-7.8) Ages 10-19 years <500: reference 500-: 1.0 (0.5-2.0) 5000-: 4.4 (1.8-184.5)			
Shors 2001[74] Soloman 2004[134] Fair	Case-control Washington, US Cases n=386 Controls n=727	*Lifetime avg days spent >4 hrs in the sun* 1stt quartile: reference 2nd quartile: 1.3 (0.86-1.9) 3rd quartile: 1.4 (0.92-2.0) 4th quartile: 1.4 (0.95-2.0) *Lifetime overall UV exposure (includes time in sun, erythemal exposure)* Men 1st quartile: reference 2nd quartile: 0.51 (0.23-0.80) 3rd quartile: 0.67 (0.31-1.03) 4th quartile: 1.24 (0.62-1.86) Women 1st quartile: reference 2nd quartile: 1.35 (0.64-2.05) 3rd quartile: 2.45 (1.23-3.68) 4th quartile: 1.99 (0.95-3.03)	NR	NR	Age; income; tendency to sunburn; #of sunburns ages 2-10
Garbe 1989[78] Fair	Case-control Germany Cases n= 200 Controls n=200	NR	NR	*Occupational sun exposure* None: reference Sometimes: 1.18 (0.56-2.48) Nearly every time: 11.62 (2.13-63.33)	NR
Gallagher 1986[75] Elwood 1985[135] Elwood 1984[136] Western Canada Melanoma Study Fair	Case-control Western Canada Cases n= 595 Controls n=595	*Total hrs annual sun exposure* <49: reference 50-99: 1.5 (0.8-2.7) 100-149: 1.5 (0.9-2.7) 150-199: 1.6 (0.9-2.9) 200-299: 1.0 (0.6-1.7) 300-399: 1.1 (0.6-1.9) 400-499: 1.6 (0.9-2.7) 500+: 1.2 (0.7-2.0)	*Total hrs recreational exposure in summer* <1: reference 1-19: 1.1 (0.7-1.6) 20-79: 1.7 (1.2-2.5) 80-159: 1.8 (1.2-2.7) 160+: 1.7 (1.1-2.7) *Total hrs vacation in summer* <1: reference 1-6: 0.9 (0.7-1.3) 7-19: 0.9 (0.6-1.4) 20-39: 1.9 (1.3-3.0) 40+: 1.5 (1.0-2.3) *# sunny vacations per decade of life*	*Occupational, hrs/summer season* <1: reference 1-99: 1.8 (1.2-2.5) 100-199: 1.0 (0.7-1.5) 200-399: 0.9 (0.6-1.4) 400+ : 0.9 (0.6-1.5)	Hair color; skin color; freckling; ethnic origin

Table 3. Association Between Sun Exposure and Skin Cancer

Study reference, USPSTF quality rating	Design, Setting, Population	Total Sun Exposure (RR or OR)*	Intermittent Sun Exposure (RR or OR [95% CI])*	ChronicSun Exposure (RR or OR)*	Adjustments reported
			0: reference <1: 1.1 (1.0-1.1) 1-3: 1.3 (1.1-1.5) 4+: 1.7 (1.2-2.3)		
Fargnoli 2004[79] Fair	Case-control Central Italy Cases n=100 Controls n=200	NR	*Hrs recreational sun exposure per year* <60: reference 60-120: 0.761 (0.420-1.378) 120-240: 1.641 (0.799-3.370) >240: 5.010 (2.110-11.891)	*Occupational sun exposure* No: reference Yes: 2.57 (1.40-4.73)	Hair color; eye color; skin type
Holly 1995[80] Fair	Case-control San Francisco, US Cases n=452 Controls n=930	NR	*Time spent outdoors on weekends, past 10 years* None: reference <1/4 of time: 0.72 (0.35-1.4) 1/4 - 1/2 of time: 0.71 (0.37-1.4) 1/2 - 3/4 of time: 0.86 (0.42-1.8) ≥3/4 of time: 0.84 (0.37-1.9) *Frequency of sunbathing in typical year, past 10 years* Never: reference <Once/month: 0.75 (0.52-1.1) Once/month: 0.57 (0.36-0.89) 2-3 times/month: 0.67 (0.46-0.98) ≥Once/week: 0.79 (0.56-1.1)	*Time spent outdoors on weekday, past 10 years* None: reference <1/4 of time: 0.71 (0.49-1.0) 1/4 - 1/2 of time: 0.83 (0.53-1.3) ≥1/2 of time: 0.83 (0.46-1.5)	None
Tabenkin 1999[76] Fair	Case-control Israel Cases n=168 Controls n=325	*# hrs sun exposure, ages 6-13* Statistically significant difference; OR not reported *# hrs sun exposure, ages 14-18, 18-21, and >21* NS; OR not reported	NR	*Occupational sun exposure age >21* No: 2.44 (1.01-5.91) Yes: reference	NR
Zanetti 1992[84] Fair	Case-control Turin, Italy Cases n=260 Controls n=416	NR	*# weeks of sunny vacation in childhood* 0: reference 1-59: 2.8 (1.6-4.6) ≥60: 1.7 (1.0-2.9) *# sunny vacations in lifetime* 0: reference 1-29: 0.9 (0.5-1.6) 30-59: 1.6 (0.9-2.8) 60-89: 1.6 (0.9-2.9) 90-119: 1.5 (0.8-2.7) ≥120: 2.3 (1.4-3.8)	NR	Age; sex

Table 3. Association Between Sun Exposure and Skin Cancer

Study reference, USPSTF quality rating	Design, Setting, Population	Total Sun Exposure (RR or OR)*	Intermittent Sun Exposure (RR or OR [95% CI])*	ChronicSun Exposure (RR or OR)*	Adjustments reported
Westerdahl 1994[86] Westerdahl 1994[40] Westerdahl 1995[41] Fair	Case-control Sweden Cases n=400 Controls n=640	NR	*Frequent sunbathing during summer* No: reference Yes: 1.2 (0.9-1.7)	NR	Exposure to sunbeds or sunlamps; history of sunburns; hair color; # of raised nevi; history of malignant melanoma in immediate family
Westerdahl 2000[85] Fair	Case-control Sweden Cases n=558 Controls n=891	NR	*Frequency of sunbathing in summer, stratified by sunscreen use* Use of sunscreen Never Ever <15 times reference 1.3 (0.8-2.2) ≥15 times 0.9 (0.5-1.8) 1.2 (0.7-2.0)	NR	Sunburns age >19; skin phototype; hair color
LeMarchand 2006[81] Fair	Case-control Hawaii, US Cases n=278 Controls n=278	NR	*# hrs during summer in bathing suit, ages 8-10* Men 0: reference 1-32: 1.2 (0.6-2.3) 33-80: 0.9 (0.4-1.8) ≥80: 2.0 (0.9-4.4) Women 0: reference 1-20: 2.1 (0.8-5.4) 21-64: 1.4 (0.5-3.7) ≥65: 3.4 (1.2-9.1) *# hrs during summer in bathing suit, past 5 yrs* Men 0: reference 1-12: 1.4 (0.6-3.0) 13-24: 1.9 (0.8-4.4) ≥25: 2.5 (1.2-5.4) Women 0: reference 1-8: 2.1 (0.8-5.6) 9-20: 4.8 (1.7-13.4) ≥21: 3.3 (1.1-10.10)	*Lifetime # f hours worked outdoors* Men ≤438: reference 439-1,644: 1.0 (0.5-2.0) 1,645-3,360: 0.7 (0.4-1.5) ≥3,361: 1.3 (0.7-2.7) Women 0: reference 1-330: 1.3 (0.6-3.8) 331-864: 1.8 (0.8-4.2) ≥865: 1.2 (0.5-3.0)	Height; education; hair color; ability to tan; drinking status

*Adjusted unless otherwise stated.
US=United States; N=sample size; CI=confidence interval; SCC=squamous cell carcinoma; RR=relative risk; BCC=basal cell carcinoma; OR=odds ratio; WBE=whole body equivalent; NS=not significant; NR=not reported

Table 4. Association Between Indoor Tanning and Skin Cancer

Study, USPSTF quality	Design, Setting, Years	Population	Ever use (RR or OR [95% CI])*	Frequency of use (RR or OR [95% CI])*	Adjustments reported
Squamous cell or basal cell carcinoma					
Han 2006[71] Nurses' Health Study Fair	Nested case-control US (11 states) 1989-1998/2000	Cases SCC n=275 BCC n=283 Controls n=804	SCC: 1.44 (0.93-2.24) BCC: 1.32 (0.87-2.03)	NR	Age; constitutional susceptibility; family history of skin cancer; # of lifetime severe sunburns which blistered; cumulative sun exposure while wearing a bathing suit; geographic region
Gallagher 1995[66] Bajdik 1996[128] Fair	Case-control Alberta, Canada 1983-1984	Cases SCC n=180 BCC n=226 Controls SCC n=406 BCC n=406	SCC: 1.4 (0.7-2.7) BCC: 1.2 (0.7-2.2)	NR	Age; ethnic origin; skin and hair color; lifetime occupational sun exposure
Rosso 1999[64] Fair	Case-control Valais, Switzerland 1994-1996	Cases n=146 Controls n=144	SCC: Not calculated BCC: 1.24 (0.53-2.88)	NR	Age; sex
Karagas 2002[88] Fair	Case-control New Hampshire and bordering regions 1993-1995	Cases n=896 (BCC n=603, SCC n=293) Controls n=540	SCC: 2.5 (1.7-3.8) BCC: 1.5 (1.1-2.1)	*Age at first tanning device use* SCC: <20: 3.6 (1.9-6.9) 20-35: 2.8 (1.4-5.5) BCC: <20: 1.8 (1.0-3.0) 20-35: 1.4 (0.8-2.3)	NR
Melanoma					
Veierod 2003[82] Norwegian-Swedish Women's Lifestyle and Health Cohort Study Fair	Cohort Norway & Sweden 1992-1992 ~8 year follow-up	n=106,379	Ages 10-19: 1.52 (0.56-4.12)	Frequent use (1+ per month), ages 10-39: 1.55 (1.04-2.32)	Age; region of residence; hair color; corresponding # of age-specific sunburns and weeks spent on annual summer vacations
Han 2006[71] Nurses' Health Study Fair	Nested case-control US (11 states) 1989-1998/2000	Cases melanoma n=200 Controls n=804	2.06 (1.30-3.26)	NR	Age; constitutional susceptibility; family history of skin cancer; # of lifetime severe sunburns which blistered; cumulative sun exposure while wearing a bathing suit; geographic region
Osterlind 1988[83] Osterlind 1988[129] Fair	Case-control East Denmark 1982-1985	Cases n=474 Controls n=926	0.7 (0.5-1.0)	NR	NR

Table 4. Association Between Indoor Tanning and Skin Cancer

Study, USPSTF quality	Design, Setting, Years	Population	Ever use (RR or OR [95% CI])*	Frequency of use (RR or OR [95% CI])*	Adjustments reported
Berwick 1996[73] Chen 1998[89] Fair	Case-control Connecticut, US 1987-1989	Cases n=624 Controls n=512	1.13 (0.82-1.54)	*Total lifetime # sunlamp uses* <10 times: 1.25 (0.84-1.84) ≥10 times: 1.15 (0.60-2.20) *Age at first use of sunlamp* <25: 1.35 (0.88-2.08) 25-45: 1.02 (0.61-1.70)	Sex; age; cutaneous phenotype index; total recreational sun exposure index
Walter 1999[90] Walter 1990[132] Fair	Case-control Ontario, Canada 1984-1986	Cases n=583 Controls n=608	1.54 (1.16-2.05)	See appendix for sex-stratified, age-adjusted only OR for 1) total lifetime # minutes use, and 2) age at first use	Sex; age; reaction to initial summer sun exposure; potential confounders
Bataille 2005[91] Fair	Case-control Sweden, The Netherlands, UK, Belgium, France 1998-2001	Cases n=597 Controls n=622	0.90 (0.71-1.14) Age <15: 1.82 (0.92-3.62)	*Total lifetime # hours use* <10: 0.95 (0.71-1.25) 10-30: 0.75 (0.50-1.11) 31-60: 0.75 (0.43-1.30) 61-100: 1.10 (0.55-2.24) >100: 1.19 (0.73-1.93)	Age; sex; skin phototype
Fargnoli 2004[79] Fair	Case-control Central Italy 2000-2001	Cases n=100 Controls n=200	0.63 (0.25-1.63)	NR	Hair color; eye color; skin type for pigmentation factors
Holly 1995[80] Fair	Case-control San Francisco, US 1981-1986	Cases n=452 Controls n=930	0.94 (0.74-1.2)	NR	None
Westerdahl 1994[86] Westerdahl 1994[40] Westerdahl 1995[41] Fair	Case-control Sweden 1988-1990	Cases n=400 Controls n=640	Age <30: 2.7 (0.7-9.8)	*# times per year use* <u>age <30 years</u> 1-10: 2.0 (0.5-8.0) >10: 7.7 (1.0-63.6) <u>age 30-60 years</u> 1-10: 1.0 (0.7-1.6) 10: 1.4 (0.7-2.7)	History of sunburns; blond/fair and red hair color; raised nevi; history of frequent sunbathing during summer
Westerdahl 2000[85] Westerdahl 2000[42] Fair	Case-control Sweden 1995-1997	Cases n=571 Controls n=913	Sometimes use: 1.1 (0.8-1.4) Regular use: 1.8 (1.2-2.7)	*Total lifetime # uses* 1-125: 2.8 (1.0-7.8) 126-250: 3.1 (1.3-7.1) >250: 1.5 (0.7-3.2) *Age at first use* ≤35: 2.3 (1.2-4.2) >35: 1.6 (0.9-2.9)	Hair color; # raised nevi; skin type; # of sunburns

Table 4. Association Between Indoor Tanning and Skin Cancer

Study, USPSTF quality	Design, Setting, Years	Population	Ever use (RR or OR [95% CI])*	Frequency of use (RR or OR [95% CI])*	Adjustments reported
Clough-Gorr 2008 [92] Fair	Case-control New Hampshire, US 1995-1998	Cases n=423 Controls n=678	Sunlamp use: 1.39 (1.00-1.96) Tanning bed use: 1.14 (0.80-1.61)	*Frequency of sunlamp use* <6 times: 1.29 (0.84-1.99) 6+ times: 1.54 (0.93-2.57) *Age at first sunlamp use* ≤20: 1.23 (0.81-1.88) >20: 1.71 (1.00-2.92) *Frequency of tanning bed use* <10 times: 1.05 (0.67-1.64) 10+ times: 1.25 (0.79-1.98) *Age at first tanning bed use* ≤20: 1.78 (0.76-4.15) >20: 1.08 (0.75-1.55)	Age; sex; family history of melanoma; hair color; freckles; sun sensitivity; total sun exposure hours

*Adjusted unless otherwise stated.
US=United States; N=sample size; CI=confidence interval; SCC=squamous cell carcinoma; RR=relative risk; BCC=basal cell carcinoma; OR=odds ratio

Table 5. Association Between Sunscreen Use and Skin Cancer

Study, USPSTF quality	Design, Setting, Years	Population	Ever use (RR or OR [95% CI])*	Frequency of use (RR or OR [95% CI])*	Adjustments reported
Squamous cell or basal cell carcinoma					
Green 1999[57] Green 1994[58] van der Pols 2006[60] Nambour Skin Cancer Prevention Trial Good for 4-yr f/u Fair for 8- yr f/u	RCT Queensland, Australia 1992 Up to 8-yr follow-up	n=1,621	*Regular sunscreen use (vs. usual sunscreen use)* <u>1993-1996</u> SCC: 0.88 (0.50-1.56) BCC: 1.03 (0.73-1.46) <u>1993-2004</u> SCC: 0.65 (0.45-0.94) BCC: 1.02 (0.78-1.35)	NR	NR
Grodstein 1995[67] Nurses' Health Study Good	Cohort US (11 states) 1982-1990 8-yr follow-up	n=107,900	*# of persons who spent regular time outdoors (never use*) SCC: 0.9 (0.6-1.2)	NR	Age; smoking; region; natural hair color; reaction to sun; lifetime # of sunburns
Hunter 1990[68] Nurses' Health Study Fair	Analytic cohort US (11 states) 1982-1990 4-yr follow-up	n=73,366	*# of persons who spent regular time outdoors (never use)* BCC: 0.70 (0.60-0.82)	NR	Age; time period; region; time spent outdoors in summer and sunscreen habit; hair color; childhood tendency to burn; lifetime # of severe and painful sunburns on face and arms
Kricker 1991[62] Kricker 1995[36] Kricker 1995[116] Fair	Case-control Western Australia 1987	BCC cases n=226 BCC controls n=1,021 (6 cases of SCC)	NR	*Use of SPF 10+ ≥half the time* 1-9 years: 1.92 (1.17-3.13) 10+ years: 1.25 (0.82-1.90)	Age; sex; ability to tan; site
Rosso 1999[64] Fair	Case-control Valais, Switzerland 1994-1996	Cases n=146 Controls n=144	*Ever use* SCC: 1.63 (0.41-6.53) BCC: 1.69 (1.14-2.05)	NR	Age; sex
Melanoma					
Cho 2005[93] Nurses' Health Study I & II, Health Professionals Follow-up Study Fair	Analytic cohort US (multistate) 1986 for NHS 1992 for HPS Up to 14-yr follow-up	n=178,155	NR	NR	NR
Fargnoli 2004[79] Fair	Case-control Central Italy 2000-2001	Cases n=100 Controls n=200	Ever use: 0.63 (0.25-1.63)	NR	Hair color; eye color; skin type for pigmentation factors

Table 5. Association Between Sunscreen Use and Skin Cancer

Study, USPSTF quality	Design, Setting, Years	Population	Ever use (RR or OR [95% CI])*	Frequency of use (RR or OR [95% CI])*	Adjustments reported
Holly 1995[80] Fair	Case-control San Francisco, CA 1981-1986	Cases (calc) n=452 Controls n=930	Sometimes use: 1.5 (1.1-2.2) Never use: 2.1 (1.5-3.0)	NR	History of sunburn ages ≤12 yrs; skin reaction after few days of sun exposure; hair color; # of large nevi; complexion; age; maternal ethnicity; history of skin cancer
Westerdahl 1994[86] Westerdahl 1994[40] Westerdahl 1995[41] Fair	Case-control Sweden 1988-1990	Cases n=400 Controls n=640	Sometimes use: 1.3 (0.9-1.9) Almost always use: 1.8 (1.1-2.8)	NR	History of sunburns; history of frequent sunbathing during summer; outdoor employment during summer; host factors (raised nevi, hair color, eye color, freckling)
Westerdahl 2000[85] Westerdahl 2000[42] Fair	Case-control Sweden 1995-1997	Cases n=558 Controls n=891	Sometimes use: 1.3 (0.9-1.9) Always initially, and sometimes use: 0.9 (0.6-1.5) Always use: 1.8 (1.1-2.9)	*# yrs of regular sunscreen use* 1-20: 4.3 (0.8-21.9) >20: 1.7 (0.5-5.6)	Hair color; history of sunburns; frequency of sunbathing during summer; duration of each sunbathing occasion

*Adjusted unless otherwise stated
US=United States; N=sample size; CI=confidence interval; SCC=squamous cell carcinoma; RR=relative risk; BCC=basal cell carcinoma; OR=odds ratio; NHS=Nurses' Health Study; NPS=Professionals Follow-up Study; NR=not reported

Table 6. Adverse Outcomes of Sun-Protective Behaviors

Study, Design, Quality	Setting (country), Population description	Study objective, Intervention or exposure	Measurement of adverse outcome
Decreased physical activity			
Milne 2007[94] Cluster CCT by school Fair	Australia **N:** 1615 children (33 schools) **Age:** 5-6 years at baseline **Sex:** NR **Skin phenotype:** NR	To determine if adherence to sun safety could have a detrimental effect on children's body mass index **IG (high- and moderate-intensity):** specially designed sun protection curriculum administered over 4 consecutive years beginning at age 6; curriculum integrated into a range of subjects, including physical education; children in high-intensity intervention group were sent program materials over summer vacation and offered low-cost sun-protective swimwear **CG:** standard Western Australian health education curriculum	**Difference in z score*** *4 years* IG high-intensity: -0.08 (95% CI, -0.22 to 0.06) IG moderate-intensity: 0.01 (95% CI, -0.12 to 0.14) CG: reference *6 years* IG high-intensity: -0.11 (95% CI, -0.27 to 0.05) IG moderate-intensity: 0.05 (95% CI, -0.09 to 0.20) CG: reference * adjusted for sex, ethnicity, parent education, z score at baseline **Relative difference in total time spent outdoors*** *4 years* IG high-intensity: 0.90 (95% CI, 0.78 to 1.05) IG moderate-intensity: 1.0 (95% CI, 0.87 to 1.15) CG: reference *6 years* IG high-intensity: 0.98 (95% CI, 0.83 to 1.15) IG moderate-intensity: 0.94 (95% CI, 0.81 to 1.09) CG: reference * adjusted for sex, ethnicity, parent education, tendency to burn, total time spent outdoors at baseline
Increased sun exposure (with sunscreen use)			
Autier 1999[95] RCT Good	France and Switzerland **N:** 87 **Age:**18-24 yrs **Sex:** 41% male **Skin phenotype:** 2% skin type I 33% skin type II 65% skin type III 0% skin type IV	To determine if sunscreen use encourages longer sun exposure duration **IG1:** SPF 10 sunscreen **IG2:** SPF 30 sunscreen	**Mean sun exposure (hours) per participant** *2 months* IG1: 58.2 (95% CI, 52.0 to 64.4) IG2: 72.6 (95% CI, 63.5 to 81.7); p=0.011 *2 months, daily sun exposure* IG1: 4.0 (95% CI, 3.3 to 4.7) IG2: 4.6 (95% CI, 3.9 to 5.3); p≤0.0001 *2 months, daily outdoor activity* IG1: 3.6 (95% CI, 2.9 to 4.3) IG2: 3.8 (95% CI, 3.0 to 4.6); p=0.62 *2 months, daily sunbathing* IG1: 2.6 (95% CI, 2.1 to 3.1) IG2: 3.1 (95% CI, 2.5 to 3.7); p=0.0013 **# of sunburns or skin-reddening episodes** IG1: 159 IG2: 159; p=0.99 **# of sunburns** IG1: 42 IG2: 34; p=0.90

Table 6. Adverse Outcomes of Sun-Protective Behaviors

Study, Design, Quality	Setting (country), Population description	Study objective, Intervention or exposure	Measurement of adverse outcome
Autier 2000[96] RCT Good	France and Belgium **N:** 62 randomized, 58 analyzed **Age:** 18-24 years **Sex:** 26% male **Skin phenotype:** 5% skin type I 53% skin type II 41% skin type III 0% skin type IV	To determine if sunscreen use encourages longer sun exposure duration **IG1:** SPF 10 sunscreen **IG2:** SPF 30 sunscreen	**Median time spent (hours) per day sunbathing** IG1: 2.4 IG2: 3.0 % change: +25%; p=0.054 **Median UVB exposure (joules/m^2) per day** IG1: 841 IG2: 984 % change: +17%; p=0.15 **Median UVA exposure (kjoules/m^2) per day** IG1: 136 IG2: 125 % change: -8%; p=0.50
Dupuy 2005[97] RCT Good	France **N:** 367 randomized, 359 analyzed **Age:** 39 years **Sex:** 18% male **Skin phenotype:** 35% fair complexion 15% neither fair nor dark 49% dark complexion	To determine if high-SPF sunscreen has an impact on sun-exposure behavior; to determine the impact of actual high-SPF protection and the impact of the impression of being well protected **IG1:** high protection label, SPF 40 sunscreen **IG2:** basic protection label, SPF 40 sunscreen **CG:** basic protection label, SPF 12 sunscreen	**Mean total sun exposure (hours) per participant at 1 week** IG1: 14.2 (SD, 7.6) IG2: 12.9 (SD,7.2) CG: 14.6 (SD,6.7) Label comparison (IG1 vs. IG2): p=0.13 SPF comparison (IG2 vs. CG): p=0.06 **Proportion with sunburn at 1 week** IG1: 0.15 IG2: 0.14 CG: 0.24 Label comparison (IG1 vs. IG2): p=0.80 SPF comparison (IG2 vs. CG): p=0.06 Label comparison (IG1 vs. IG2): OR, 0.91 (95% CI, 0.43 to 1.91) SPF comparison (IG2 vs. CG): OR, 1.96 (95% CI, 0.98 to 3.92)
Green 1999[57,108] RCT Good	Australia **N:** 1621 **Age:** 49 years **Sex:** 44% male **Skin phenotype:** ~21% burn only ~68% burn/tan ~11% tan only	To investigate effectiveness of daily sunscreen application and dietary betacarotene supplement in reducing the incidence of basal cell and squamous cell carcinoma; secondary endpoint included sun exposure **IG1:** SPF 15 sunscreen plus betacarotene **IG2:** SPF 15 sunscreen and placebo tablet **IG3:** 30 mg betacarotene and placebo cream **CG:** Placebo cream and placebo tablet	**Spent <50% of weekend outdoors in previous summer** *4.5 years* IG1 and IG2: 79.3% (549/692); p=NR IG3 and CG: 77.4% (535/691) **Median ambient UV exposure from polysuphone badges (n=175)** *Over summer (range)* IG1 and IG2: 2.8% (0-32.2); p=0.55 IG3 and CG: 3.5% (0-23.8) *Over winter* IG1 and IG2: 6.5% (0-36.2); p=0.36 IG3 and CG: 7.1% (1.0-35.8)

Table 6. Adverse Outcomes of Sun-Protective Behaviors

Study, Design, Quality	Setting (country), Population description	Study objective, Intervention or exposure	Measurement of adverse outcome
Gallagher 2002[109] RCT Fair	Canada **N:** 458 **Age:** 51% 6-7 yrs, 49% 9-10 yrs **Sex:** NR **Skin reflectance:** ~33% dark ~33% medium ~33% light	To determine whether use of broad-spectrum, high-SPF sunscreen attenuates development of nevi in white children; secondary endpoint included sun exposure **IG:** SPF 30 sunscreen plus advice **CG:** no advice, no placebo	**Median UV exposure from 1993 to 1996** *Time spent outdoors* IG: 357.0; p=NR CG: 361.5 *Vacation sun exposure* IG: 962.5; p=NR CG: 962.5 *Total sunlight exposure for whole body, adjusted for clothing coverage* IG: 1252.2; p=NR CG: 1214.3
Bauer 2005[110] Cluster RCT Fair	Germany **N:** 1887 **Age:** 4.3 years **Sex:** 51% male **Skin phenotype:** 10.1% skin type I	To determine if children receiving education or education and sunscreen develop less incident nevi; secondary endpoint included sun exposure and sun protection habits **IG1:** education and SPF 25 sunscreen **IG2:** education only **CG:** control	**Sun exposure in 2001 and changes between 1998 and 2001** *Median time (weeks) on holiday in sunny climates* IG1: 4 (IQR, 2 to 7.5); p=0.021 IG2: 6 (IQR, 2 to 8) CG: 5 (IQR, 2 to 8) *Median difference in hours/day sun exposure during sunny holiday* IG1: 0 (IQR, -1 to 1); p=0.061 IG2: 0 (IQR, -1 to 1) CG: 0 (IQR, -1 to 1) *Mean difference in hours/day outdoors at home* IG1: 0.15 (SD, 1.12); p=0.353 IG2: 0.14 (SD, 1.13) CG: 0.24 (SD, 1.09)
Vitamin D deficiency			
Marks 1995[98] RCT Fair	Australia **N:** 153 randomized, 113 analyzed **Age:** 52% ages <70 years **Sex:** 41% male **Skin phenotype:** 27% burn 50% burn/tan 23% tan	To determine if regular use of sunscreen may put individuals at risk for vitamin D deficiency **IG:** SPF 17 sunscreen; participants were given specific instructions on application of sunscreen and were given other sun-protective behavior instructions **CG:** placebo cream, participants were given same instructions	**Mean change in vitamin D levels at 7 months** *25-hydroxyvitamin D (nmol/L)* IG: 11.8 (95% CI, 7.6 to 15.9); 21% change CG: 12.8 (95% CI, 8.4 to 17.1); 25% change p=0.75 *1,25-hydroxyvitamin D (nmol/L)* IG: 1.3 (95% CI, -2.3 to 4.9); 1% change CG: 10.8 (95% CI, 6.7 to 14.8); 14% change p=0.0009 **Change in vitamin D levels at 7 months by age, sex, and skin type** No statistically significant changes Also reported: "no person using sunscreen developed serum vitamin D levels below the reference range over the period of the study."

Table 6. Adverse Outcomes of Sun-Protective Behaviors

Study, Design, Quality	Setting (country), Population description	Study objective, Intervention or exposure	Measurement of adverse outcome
Brot 2001[99] Cohort, prospective Fair	Denmark **N:** 2016 **Age:** 45-58 years **Sex:** 0% male **Skin phenotype:** NR	To assess prevalence of vitamin D deficiency in perimenopausal women; to estimate relative influences of sun exposure and vitamin D intake on 25-hydroxyvitamin D concentration All participants were interviewed by two physicians to determine sun exposure (never, occasionally, regularly) and sunbed use (no, yes)	**Prevalence of low vitamin D status during winter and spring** *Mean 25-hydroxyvitamin D serum level (nmol/L)* Vitamin supplement: No / Yes Never 36.5 / 45.3 Occasionally 41.5 / 49.3 Regularly 53.5 / 62.3 *Percent of subgroup with low 25-hydroxyvitamin D status (≤25 nmol/L)* Never 32.8 / 12.9 Occasionally 17.6 / 10.7 Regularly 9.8 / 2.8
Increased cancer risk (due to protective nature of vitamin D)			
John 1999[100] Cohort, retrospective Fair	US **N:** 5009 analyzed **Age:** 25-74 years **Sex:** 0% male **Skin phenotype:** NR	To examine possible protective role of vitamin D (dietary or sun exposure) on breast cancer risk In-person interviews; medical exams to determine usual sunlight exposure, sun-induced skin damage, residential sulight exposure, and dietary and supplemental vitamin D intake	**Sun exposure and breast cancer risk** *Recreational sun exposure (# cases)* Rare or never: 40 (age-adj RR, 1.0; mv-adj RR,1.0) Occasional: 55 (age-adj RR, 0.70 [95% CI, 0.46-1.06]; mv-adj RR, 0.65 [95% CI, 0.43-0.98]) Frequent: 60 (age-adj RR, 0.70 [95% CI, 0.47-1.05]; mv-adj RR, 0.66 [95% CI, 0.44-0.99]) p=0.12 (trend=0.08) *Occupational sun exposure (# cases)* Rare or never: 81 (age-adj RR, 1.0; mv-adj RR,1.0) Occasional: 44 (age-adj RR, 1.05 [95% CI, 0.73-1.51]; mv-adj RR, 1.06 [95% CI, 0.73-1.53]) Frequent: 29 (age-adj RR, 0.60 [95% CI, 0.39-0.91]; mv-adj RR, 0.64 [95% CI, 0.41-0.98]) p=0.03 (trend=0.07) *Combined recreational and occupational sun exposure (# cases)* Low: 32 (age-adj RR, 1.0; mv-adj RR, 1.0) Medium: 99 (age-adj RR, 0.67 [95% CI, 0.45-1.01]; mv-adj RR, 0.81 [95% CI, 0.56-1.17]) High: 23 (age-adj RR, 0.50 [95% CI, 0.29-0.86]; mv-adj RR, 0.67 [95% CI, 0.42-1.06]) p=0.01 (trend=0.06) *Sun exposure and dietary vitamin D (# cases)* Low sun + <200 IU: 71 (age-adj RR, 1.0; mv-adj RR, 1.0) Low sun + ≥200 IU: 18 (age-adj RR, 0.79 [95% CI, 0.57-1.11]; mv-adj RR, 0.75 [95% CI, 0.54-1.06]) High sun + <200 IU: 65 (age-adj RR, 0.78 [95% CI,0.46-1.31]; mv-adj RR, 0.77 [95% CI, 0.46-1.29] High sun + ≥200 IU: 22 (age-adj RR, 0.72 [95% CI, 0.45, 1.17]; mv-adj RR, 0.71 [95% CI, 0.44-1.14] p=0.11 (trend=0.08) **Sunlight exposure by region of residence (low, medium, or high solar radiation)** *Combined recreational and occupational sun exposure (# cases)* Low Solar / Medium Solar / High Solar Low: 15 (RR,1.0) / 9 (RR,1.0) / 8 (RR,1.0) Med: 44 (RR,0.53 [0.29-0.97]) / 34 (RR,0.83 [0.39-1.76]) / 19 (RR,0.54 [0.23-1.25]) High: 9 (RR,0.40 [0.17-0.94]) / 10 (RR,0.77 [0.31-1.93]) / 4 (RR,0.35 [0.10-1.20]) Multivariate-adjusted RR: adjusted for age, education, age at menarche, age at menopause, BMI, alcohol consumption, physical activity, and calcium

Table 6. Adverse Outcomes of Sun-Protective Behaviors

Study, Design, Quality	Setting (country), Population description	Study objective, Intervention or exposure	Measurement of adverse outcome
Kampman 2000[101] Case-control Fair	US **N:** 1983 cases, 2400 controls **Age:** 65 years **Sex:** 54% male **Skin phenotype:** NR	To evaluate sources of inconsistency in the association between calcium and vitamin D (dietary or sun exposure) and colon cancer risk In-person interviews asking participants to recall behaviors 2 years before date of selection to determine dietary intake, supplement use, and sun exposure	**Association between sun exposure (per quintile) and colon cancer** Men: Quintile / # Cases / OR [95% CI]; Women: Quintile / # Cases / OR [95% CI] Low 236 260 1.0 [N/A] — 196 239 1.0 [N/A] 2 224 264 1.0 [0.8-1.3] — 198 203 1.3 [1.0-1.7] 3 230 252 1.1 [0.8-1.4] — 155 231 0.9 [0.7-1.2] 4 211 273 0.9 [0.7-1.2] — 171 216 1.1 [0.8-1.5] High 185 235 0.9 [0.7-1.1] — 160 216 1.0 [0.8-1.4] Multivariate-adjusted OR: adjusted for age, BMI, family history, aspirin or nonsteroidal anti-inflammatory drug use, energy intake, physical activity, fiber, and calcium
Hughes 2004[103] Hughes 2004[102] Case-control Fair	Australia **N:** 704 cases, 694 controls **Age:** 73% <50 years **Sex:** 54% male **Skin phenotype:** 27% cases, 29% controls have ability to deeply tan 44% cases, 42% controls have ability to moderately tan 21% cases, 42% controls have ability to mildly tan 8% cases, 6% controls have no ability to tan	To determine if high levels of sun exposure are associated with increased risk for nonHodgkin lymphoma Brief paper questionnaire and telephone interview to determine sun exposure; three measures of ambient solar irradiance were assigned to each residential location for each subject using latitude/longitude coordinates; socioeconomic status assessed using census data	**Sun exposure (years) and nonHodgkin lymphoma risk (per quartile)** *During the past decade* Lowest: OR, 1.0 25-50%: OR, 0.72 (95% CI, 0.53-0.98) 50-75%: OR, 0.66 (95% CI, 0.48-0.91) Highest: OR, 0.65 (95% CI, 0.46-0.91) p=0.01 *Lifetime occupational sun exposure* Lowest: OR, 1.0 25-50%: OR, 1.03 (95% CI, 0.76-1.40) 50-75%: OR, 1.04 (95% CI, 0.76-1.43) Highest: OR, 1.21 (95% CI, 0.87-1.69) p=0.30 **Vacation sun exposure (years) and nonHodgkin lymphoma risk** *During the past decade* Lowest: OR, 1.0 25-50%: OR, 0.98 (95% CI, 0.72-1.32) 50-75%: OR, 0.82 (95% CI, 0.60-1.12) Highest: OR, 0.60 (95% CI, 0.43-0.85) p=0.003 Multivariate-adjusted OR: adjusted for age, sex, state, ethnicity, skin color, and ability to tan

Table 6. Adverse Outcomes of Sun-Protective Behaviors

Study, Design, Quality	Setting (country), Population description	Study objective, Intervention or exposure	Measurement of adverse outcome
Smedby 2005[104] Case-control Fair	Denmark and Sweden **N:** 3740 cases, 3187 controls **Age:** median 59 years **Sex:** 56% male **Skin phenotype:** 17% cases, 15% controls skin type I 20% cases, 25% controls skin type II 28% cases, 31% controls skin type III 32% cases, 29% controls skin type IV	To determine if UV exposure (sun and sunbeds) is associated with increased lymphoma risk Telephone interview to determine host factors and exposure (sun and sunbed/lamps), as well as self-reported skin cancer	**Sun exposure and lymphoma risk** nonHodgkin lymphoma / Hodgkin lymphoma # controls / (OR [95% CI]) / (OR [95% CI]) *Sunbathing in past 5-10 years* Never 799 946 (1.0 [N/A]) 122 (1.0 [N/A]) ≤Once/wk 1013 938 (0.9 [0.7-1.0]) 236 (0.8 [0.6-1.0]) 2 to 3 times/wk 666 555 (0.8 [0.7-0.9]) 141 (0.7 [0.5-1.0]) ≥4 times/wk 666 581 (0.7 [0.6-0.9]) 118 (0.7 [0.5-1.0]) p<0.001 (trend=0.06) *Sunbathing at age 20 years* Never 434 568 (1.0 [N/A]) 49 (1.0 [N/A]) ≤Once/wk 931 918 (0.8 [0.7-0.9]) 84 (0.8 [0.5-1.2]) 2 to 3 times/wk 674 635 (0.7 [0.6-0.9]) 50 (0.6 [0.4-1.0]) ≥4 times/wk 653 642 (0.7 [0.6-0.9]) 73 (0.9 [0.6-1.4]) p=0.001 (trend=0.84) *Sun vacations abroad* Never 830 910 (1.0 [N/A]) 146 (1.0 [N/A]) 1 to 5 times 1002 1000 (1.0 [0.9-1.1]) 234 (0.8 [0.6-1.0]) 6 to 20 times 919 822 (0.9 [0.8-1.0]) 177 (0.7 [0.5-0.9]) >20 times 410 305 (0.7 [0.6-0.8]) 60 (0.8 [0.6-1.2]) p<0.001 (trend=0.06) *Sunbed/sunlamp use* Never 1254 1317 (1.0 [N/A]) 203 (1.0 [N/A]) <10 times 742 790 (1.0 [0.9-1.2]) 134 (0.8 [0.6-1.0]) 10 to 49 times 765 643 (0.9 [0.8-1.0]) 161 (0.7 [0.5-0.9]) ≥50 times 377 270 (0.8 [0.7-1.0]) 116 (0.7 [0.5-0.9]) p=0.01 (trend=0.004) **History of sun burn and lymphoma risk** *Sunburn in past 5-10 years* Never 2001 2121 (1.0 [N/A]) 308 (1.0 [N/A]) <1/year 702 590 (0.9 [0.8-1.0]) 186 (0.8 [0.6-1.0]) 1/year 319 224 (0.8 [0.6-0.9]) 78 (0.7 [0.5-0.9]) ≥2/year 134 96 (0.8 [0.6-1.1]) 34 (0.7 [0.4-1.0]) p=0.003 (trend=0.006) *Sunburn at age 20 years* Never 1077 1208 (1.0 [N/A]) 108 (1.0 [N/A]) <1/year 804 929 (1.0 [0.9-1.2]) 79 (0.9 [0.7-1.3]) 1/year 485 420 (0.8 [0.7-0.9]) 38 (0.8 [0.5-1.1]) ≥2/year 305 211 (0.6 [0.5-0.8]) 27 (0.8 [0.5-1.3]) p<0.001 (trend=0.14) *Sunburn in childhood* Never 1570 1747 (1.0 [N/A]) 283 (1.0 [N/A]) <1/year 546 461 (0.8 [0.7-1.0]) 156 (0.9 [0.7-1.2]) 1/year 358 284 (0.8 [0.6-0.9]) 79 (0.9 [0.7-1.3]) ≥2/year 219 172 (0.7 [0.6-0.9]) 39 (0.7 [0.5-1.1]) p<0.001 (trend=0.14) Multivariate-adjusted OR: adjusted for age, sex, country, and skin type

Table 6. Adverse Outcomes of Sun-Protective Behaviors

Study, Design, Quality	Setting (country), Population description	Study objective, Intervention or exposure	Measurement of adverse outcome
John 2005[105] Case-control Fair	US **N:** 450 cases, 455 controls **Age:** median 65 years **Sex:** 100% male **Skin phenotype:** NR	To determine if sun exposure is associated with increased risk for advanced prostate cancer In-person interviews and structured questionnaires; exam including skin pigmentation measurement with portable reflectometer and DNA sample (blood or mouthwash); and solar radiation level by state of residence, as assessed by National Weather Service stations	**Sun exposure and risk for advanced prostate cancer** age-adj OR mv-adj OR # cases # controls (95% CI) (95% CI) *Lifetime outdoor activities (hours/week)* <2.7 85 91 1.0 (N/A) 1.0 (N/A) 2.7-5.6 99 91 1.16 (0.77-1.75) 1.15 (0.76-1.73) 5.7-10.4 92 91 1.08 (0.72-1.64) 1.09 (0.72-1.65) 10.5-19.8 94 91 1.11 (0.73-1.67) 1.10 (0.73-1.67) ≥19.9 80 91 0.94 (0.62-1.44) 0.95 (0.62-1.45) p=0.8 *Lifetime outdoor jobs (hours/week)* 0 123 120 1.0 (N/A) 1.0 (N/A) <1.4 84 84 0.99 (0.67-1.47) 0.96 (0.65-1.43) 1.4-5.6 100 83 1.19 (0.81-1.75) 1.20 (0.81-1.77) 5.7-14.7 81 84 0.94 (0.63-1.40) 0.95 (0.64-1.41) ≥14.8 62 84 0.73 (0.48-1.10) 0.73 (0.48-1.11) p=0.3 *Facultative pigmentation* Light 100 90 1.0 (N/A) 1.0 (N/A) 2 107 90 1.08 (0.73-1.61) 1.08 (0.73-1.62) 3 86 91 0.85 (0.56-.28) 0.83 (0.55-1.26) 4 86 91 0.85 (0.56-1.28) 0.83 (0.55-1.26) Dark 68 90 0.68 (0.44-1.03) 0.66 (0.43-1.01) p=0.03 *Sun exposure index* Low 106 89 1.0 (N/A) 1.0 (N/A) 2 93 90 0.85 (0.57-1.28) 0.87 (0.58-1.30) 3 89 92 0.81 (0.54-1.21) 0.80 (0.53-1.20) 4 103 91 0.94 (0.63-1.40) 0.95 (0.64-1.42) High 56 90 0.52 (0.33-0.80) 0.51 (0.33-0.80) p=0.02 Multivariate-adjusted OR: adjusted for age, family history of prostate cancer, +/- month of pigmentation measurements

Table 6. Adverse Outcomes of Sun-Protective Behaviors

Study, Design, Quality	Setting (country), Population description	Study objective, Intervention or exposure	Measurement of adverse outcome
Hartge 2006[106] Case-control Fair	US **N:** 551 cases,462 controls **Age:** 35% <55 years **Sex:** 53% male **Skin phenotype:** 5% cases, 4% controls dark 56% cases, 55% controls medium 39% cases, 41% controls light	To determine if UV exposure is associated with risk for nonHodgkin lymphoma In-person interviews plus mailed questionnaire to determine demographic, diet, and sun exposure history; measurements of solar radiation obtained from Robertson-Berger meters, located in many states	**Sun exposure and risk for nonHodgkin lymphoma** # cases # controls OR (95% CI) *Exposure to midday sun (hours) in last 10 years* <7 216 159 1.0 (N/A) <14 145 126 0.85 (0.62-1.18) <28 131 123 0.75 (0.54-1.05) ≥28 59 51 0.73 (0.46-1.15) p=0.07 *Exposure to midday sun (hours) during teen years* <7 62 46 1.0 (N/A) <14 89 68 0.97 (0.59-1.61) <28 185 155 0.81 (0.52-1.27) ≥28 211 187 0.75 (0.48-1.18) p=0.12 *Exposure to midday sun (hours) during 20s* <7 143 107 1.0 (N/A) <14 143 124 0.86 (0.60-1.22) <28 156 132 0.83 (0.58-1.18) ≥28 105 94 0.75 (0.50-1.11) p=0.15 *Exposure to midday sun during 30s* <7 183 137 1.0 (N/A) <14 135 135 0.75 (0.54-1.04) <28 145 112 0.95 (0.68-1.33) ≥28 68 66 0.78 (0.50-1.19) p=0.44 *Sunlamp or sunbed use* Never 401 338 1.0 (N/A) <5 times 32 33 0.78 (0.46-1.32) 5-9 times 32 25 0.90 (0.52-1.58) ≥10 times 84 66 0.90 (0.61-1.30) p=0.49 *History of blistering sunburns* Never 224 177 1.0 (N/A) Once 117 103 0.87 (0.62-1.23) 2-4 times 114 84 1.02 (0.72-1.46) ≥5 times 92 96 0.68 (0.47-0.97) p=0.10 Multivariate-adjusted OR: NR

Table 6. Adverse Outcomes of Sun-Protective Behaviors

Study, Design, Quality	Setting (country), Population description	Study objective, Intervention or exposure	Measurement of adverse outcome
John 2007[107] Case-control Good	US **N:** 1786 cases, 2127 controls **Age:** 40% ages 50-64 years **Sex:** 0% male **Skin phenotype:** NR	To determine if sun exposure is associated with increased risk for breast cancer In-person interviews and structured questionnaires, plus exam including measurement of skin pigmentation with portable reflectometer and DNA sample (blood or mouthwash)	**Sun exposure and risk for advanced breast cancer** Light pigment: cases|controls|OR (95%CI) — Medium pigment: cases|controls|OR (95%CI) — Dark pigment: cases|controls|OR (95%CI) *Lifetime outdoor activities (hours/week by quartile)* Low 37 153 1.0 (N/A) — 43 180 1.0 (N/A) — 49 174 1.0 (N/A) 2 41 167 0.97 (0.58-1.62) — 47 154 1.17 (0.72-1.91) — 52 180 1.01 (0.65-1.59) 3 59 188 1.29 (0.80-2.09) — 55 169 1.23 (0.76-1.97) — 61 165 1.31 (0.84-2.03) High 37 180 0.86 (0.51-1.45) — 36 175 0.77 (0.46-1.29) — 50 153 1.14 (0.72-1.81) p 0.90 — 0.82 — 0.36 *Facultative pigmentation* Light 55 171 1.0 (N/A) — 48 171 1.0 (N/A) — 53 169 1.0 (N/A) 2 48 183 0.73 (0.45-1.17) — 54 161 1.22 (0.76-1.98) — 48 169 0.89 (0.52-1.55) 3 35 167 0.56 (0.33-0.94) — 38 180 0.86 (0.51-1.46) — 56 169 1.00 (0.56-1.81) Dark 37 173 0.54 (0.32-0.94) — 41 171 1.07 (0.62-1.85) — 57 174 1.00 (0.55-1.81) p 0.02 — 0.88 — 0.81 *Sun exposure index* Low 56 174 1.0 (N/A) — 47 172 1.0 (N/A) — 50 171 1.0 (N/A) 2 47 174 0.78 (0.49-1.26) — 55 173 1.29 (0.80-2.08) — 52 170 1.15 (0.73-1.82) 3 37 171 0.62 (0.37-1.04) — 35 167 0.90 (0.53-1.55) — 59 168 1.39 (0.89-2.17) High 35 175 0.53 (0.31-0.91) — 44 171 1.26 (0.74-2.15) — 53 172 1.28 (0.81-2.05) p 0.01 — 0.68 — 0.20 **Sun exposure and risk for localized breast cancer** *Lifetime outdoor activities (hours/week by quartile)* Low 85 153 1.0 (n/a) — 97 180 1.0 (n/a) — 101 174 1.0 (n/a) 2 91 167 0.95 (0.65-1.40) — 70 154 0.79 (0.53-1.17) — 89 180 0.80 (0.56-1.15) 3 103 188 0.89 (0.61-1.29) — 129 169 1.35 (0.94-1.93) — 96 165 0.94 (0.66-1.35) High 107 180 1.05 (0.72-1.54) — 92 175 1.02 (0.70-1.50) — 64 153 0.70 (0.47-1.04) p 0.85 — 0.20 — 0.18 *Facultative pigmentation* Light 95 171 1.0 (N/A) — 101 171 1.0 (N/A) — 73 169 1.0 (N/A) 2 109 183 1.18 (0.82-1.71) — 118 161 1.34 (0.93-1.94) — 87 169 1.22 (0.76-1.97) 3 97 167 1.10 (0.75-1.61) — 90 180 1.04 (0.70-1.54) — 88 169 1.20 (0.71-2.01) Dark 89 173 1.11 (0.74-1.67) — 81 177 1.12 (0.73-1.71) — 102 174 1.40 (0.83-2.33) p 0.72 — 0.80 — 0.24 *Sun exposure index* Low 104 174 1.0 (N/A) — 108 172 1.0 (N/A) — 75 171 1.0 (N/A) 2 103 174 1.09 (0.76-1.58) — 107 173 1.12 (0.78-1.62) — 99 170 1.43 (0.97-2.10) 3 87 171 0.96 (0.65-1.41) — 90 167 1.01 (0.68-1.49) — 87 168 1.30 (0.88-1.93) High 96 175 1.10 (0.74-1.63) — 84 171 1.06 (0.71-1.60) — 89 172 1.11 (0.74-1.67) p 0.81 — 0.86 — 0.74 Multivariate-adjusted OR: adjusted for age, race/ethnicity, education, family history of breast cancer, personal history of breast disease, age at menarche, # full-term pregnancies, breastfeeding, BMI, height, physical activity, and alcohol consumption

CCT=controlled clinical trial; RCT=randomized controlled trial; IG=intervention group; CG=control group; BMI=body mass index; UK=United Kingdom; US=United States; SPF=sun protection factor; PC=primary care;calc=calculated; NR=not reported; CI=confidence interval; OR=odds ratio; RR=relative risk; mv=multivariate; adj=adjusted; #=number; N/A=not applicable; nmol=nanomole; L=liter; IU=international unit

Table 7. Summary of Evidence By Key Question

# of studies	Design	Limitations	Consistency	Applicability	Overall Quality	Summary of Findings
KQ1. Is there direct evidence that counseling patients in sun-protective behaviors reduces intermediate outcomes or skin cancer?						
No direct evidence was found.						
KQ2. Do primary care relevant counseling interventions change sun-protective behaviors?						
Adults						
4 (n=8,950)	RCT	Unclear clinical significance of small changes in composite scores in absence of statistically significant differences in individual self-reported outcomes.	Consistent. 1 trial was conducted in a different population and used different outcome measures; no significant change in behavior reported.	Successful interventions all included computerized support and were conducted in predominantly white populations.	Fair	3 of 4 trials (n=6,225) showed that primary care feasible counseling with computer support can increase self-reported sun-protective behaviors, as measured by composite behavior scores at 6 to 12 months of follow-up. Interventions ranged from a single low-intensity intervention (15-min session) to multiple (<4) in-person or phone counseling, followed by tailored written feedback.
Adolescents and college students						
3 (n=1,382)	RCT	Only 1 trial in young adolescents, and 2 smaller trials in college students.	Trial in young adolescents consistent with adult trials. 2 trials in college students used appearance-focused intervention compared with health-based message in other interventions.	Intervention in adolescents included computerized support; appearance-focused interventions involved a professionally produced booklet and a video with or without UV photos. College students were explicit indoor tanners in 1 trial, and received course credit in another.	Fair	1 trial in young adolescents (n=819) showed that brief primary care counseling, coupled with interactive computer sessions, phone follow-up, and tailored written feedback can moderately increase self-reported sun-protective behaviors at 24 months of follow-up. In 2 trials in predominantly young college women (n=563), appearance-focused interventions decreased self-reported frequency of indoor tanning and objectively measured UV exposure (by skin reflectance spectrophotometry) at 6 to 12 months of follow-up. Interventions included a professional produced booklet in 1 trial and a short video (with or without a UV photo) in another.
Parents and children						
1 (n=728)	RCT	Only 1 trial. Unclear clinical significance of small changes in composite scores in absence of statistically significant differences in individual self-reported outcomes.	Only 1 trial. Consistent with trials conducted in adults and adolescents.	Intervention was integrated into 4 consecutive well-child visits and was conducted in a predominantly white population.	Fair	1 trial showed that primary care counseling with written information and samples of sun protection products integrated into consecutive well-child visits can increase self-reported sun-protective behaviors, as measured by a composite behavior score at 36 months. However, individual self-reported outcomes were generally not statistically significant.
Community-based interventions with primary care counseling						
2 (n=1,662)	Cluster RCT	Unable to assess the contribution of primary care counseling to the entire community-based intervention. Outcomes were assessed on the community level, and not per individual.	Consistent. Both trials were conducted by the same group of study investigators.	Primary care counseling was one component of a multifaceted community-based approach. Interventions were conducted in predominantly white communities.	Fair	2 trials showed that a multifaceted community-based intervention to promote sun-protective behaviors, including primary care counseling with temporary tattoos and stickers, integrated into well-child and illness visits can increase directly observed measures of body surface area protection in adolescents and self-reported measures of sunscreen use in adolescents and grade school children at 12 to 24 months follow-up.

Table 7. Summary of Evidence By Key Question

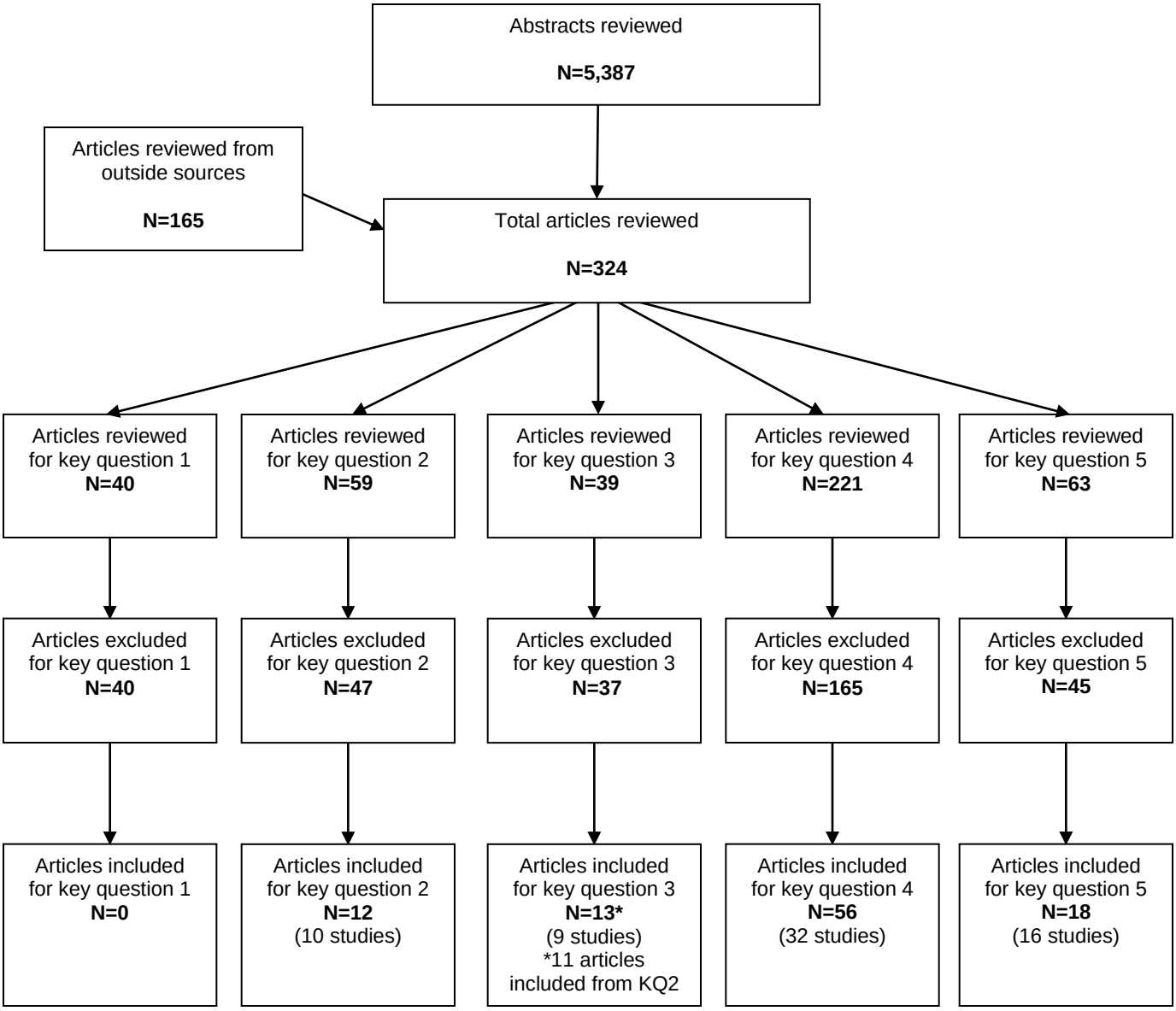
# of studies	Design	Limitations	Consistency	Applicability	Overall Quality	Summary of Findings
KQ3. Do primary care relevant counseling interventions have adverse effects?						
10 (n=12,722)	RCT and cluster RCT	Only 1 trial examined adverse outcomes other than decrease in sun protection behaviors.	Consistent with trial conducted in schools examining sedentary behaviors (see KQ5).	Interventions were conducted in predominantly white populations.	Fair	Of the 10 trials included in KQ2, there was no evidence for a paradoxical decrease in sun-protective behaviors. In the trial conducted in adolescents (n=819), there were no statistically significant changes in self-reported measures of physical activity or sedentary behaviors.
KQ4. Is sun exposure (intentional or unintentional), indoor tanning, or sunscreen use associated with skin cancer outcomes?						
Sun exposure (intentional or unintentional)						
6 (n=335,848) 22 (n=18,240)	Cohort Case-control	Very large variation in measures of sun exposure, delineation of levels of exposure, and use of reference groups. Very complex exposure to measure well. Cohort studies were not primarily designed to examine sun exposure. All case-control studies subject to recall bias. Variation in latitudes of countries of included studies.	No major inconsistencies. Large variation in measurement of sun exposure makes direct comparisons across studies difficult.	Body of evidence not able to detail what level of reduction in sun exposure would be necessary to decrease skin cancer risk. Unlikely that persons can change sun behavior from highest to lowest percentile. Most studies included predominantly white populations.	Fair	**SCC and BCC (11 studies)**: Based mostly on fair-quality cohort and case-control studies, there is an increased risk for both SCC and BCC with increasing recreational sun exposure (range OR, 1.3-3.9). Evidence is more consistent for sun exposure in childhood leading to an increased risk. Fewer studies examine the association of total or occupational sun exposure and do not suggest a strong association of exposure with SCC or BCC. **Melanoma (18 studies)**: Case-control literature does not show strong association of total and occupational sun exposure with melanoma. However, some evidence suggests that total childhood sun exposure is associated with melanoma risk (range OR, 1.8-4.4) and occupation-al sun exposure may be associated with a decreased risk for melanoma. Case-control studies examining the risk for recreational sun exposure are inconsistent, but some studies suggest that increasing recreational sun exposure increases the risk for melanoma (range OR, 1.3-5.0). The evidence is more consistent for recreational sun exposure in childhood leading to an increased risk for melanoma (range OR, 1.7-3.5).
Indoor tanning						
1 (n=106,379) 14 (n=13,675)	Cohort Case-control	Crude measures of indoor tanning. Cohort study was not primarily designed to examine UV exposure. Case-control studies are subject to recall bias.	No major inconsistencies. Inconsistent adjusting for important confounders.	Sunlamps or tanning bed use assessed in studies may not be equivalent to currently available indoor tanning devices. Most studies included predominantly white populations.	Fair to poor	**SCC and BCC (5 studies)**: We found very limited evidence (limited # of studies using crude measures of exposure) examining indoor tanning and the risk for SCC and BCC, after adjusting for important confounders. **Melanoma (11 studies)**: There is some evidence to suggest that "regular" or "early" use of indoor tanning may increase the risk for melanoma (range RR, 1.6-2.3), after adjusting for important confounders.
Sunscreen use						
1 (n=1621) 3 (n=359,421) 6 (n=5708)	Trial Cohort Case-control	Crude measure of sun-screen use. Cohort studies were not primarily design-ed to examine sun expos-ure or sunscreen use. Difficult exposure to meas-ure. Case-control studies are subject to recall bias.	Inconsistencies in studies examining sunscreen use and risk for melanoma. Inconsistent adjusting for important confounders.	Sunscreen use assessed in studies may not be equivalent to currently available sunscreens. Most studies included predominantly white populations.	Fair to poor	**SCC and BCC (5 studies)**: Based on 1 fair trial (n=1621), regular sunscreen use can prevent SCC (RR, 0.65 [95% CI, 0.45-0.94]). It is unclear if sunscreen use prevents BCC; case-control studies that suggest a protective effect have major limitations. **Melanoma (5 studies)**: Based on limited studies, there does not appear to be a clear protective or harmful effect of sunscreen use on the risk for melanoma.

Table 7. Summary of Evidence By Key Question

# of studies	Design	Limitations	Consistency	Applicability	Overall Quality	Summary of Findings
KQ5. Are sun-protective behaviors associated with adverse effects?						
Reduced physical activity						
1 (n=1615)	Trial	Only 1 trial.	Only 1 trial. Consistent with trial included in KQ3.	Conducted in Australia.	Fair	Based on 1 cluster nonRCT, grade-school children who received a 4-year sun protection curriculum in school had no difference in mean BMI or self-reported time spent outdoors compared to children in control schools.
Increased sun exposure						
6 (n=4,482)	Trial	Three trials reported secondary outcomes of sun exposure but were not primarily designed to determine the effect of sunscreen use on sun exposure. Variation in measures of sun exposure.	Inconsistencies in trials based on populations studied.	None were conducted in US. Trials that found increases in intentional sun exposure with higher SPF sunscreen were conducted in young persons on sunbathing vacations.	Fair	Based on 2 good-quality RCTs, higher SPF sunscreen use, compared with low SPF sunscreen use, can increase intentional sun exposure, though not risk for sunburn, in young adults on sunbathing vacations. One similarly designed fair-quality RCT in a slightly older population did not find increased intentional sun exposure with higher SPF use. Based on 1 good-quality large RCT, there was no difference in self-reported time spent outdoors or objectively measured ambient UV exposure among adults who received SPF 15 sun-screen versus placebo cream.
Vitamin D deficiency						
1 (n=153) 1 (n=2016)	Trial Cohort	Only 1 trial examining sunscreen use and 1 trial examining sun exposure.	Only 1 trial per category.	Sunscreen trial conducted in Australia. Cohort study conducted in Denmark (high latitude country).	Fair to poor	Based on 1 trial, sunscreen use (SPF 17) does not lead to vitamin D deficiency, although it can decrease vitamin D levels in adults. Based on 1 cohort study, vitamin D levels are greatly influenced by sun exposure, and women living at high latitudes who avoid direct sun exposure are at increased risk for vitamin D deficiency during the winter and spring months.
Increased cancer risk						
1 (n=5009) 8 (n=21,028)	Cohort Case-control	Only 1 study examining prostate cancer risk, 1 study examining colon cancer risk. Sun exposure is a complex exposure to measure well.	Inconsistencies when examining association between sun exposure and risk for breast cancer and nonHodgkin lymphoma. Variation in sun exposure measurement makes direct comparisons across studies difficult.	Unable to determine level of reduction in sun exposure that might increase risk for other types of cancer. Unlikely that persons can change sun behaviors from highest to lowest percentile. Most studies included predominantly white populations.	Poor	Based on very limited evidence, it appears that sun exposure may be positively associated with risk for advanced breast and prostate cancer, after adjusting for well-established risk factors. Intermittent sun exposure may be inversely related to risk for nonHodgkin lymphoma. Two case-control studies conducted in Sweden found that persons who reported always or almost always using sunscreen were at increased risk for melanoma, after adjusting for both skin phenotype and sun exposure.

KQ=key question; RCT=randomized controlled trial; SCC=squamous cell carcinoma; BCC=basal cell carcinoma; BMI=body mass index; US=United States; SPF=sun protection factor; RR=relative risk; OR=odds ratio; CI=confidence interval; UV=ultraviolet

Appendix A Figure 1. Search Results and Article Flow



Appendix A Table 1. Search Strategies

Key Questions 1 to 3

Database: Ovid MEDLINE(R), Cochrane Central Controlled Trials Registry
Search Period: 1996 to December 2008>
Search Strategy:

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1 Skin Neoplasms/ (30148)
2 Melanoma/ (20680)
3 Hutchinson's Melanotic Freckle/ (234)
4 melanoma$.ti,ab. (27508)
5 lentigo maligna.ti,ab. (270)
6 Carcinoma, Basal Cell/ (3871)
7 Carcinoma, Squamous Cell/ (32609)
8 neoplasms, basal cell/ (223)
9 neoplasms, squamous cell/ (591)
10 skin cancer.ti,ab. (4103)
11 (carcinoma and (skin or cutaneous)).ti,ab. (6804)
12 Nevus/ (1187)
13 Nevus, Pigmented/ (1794)
14 (nevus or naevus or nevi or naevi).ti,ab. (4385)
15 Keratosis/ (1517)
16 keratos#s.ti,ab. (1866)
17 Sunburn/ (880)
18 Sunburn$.ti,ab. (839)
19 Sunscreening Agents/ (1645)
20 sunscreen$.ti,ab. (1386)
21 Sunlight/ (3594)
22 Ultraviolet Rays/ (18712)
23 sunlamp$.ti,ab. (67)
24 tanning.ti,ab. (609)
25 sunbed$.ti,ab. (97)
26 photoprotection.ti,ab. (592)
27 sun protecti$.ti,ab. (751)
28 sun awareness.ti,ab. (25)
29 sun safety.ti,ab. (57)
30 sun exposure.ti,ab. (1438)
31 or/1-30 (105418)
32 Health Promotion/ (21101)
33 Health Education/ (15625)
34 Patient Education as Topic/ (30487)
35 Preventive Health Services/ (3856)
36 Consumer Health Information/ (66)
37 Counseling/ (9180)
38 Directive Counseling/ (261)
39 Behavior Therapy/ (5865)
40 Health Behavior/ (13466)
41 Physician's Role/ (10481)
42 Teaching Materials/ (2315)
43 Parents/ed [Education] (2509)
44 counsel$.ti,ab. (24396)
45 advice.ti,ab. (12052)
46 advise.ti,ab. (2322)
47 behavio$ intervention$.ti,ab. (2012)
48 prevention intervention$.ti,ab. (1189)
49 or/32-48 (129549)
50 31 and 49 (1282)
51 limit 50 to (clinical trial or controlled clinical trial or meta analysis or randomized controlled trial) (123)
52 meta-analysis as topic/ (6066)
53 clinical trials as topic/ or controlled clinical trials as topic/ or randomized controlled trials as topic/ (98957)
54 (control$ adj3 trial$).ti,ab. (54622)
55 random$.ti,ab. (269819)

56 clinical trial$.ti,ab. (80740)
57 or/52-56 (391015)
58 50 and 57 (193)
59 51 or 58 (224)
60 limit 59 to english language (216)
61 limit 60 to yr="2001 - 2008" (146)

Protective Behaviors

Database: Ovid MEDLINE(R), Cochrane Central Controlled Trials Registry
Search Period: 1950 to December 2008
Search Strategy:

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1 sun exposure.ti,ab. (2123)
2 sun exposed.ti,ab. (1203)
3 Sunburn/ (1851)
4 sunburn$.ti,ab. (1457)
5 sunbath$.ti,ab. (270)
6 Sunlight/ (8313)
7 Ultraviolet Rays/ (51710)
8 Solar radiation.ti,ab. (1192)
9 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 (61284)
10 Melanoma/ (51583)
11 melanoma$.ti,ab. (56926)
12 skin neoplasms/ (73435)
13 skin cancer$.ti,ab. (8057)
14 10 or 11 or 12 or 13 (121192)
15 9 and 14 (6548)
16 limit 15 to yr="2001 - 2008" (2582)
17 sun exposure.ti,ab. (2123)
18 sun exposed.ti,ab. (1203)
19 Sunburn/ (1851)
20 sunburn$.ti,ab. (1457)
21 sunbath$.ti,ab. (270)
22 Sunlight/ (8313)
23 Ultraviolet Rays/ (51710)
24 Solar radiation.ti,ab. (1192)
25 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 (61284)
26 Neoplasms, Basal Cell/ (284)
27 Carcinoma, Basal Cell/ (11126)
28 basal cell carcinoma.ti,ab. (5179)
29 Neoplasms, Squamous Cell/ (644)
30 Carcinoma, Squamous Cell/ (79676)
31 squamous cell carcinoma.ti,ab. (33038)
32 nonmelanom$.ti,ab. (1148)
33 non melanom$.ti,ab. (901)
34 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 (96164)
35 25 and 34 (2035)
36 limit 35 to yr="1966 - 2008" (2021)
37 Neoplasms, Basal Cell/ (284)
38 Carcinoma, Basal Cell/ (11126)
39 basal cell carcinoma.ti,ab. (5179)
40 Neoplasms, Squamous Cell/ (644)
41 Carcinoma, Squamous Cell/ (79676)
42 squamous cell carcinoma.ti,ab. (33038)
43 Melanoma/ (51583)
44 melanoma$.ti,ab. (56926)
45 nonmelanom$.ti,ab. (1148)
46 non melanom$.ti,ab. (901)
47 Skin Neoplasms/ (73435)

Appendix A Table 1. Search Strategies

48 skin cancer.ti,ab. (6709)
49 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 (199909)
50 sunlamp$.ti,ab. (256)
51 sunbed$.ti,ab. (155)
52 tanning bed$.ti,ab. (63)
53 tanning booth$.ti,ab. (17)
54 tanning salon$.ti,ab. (57)
55 tanning device$.ti,ab. (32)
56 artificial light.ti,ab. (425)
57 artificial UV.ti,ab. (104)
58 indoor tanning.ti,ab. (67)
59 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 (1085)
60 49 and 59 (288)
61 limit 60 to yr="2005 - 2008" (64)
62 Sunscreening Agents/ (2763)
63 sunscreen$.ti,ab. (2199)
64 62 or 63 (3384)
65 Melanoma/ (51583)
66 melanoma$.ti,ab. (56926)
67 skin neoplasms/ (73435)
68 skin cancer$.ti,ab. (8057)
69 65 or 66 or 67 or 68 (121192)
70 64 and 69 (1216)
71 limit 70 to yr="2002 - 2008" (499)
72 Sunscreening Agents/ (2763)
73 sunscreen$.ti,ab. (2199)
74 72 or 73 (3384)
75 Neoplasms, Basal Cell/ (284)
76 Carcinoma, Basal Cell/ (11126)
77 basal cell carcinoma.ti,ab. (5179)
78 Neoplasms, Squamous Cell/ (644)
79 Carcinoma, Squamous Cell/ (79676)
80 squamous cell carcinoma.ti,ab. (33038)
81 nonmelanom$.ti,ab. (1148)
82 non melanom$.ti,ab. (901)
83 75 or 76 or 77 or 78 or 79 or 80 or 81 or 82 (96164)
84 75 and 83 (284)
85 limit 84 to yr="1966 - 2008" (282)
86 16 or 36 or 61 or 71 or 85 (4258)
87 (clinical trial or controlled clinical trial or meta analysis or randomized controlled trial).pt. (514646)
88 Meta-Analysis as Topic/ (8243)
89 clinical trials as topic/ or controlled clinical trials as topic/ or randomized controlled trials as topic/ (193771)
90 (control$ adj3 trial$).ti,ab. (75931)
91 random$.ti,ab. (408387)
92 clinical trial$.ti,ab. (118671)
93 observational.ti,ab. (29208)
94 (cohort adj (study or studies)).ti,ab. (35294)
95 cohort analys$.ti,ab. (1638)
96 cohort studies/ (84711)
97 retrospective$.ti,ab. (206916)
98 Retrospective Studies/ (297957)
99 longitudinal$.ti,ab. (86086)
100 Longitudinal Studies/ (51243)
101 (follow up adj (study or studies)).ti,ab. (27678)
102 Follow-Up Studies/ (367133)
103 prospective$.ti,ab. (259500)
104 Prospective Studies/ (243484)
105 database$.ti,ab. (82828)
106 nonrandomi$.ti,ab. (4953)
107 population$.ti,ab. (640534)
108 case control$.ti,ab. (42298)
109 case-control studies/ (97627)

Appendix A Table 1. Search Strategies

110 Cross-Sectional Studies/ (88036)
111 cross sectional.ti,ab. (77621)
112 systematic$ review$.ti,ab. (14698)
113 systematic$ overview$.ti,ab. (329)
114 quantitative$ review$.ti,ab. (331)
115 quantitative$ overview$.ti,ab. (61)
116 (meta analy$ or metaanaly$).ti,ab. (21215)
117 evidence based review$.ti,ab. (516)
118 morbidity/ or incidence/ or prevalence/ or mortality/ or "cause of death"/ or survival rate/ (353096)
119 (morbidity or incidence or prevalen$ or mortality or survival).ti,ab. (1122388)
120 (epidemiology or etiology or genetics or mortality or statistics numerical data).fs. (4167223)
121 (epidemiol$ or etiolog$ or aetiolog$).ti,ab. (322045)
122 Risk Factors/ (350233)
123 risk factor$.ti,ab. (189335)
124 Skin/re [Radiation Effects] (7487)
125 associated.ti,ab. (1365964)
126 association$.ti,ab. (442678)
127 or/87-126 (6674934)
128 86 and 127 (3591)
129 limit 128 to english language (3333)
130 limit 129 to humans (2908)
131 limit 129 to animals (736)
132 131 not 130 (409)
133 129 not 132 (2924)
134 from 133 keep 1-500 (500)

Harms

Database: Ovid MEDLINE(R), Cochrane Central Controlled Trials Registry
Search Period: 1950 to December 2008
Search Strategy:

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1 Sunscreening Agents/ (2766)
2 sunscreen$.ti,ab. (2207)
3 Protective Clothing/ (3781)
4 protective cloth$.ti,ab. (921)
5 (((hat or hats) and (wear$ or wore or brim$)) or (use$ adj3 hat) or (use$ adj3 hats)).ti,ab. (306)
6 TINOSORB FD.ti,ab. (1)
7 TINOSORB FR.ti,ab. (0)
8 ((UV absorb$ or photoprotect$ or UV protect$) and (laundry or detergent$)).ti,ab. (32)
9 sun protect$.ti,ab. (1228)
10 photoprotect$.ti,ab. (1347)
11 ((seek$ or sun or sunscreen$) and shade).ti,ab. (305)
12 ((avoid$ or minimiz$ or minimis$) and (sun exposure or midday sun)).ti,ab. (221)
13 (avoid$ and (sunlamp$ or sunbed$ or tanning bed$ or tanning booth$ or tanning salon$ or tanning device$ or indoor tanning or artificial light or artificial UV)).ti,ab. (34)
14 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 (9269)
15 adverse effects.fs. (1016592)
16 harm$.ti,ab. (48820)
17 adverse$.ti,ab. (170899)
18 (increas$ and ((time and sun) or sun exposure)).ti,ab. (1144)
19 ((reduce$ or reduction) and physical activit$).ti,ab. (5670)
20 sedentary behavio$.ti,ab. (414)
21 depression/ (49597)
22 Depressive Disorder/ (47333)
23 mood disorders/ (7539)
24 mood.ti,ab. (27405)
25 vitamin D deficiency/ (4637)
26 (vitamin D adj5 deficien$).ti,ab. (3478)
27 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 (1276195)

Appendix A Table 1. Search Strategies

28	14 and 27 (3105)
29	limit 28 to english language (2770)
30	limit 29 to humans (2542)
31	limit 29 to animals (326)
32	31 not 30 (139)
33	29 not 32 (2631)
34	limit 33 to yr="1966 - 2008" (2627)

Appendix A Table 2. Inclusion and Exclusion Criteria

Definitions of included diseases

Include: skin cancer including: cutaneous melanoma, squamous cell carcinoma of the skin, basal cell carcinoma of the skin

Exclude: acral lentiginous and subungual melanoma, mucosal melanoma, ocular melanoma, and pre-pubertal melanoma ("childhood melanoma")

Settings

Include:

Key questions 1 to 3: studies performed in primary care (including pediatric, OB/GYN, internal medicine, family practice, military, adolescent, and school-based health clinics) or otherwise generalizable to primary care; studies conducted in English speaking countries, or those otherwise generalizable to the United States

Key questions 4 and 5: any setting

Exclude:

Key questions 1 to 3: settings not generalizable to primary care (e.g., inpatient hospital units, emergency departments, pharmacies, school-based programs, recreational settings, occupational settings, and other community-based settings); trials conducted in developing countries, as defined by the United Nations Human Development Index

Key questions 4 and 5: no a priori exclusion criteria

Populations

Include:

Key questions 1 to 3: populations generalizable to primary care, any age population without current or personal history of malignant or pre-malignant skin lesions

- infants/children and their parent(s) or care giver(s)
- children/adolescents
- adults

Key questions 4 and 5: any population, as long as description of population host and environmental risk factors is provided

Exclude:

Key questions 1 to 3: persons with current or past history of malignant or pre-malignant skin lesions (e.g., Bowen's disease, actinic keratoses, atypical/dysplasitic nevi); persons with syndromes at risk for skin cancer and who therefore have lowered immunity (inherited or acquired immunodeficiency) including: xeroderma pigmentosum, albinism, trauma or burn victims, basal cell nevus syndrome (Gorlin's syndrome), exposure to arsenic, recessive dystrophic epidermolysis bullosa, psoralen or ultraviolet A treatment, familial atypical mole and melanoma syndrome, strong familial history of melanoma, or numerous melanocytic nevi (>100 nevi)

Key questions 4 and 5: persons with syndromes at risk for skin cancer (see above)

Interventions/Exposures

Include:

Key questions 1 to 3: primary care feasible or referable counseling interventions aimed at changing sun-protective behaviors (decreasing sun exposure, avoidance of sunlamps/tanning beds, or sunscreen use), based on any theoretical foundation (NOTE: primary care feasible or referable interventions that are part of a multicomponent intervention will be included but discussed separately)

- *Primary care feasible or conducted* counseling interventions, either conducted in a primary care research setting or judged to be feasible in "usual" primary care
  - Target: involve individual-level identification of being a patient or in need of intervention
  - Delivery: usually involve primary care physicians, other physicians, nurses, nurse practitioners, physician assistants, or related clinical staff (e.g., health educators,

Appendix A Table 2. Inclusion and Exclusion Criteria

other counselors); **or** the intervention is seen as connected to the health care system by the participant
- Format: to individuals or small groups (i.e., ≤15); does not primarily involve group-level interventions outside the primary care setting; generally does not involve more than eight group sessions and the intervention period is no longer than 12 months
- Location: anywhere, as long as linked to primary care

- *Primary care referable* such that intervention needs to be conducted as part of a health care setting, or is widely available in the community at a national level

Key questions 4 and 5: exposure due to sun, sunlamps/tanning beds, or sunscreen, with description of how exposure is measured

Exclude:

Key questions 1 to 3: noncounseling interventions; counseling interventions focused on secondary prevention (i.e., counseling for skin self-examinations); counseling interventions that are primarily community, nonreferral (e.g., occupational/worksite, recreational, or school-based); social marketing (e.g., media campaigns); policy (e.g., local or state public/health policy)

Key questions 4 and 5: no a priori exclusion criteria

Outcomes

Include:

Key questions 1 and 2: skin cancer incidence or associated morbidity/mortality, intermediate outcomes (sunburn, nevi, actinic keratosis) or behavioral outcomes at ≥3 months after counseling intervention (decreased sun exposure through avoidance of peak hours of sun exposure, wearing protective clothing, avoidance of sunlamps or tanning beds, and use of sunscreen)

Key question 4: skin cancer incidence or associated morbidity/mortality, intermediate outcomes (sunburn, nevi, actinic keratosis)

Key questions 3 and 5: any adverse effects (e.g., paradoxical increase in sun exposure, reduced physical activity, dysphoric mood, vitamin D deficiency, increased incidence of other types of cancer)

Exclude:

Key questions 1 and 2: any trial with >40 percent attrition or no behavioral outcome assessment beyond 3 months; attitude, knowledge, or ability changes

Key question 4: no a priori exclusion criteria

Key questions 3 and 5: opportunity cost of counseling

Study Design

Include:

Key questions 1 to 3: good-quality systematic reviews of trials and individual randomized or controlled clinical trials

Key questions 4 and 5: fair- to good-quality systematic reviews of observational studies, individual randomized or controlled clinical trials (only pertains to KQ4c), and individual observational (cohort, population-based case-control) studies not included in systematic reviews

Exclude: All poor-quality studies as dual reviewed and defined by USPSTF quality criteria

Key questions 1 to 3: any nonexperimental study design, modeling studies

Key questions 4 and 5: ecologic analyses, hospital-based case-control studies, cross-sectional studies, case-series, case reports

Appendix A Table 3. Quality Rating Criteria

Design	USPSTF Quality Rating Criteria[137]	NICE Methodology Checklists[138]	Newcastle-Ottawa Quality Assessment Scales[139]
Systematic reviews and meta-analyses	• Comprehensiveness of sources considered/search strategy used • Standard appraisal of included studies • Validity of conclusions • Recency and relevance are especially important for systematic reviews	• Study addresses an appropriate and clearly focused question • Description of the methodology used is included • Literature search is sufficiently rigorous to identify all relevant studies • Study quality is assessed and taken into account • There are enough similarities between the studies selected to make combining them reasonable	N/A
Case-control studies	• Accurate ascertainment of cases • Nonbiased selection of cases/controls with exclusion criteria applied equally to both • Response rate is reported • Diagnostic testing procedures applied equally to each group • Measurement of exposure accurate and applied equally to each group • Appropriate attention to potential confounding variables	• Sstudy addresses an appropriate and clearly focused question • Cases and controls are taken from comparable populations • Same exclusion criteria are used for both cases and controls • Percentage of each group (cases and controls) that participated in the study is reported • Comparison is made between participants and non-participants to establish similarities or differences • Cases are clearly defined and differentiated from controls • It is clearly established that controls are non-cases • Measures have been taken to prevent knowledge of primary exposure influencing case ascertainment • Exposure status is measured in a standard, valid, and reliable way • Main potential confounders are identified and taken into account in the design and analysis • Confidence intervals are provided	• Case definition is adequate • Cases are representative • Controls are from the same population as cases • If cases are first occurrence of outcome, then controls have no history of this outcome • Cases and controls are matched, and/or confounders are adjusted for in the analysis • Same method of exposure ascertainment for cases and controls • Acceptable ascertainment of exposure
Randomized controlled trials (RCTs)	• Initial assembly of comparable groups employs adequate randomization, including first concealment and whether potential confounders were distributed equally among groups • Maintenance of comparable groups (includes attrition, crossovers, adherence, contamination) • Important differential loss to follow-up or overall high loss to follow-up • Measurements are equal, reliable, and valid (includes masking of outcome assessment) • Clear definition of the interventions • All important outcomes considered	• Study addresses an appropriate and clearly focused question • Assignment of subjects to treatment groups is randomized • An adequate concealment method is used • Subjects and investigators are kept blind about treatment allocation • Treatment and control groups are similar at start of trial • Only difference between groups is the treatment under investigation • All relevant outcomes are measured in a standard, valid, and reliable way • Percentage of individuals or clusters recruited into each treatment arm that dropped out before study completion is reported • All subjects are analyzed in the groups to which they were randomly allocated (often referred to as intention-to-treat analysis) • When the study is carried out at more than one site, results are comparable for all sites	N/A

Appendix A Table 3. Quality Rating Criteria

Design	USPSTF Quality Rating Criteria[137]	NICE Methodology Checklists[138]	Newcastle-Ottawa Quality Assessment Scales[139]
Cohort studies	• Initial assembly of comparable groups employs consideration of potential confounders with either restriction or measurement for adjustment in the analysis; consideration of inception cohorts • Maintenance of comparable groups (includes attrition, crossovers, adherence, contamination) • Important differential loss to follow-up or overall high loss to follow-up • Measurements are equal, reliable, and valid (includes masking of outcome assessment) • Clear definition of the interventions • All important outcomes considered	• Study addresses an appropriate and clearly focused question • Groups being studied are selected from source populations that are comparable in all respects other than the factor under investigation • Study indicates how many of the people asked to take part did so, in each of the groups being studied • Likelihood that some eligible subjects might have the outcome at time of enrollment is assessed and taken into account in the analysis • Percentage of individuals or clusters recruited into each study arm that dropped out before study completion is reported • Comparison is made between full participants and those lost to follow-up, by exposure status • Outcomes are clearly defined • Assessment of outcome is made blind to exposure status • When blinding is not possible, there is some recognition that knowledge of exposure status could have influenced the assessment of outcome • Measure of assessment of exposure is reliable • Evidence from other sources is used to demonstrate that the method of outcome assessment is valid and reliable • Exposure level or prognostic factor is assessed more than once • Main potential confounders are identified and taken into account in the design and analysis • Confidence intervals are provided	• Exposed cohort is representative of exposed individuals in the community • The non-exposed cohort is drawn from the same community as the exposed cohort • Appropriate ascertainment of exposure • Demonstration that the outcome of interest was not present at the start of the study • Exposed and non-exposed cohorts are matched and/or confounders are adjusted for in the analysis • Adequate assessment of outcomes • Follow-up long enough for outcomes to occur • Follow-up adequate to ensure that losses are not due to exposure or outcomes
Diagnostic accuracy studies	• Screening test relevant, available for primary care, and adequately described • Study uses a credible reference standard, performed regardless of test results • Reference standard interpreted independently of screening test • Handles indeterminate results in a reasonable manner • Spectrum of patients included in study • Sample size reported • Administration of reliable screening test	• Nature of the test being studied is clearly specified • Test is compared with an appropriate gold standard • Where no gold standard exists, a validated reference standard is used as a comparator • Patients for testing are selected either as a consecutive series or randomly, from a clearly defined study population • Test and gold standard are measured independently (blind) of each other • Test and gold standard are applied as close together in time as possible • Results are reported for all patients that entered the study • A pre-diagnosis is made and reported	N/A

Hierarchy of research design

I: Properly conducted randomized controlled trial
II-1: Well-designed controlled trial without randomization
II-2: Well-designed cohort or case-control analytic study
II-3: Multiple time series with or without the intervention; dramatic results from uncontrolled experiments
III: Opinions of respected authorities, based on clinical experience; descriptive studies or case reports; reports of expert committees

Appendix B Table 1. Evidence Table for Effectiveness and Adverse Effects of Counseling for Sun Protective Behaviors

Study reference, USPSTF quality rating	Study design, Location, Population	Participant inclusion/ exclusion criteria	Baseline demographics	Intervention theory description
Adults				
Glazebrook 2006[46] **Fair**	**Study Design** Cluster RCT (by practice) **Location** 10 primary care practices (5 pairs: 1 rural, 1 urban, 3 suburban), in Nottinghamshire, UK **Population** Adults with "higher risk skin characteristics"	**Inclusion** "higher risk skin characteristics"- any one of the following risk factors: red hair, multiple moles, history of sunburn as a child, freckling, family history of melanoma, fair sun-sensitive skin); patients from 'control' family practices were invited to participate if they appeared to match the skin and demographic profile of participants in the intervention group **Exclusion** NR	**N participants, (10 sites randomized)** Total: 589 IG: 259 CG: 330 **Mean age (SD)** Total: NR IG: 38.2 (14.3) CG: 38.4 (15.2) **% Male** Total: 19.7 (c) IG: 17.4 CG: 21.5 **Race** % White: NR **SES** Highest educational level (% with further or higher education) Total: 52.5 (c) IG: 54.1 CG: 51.2 Occupation (% with professional or skilled) Total: 41.3 (c) IG: 39.8 CG: 42.4 **High risk** % with high risk characteristic, not specified Total: 100.0 % sought advice for suspicious lesion in past year Total: 12.8 (c) IG: 14.2 CG: 11.6	Skinsafe intervention based on the Health Belief Model, developed by multidisciplinary team of health psychologists, dermatologists, and a multimedia developer.

Study intervention	Follow-up	Intermediate outcomes	Behavioral outcomes: sun avoidance, sun protection	Behavioral outcomes: sunscreen use
Intervention IG: Prescription for "Skinsafe program": 8 sections designed to be completed in a single 10-15 minute sitting, using animation, photographs, and simple text to inform users about dangers of excessive sun exposure, how to protect skin from the sun, characteristics of skin at risk, early signs of melanoma, how to reduce risk for melanoma, how to check skin for suspicious lesions CG: Usual care, details not given **Format** IG: Self-directed computer workstation in quiet area CG: N/A **Intensity** IG: Approximately 10-15 minute single session CG: N/A **Delivery** IG: Computer CG: N/A	**% followup, @ 6mo** IG: 82.6, p=0.02 CG: 74.2	Sunburn is included in sun protective behavior score, NR separately	NR	Use of sunscreen is included in sun protective behavior score, NR separately

Appendix B Table 1. Evidence Table for Effectiveness and Adverse Effects of Counseling for Sun Protective Behaviors

Study reference, USPSTF quality rating	Behavioral outcomes: sunlamps and tanning bed avoidance	Composite behavioral outcomes	Other behavioral outcomes	Adverse outcomes	Other positive outcomes	Comments
Adults						
Glazebrook 2006[46] **Fair**	NR	**Sun protection behavior score (8-item, range 0-8 with higher scores indicating safer behavior)** @ 6mo **Mean score (SD), pre-, post- (complete case analysis), post- (missing values imputed)** IG: 4.60 (1.82); 5.70 (1.51); 5.36 (1.72) CG: 4.66 (1.55), 5.30 (1.57); 5.06 (1.59) **Mean difference between IG and CG [95%CI]** Complete case analysis: 0.33 [0.09, 0.57], p=0.007 Missing values at followup replaced by baseline values: 0.30 [0.10, 0.51], p=0.004	# of participants checking moles	Specific harms not mentioned, no paradoxical behavior change	Melanoma knowledge, perceived risk	No financial incentives

Study reference, USPSTF quality rating	Study design, Location, Population	Participant inclusion/ exclusion criteria	Baseline demographics	Intervention theory description
Adults				
Geller 2006[50] **Fair**	**Study Design** Cluster RCT by sibship **Location** Home-based by phone, but patient recruited through dermatologists at teaching hospitals (Boston University) Boston area, MA **Population** Adult siblings of melanoma patients	**Inclusion** At least 18 years old, being contacted by the 'case' relative **Exclusion** Current or previous diagnosis of melanoma	**N Randomized** Total: 494 IG: 237 CG: 257 **Age** % age 18-50 years Total: 58.3 (c) IG: 55.7 CG: 60.6**%** **Male** Total: 46.6 IG: 48.1 CG: 45.1 **Race** % White Total: 100% **SES** Highest educational level (% with at least some college) Total: 76.7 IG: 75.6 CG: 78.0 **Sun sensitivity** Skin type (% fair skin) Total: 84.8 IG: 81.3 CG: 88.0	Intervention based on Social Cognitive Theory, Theory of Planned Behavior, the Health Belief Model, the Precaution Adoption Model, and the Transtheoretical Model

Appendix B Table 1. Evidence Table for Effectiveness and Adverse Effects of Counseling for Sun Protective Behaviors

Study reference, USPSTF quality rating	Study intervention	Follow-up	Intermediate outcomes	Behavioral outcomes: sun avoidance, sun protection	Behavioral outcomes: sunscreen use
Adults					
Geller 2006[50] **Fair**	**Intervention** IG: Initial motivational and goal-setting phone intervention by health educator, computer generated tailored print materials with 3 phone counseling sessions by health educator timed to follow receipt of mailed materials, and linkages to free screening programs CG: Usual care (receipt of written nontailored study materials after completion of 12-month survey) **Format** IG: Individual phone counseling with computer support CG: N/A **Intensity** IG: Four 10-15 minute counseling sessions at 0, 1, 3, and 5 months CG: N/A **Delivery** IG: Health educator (by phone) and computer system CG: N/A	**% followup@ 6mo** Total: 81.6 IG: 81.9 CG: 81.3 **@ 12mo** Total: 63.6 IG: 62.9 CG: 64.2	NR	**% tanned by end of last summer** @ 6mo IG: 36.8 CG: 38.0 @ 12mo IG: 25.7 CG: 35.6 Odds ratio, adjusted [95% CI] 0.72 [0.47, 1.09]	**% routinely use sunscreen with SPF15+** @ 6mo IG: 66.7 CG: 64.4 @ 12mo G: 67.4 CG: 66.1 Odds ratio, adjusted [95% CI] 0.96 [0.67, 1.38]

Behavioral outcomes: sunlamps and tanning bed avoidance	Composite behavioral outcomes	Other behavioral outcomes	Adverse outcomes	Other positive outcomes	Comments
NR	NR	Skin self-exam and dermatologic skin exam	Specific harms not mentioned, no paradoxical behavior change	Melanoma knowledge, attitudes (confidence, intentions)	Unclear generalizability of siblings with melanoma to general PC population. Minimal financial incentives

Study reference, USPSTF quality rating	Study design, Location, Population	Participant inclusion/ exclusion criteria	Baseline demographics	Intervention theory description
Adults				
Prochaska 2005[51] **Fair**	**Study Design** RCT **Location** Home-based by phone, but patients recruited through large health insurance organization from 79 non-hospital based primary care practices (family medicine, internal medicine, obstetrics/gynecology) **Population** Adults	**Inclusion** Patients of participating primary care practices, persons at risk (defined as being in precontemplation, contemplation, or preparation stage of change) for at least one of the four health risk behaviors targeted for intervention in the study, women over 50 years could be eligible even if they were in action or maintenance stage for mammography screening because of risk of relapse **Exclusion** NR	**N Randomized** Total: 5407, subset of 3834 at risk for sun exposure IG: 2667, subset of 1822 CG: 2740, subset of 2012 **Mean age (SD)** Total: 44.7 (12.7) IG: 45.8 (13.2) CG: 44.2 (12.5) **% Male** Total: 30.1 IG: 30.1 CG: 30.1 **Race** % White Total: 96.7 IG: 96.4 CG: 97.3 **SES** Mean education, years (SD) Total: 14.5 (3.2) IG: 14.5 (3.2) CG: 14.5 (3.2) **Sun sensitvity** Total: NR **% in precontemplation stage of change for sun exposure**	Expert System Intervention, stage-based tailored communications targeting multiple health behavior changes based on the transtheoretical model

Appendix B Table 1. Evidence Table for Effectiveness and Adverse Effects of Counseling for Sun Protective Behaviors

			Total: 32.1 **% in contemplation stage of change for sun exposure** Total: 23.9 **% in preparation stage of change for sun exposure** Total: 44.0		
Study reference, USPSTF quality rating	**Study intervention**	**Followup**	**Intermediate outcomes**	**Behavioral outcomes: sun avoidance, sun protection**	**Behavioral outcomes: sunscreen use**
Adults					
Prochaska 2005[51] **Fair**	**Intervention** IG: Phone and written survey assessments with mailed printed tailored feedback using computerized support (3), intervention materials provided for each risk only when subject was identified as at-risk; for reducing sun exposure, focused on limiting sun exposure to 15 min or always using SPF 15 or higher sunscreen CG: Assessment only **Format** IG: Phone or written assessment followed by tailored feedback generated using expert system computer support CG: N/A **Intensity** IG: Assessments of unknown duration at 0, 6, 12 and 24 months, 6 and 12 month assessments were mailed (non-responders, ~70% were surveyed by phone), 3 to 5 page mailed feedback reports divided into 5 sections CG: Only had assessments at 0, 12 and 24 months **Delivery** IG: Assesors (by phone), and computer system CG: N/A	**% followup** **@12mo** IG: 75 CG: 82 **@ 24mo** IG: 71 CG: 78	NR	**Sun avoidance subscale of Sun Protection Behavior Scale** (subset of n=3834) Mean raw score (SD) @ baseline, 12, 24 mo IG: 12.7 (3.6), 13.5 (3.5), 13.7 (3.5) CG: 12.4 (3.7), 12.9 (3.6), 12.9 (3.6) p<0.005	**Sunscreen use subscale of Sun Protection Behavior Scale** (subset of n=3834) Mean raw score (SD) @ baseline, 12, 24 mo IG: 8.6 (3.9), 9.8 (3.8), 10.0 (3.9) CG: 8.5 (3.9), 8.9 (3.9), 9.2 (3.9) p<0.0001

Behavioral outcomes: sunlamps and tanning bed avoidance	**Composite behavioral outcomes**	**Other behavioral outcomes**	**Adverse outcomes**	**Other positive outcomes**	**Comments**
NR	NR	Movement to the action and maintenance stage of change	Specific harms not mentioned, no paradoxical behavior change	NR	Expert system NOT widely available. There appears to be a larger study context ongoing with practice level intervention

Study reference, USPSTF quality rating	**Study design, Location, Population**	**Participant inclusion/ exclusion criteria**	**Baseline demographics**	**Intervention theory description**
Adults				
Prochaska 2004[52] **Fair**	**Study Design** RCT **Location** Home-based by phone, but participants recruited through schools (parents of 9th graders) **Population** Parents of teenagers	**Inclusion** Parents (of 9th graders) at risk (defined as being in precontemplation, contemplation, or preparation stage of change) for at least one of the three health risk behaviors targeted for intervention in the study **Exclusion** NR	**N Randomized** Total: 2460, subset of 1802 at risk for sun exposure IG: 1209, subset of 863 CG: 1251, subset of 939 **Mean age (SD)** Total: 42.5 (5.5) IG: 42.7 (5.7) CG: 42.4 (5.4) **% Male** Total: 25 IG: 24 CG: 25 **Race** % White Total: 92 IG: 93	Expert System Intervention, stage-based tailored communications targeting multiple health behavior changes based on the transtheoretical model

Appendix B Table 1. Evidence Table for Effectiveness and Adverse Effects of Counseling for Sun Protective Behaviors

			CG: 91 **SES** Mean education, years (SD) Total: 14 (3.2) IG: 14 (3.1) CG: 14 (3.2) **Sun sensitvity** Total: NR **% in precontemplation stage of change for sun exposure** Total: 36 **% in contemplation stage of change for sun exposure** Total: 20 **% in preparation stage of change for sun exposure** Total: 44	

Study reference, USPSTF quality rating	Study intervention	Follow-up	Intermediate outcomes	Behavioral outcomes: sun avoidance, sun protection	Behavioral outcomes: sunscreen use
Adults					
Prochaska 2004[52] **Fair**	**Intervention** IG: Phone and written survey assessments with subsequent mailed printed tailored feedback using computerized support (3), intervention materials were provided for each risk only when the subject was identified as at-risk; for reducing sun exposure, focused on limiting sun exposure to 15 minutes or always using SPF 15 or higher sunscreen CG: Assessment only **Format** IG: Phone or written assessment followed by tailored feedback generated using expert system computer support CG: N/A **Intensity** IG: Assessments of unknown duration at 0, 6, 12 and 24 months, 6 and 12 month assessments were mailed (non-responders were surveyed by phone), 3 to 5 page mailed feedback reports divided into 5 sections CG: Only had assessments at 0, 12 and 24 months **Delivery** IG: Assesors (by phone), and computer system CG: N/A **Other components (multimodal)** See computerized support as described above	**% followup** **@ 12mo** IG: 71 CG: 78 **@ 24mo** IG: 67 CG: 74	NR	**Sun avoidance subscale of Sun Protection Behavior Scale** (subset of n=1784) Mean raw score (SD) @ baseline, 12, 24 mo IG: 12.65 (3.86), 13.71 (3.52), 13.99 (3.39) CG: 12.60 (3.90), 13.22 (3.64), 13.35 (3.73) p for interaction term, p>0.05	**Sunscreen use subscale of Sun Protection Behavior Scale** (subset of n=1781) Mean raw score (SD) @ baseline, 12, 24 mo IG: 8.32 (4.00), 9.96 (3.87), 10.21 (3.94) CG: 8.16 (3.99), 9.29 (3.98), 9.18 (3.82) p for interaction term, p<0.05

Behavioral outcomes: sunlamps and tanning bed avoidance	Composite behavioral outcomes	Other behavioral outcomes	Adverse outcomes	Other positive outcomes	Comments
NR	NR	Movement to the action and maintenance stage of change	Specific harms not mentioned, no paradoxical behavior change	NR	Expert system NOT widely available. These are parents of adolescents involved in another study by Prochaska.

Appendix B Table 1. Evidence Table for Effectiveness and Adverse Effects of Counseling for Sun Protective Behaviors

Study reference, USPSTF quality rating	Study design, Location, Population	Participant inclusion/ exclusion criteria	Baseline demographics	Intervention theory description
Young adults				
Hillhouse 2008[49] **Fair**	**Study Design** RCT **Location** Two universities, US **Population** Female students (young adults) who reported indoor tanning	**Inclusion** Female university students who tanned indoors last year or reported an indoor tanning score of 5+ (7-point scale that measured intentions to tan in the next year) on an email screening survey **Exclusion** NR	**N randomized (analyzed)** Total: 430 (412) IG: 200 (195) CG: 230 (217) **Mean age (SD)** Total: NR IG: 18.6 (0.74) CG: 18.7 (0.82) **% Male** Total: 0 **Race** % White: NR **SES** Family SES (% below average) Total: NR IG: 11.9 (c) CG: 11.1 (c) **Sun sensitivity** % Fitzpatrick skin type I or II Total: NR IG: 34.6 (c) CG: 27.6 (c)	Appearance-focused interventions based on decision-theoretical models of health behaviors and the Jaccard behavioral alternative model to reduce indoor tanning behavior.

Study intervention	Follow-up	Intermediate outcomes	Behavioral outcomes: sun avoidance, sun protection	Behavioral outcomes: sunscreen use
Intervention IG: Professionally produced booklet with 5 sections: history of tanning and context for tanning norms, analysis of tanning norms and media/peer image norms, effects of UV radiation on skin, effects of indoor tanning, and indoor tanning guidelines emphasizing tanning abstinence as well as harm reduction CG: Assessment only, details NR **Format** IG: Self-directed booklet CG: N/A **Intensity** IG: N/A CG: N/A **Delivery** IG: Self-administered CG: N/A	**% followup, @ 6mo** IG: 97.5 CG: 94.3	NR	NR	NR

Behavioral outcomes: sunlamps and tanning bed avoidance	Composite behavioral outcomes	Other behavioral outcomes	Adverse Outcomes	Other positive outcomes	Comments
Means (SE) of indoor tanning in past 3 months , pre-, post- @ 6mo IG: 4.67 (0.60); 6.80 (0.93) CG: 4.48 (0.55), 10.90 (0.93) P<0.001	NR	NR	Specific harms not mentioned, no paradoxical behavior change	Intention to use indoor tanning, attitudes toward tanning alternatives, and beliefs about tanning and image norms	$20 incentive for completed assessments

Appendix B Table 1. Evidence Table for Effectiveness and Adverse Effects of Counseling for Sun Protective Behaviors

Study reference, USPSTF quality rating	Study design, Location, Population	Participant inclusion/ exclusion criteria	Baseline demographics	Intervention theory description
Young adults				
Mahler 2007[53] **Fair**	**Study Design** RCT **Location** University, US **Population** Undergraduate students	**Inclusion** At least 18 years old, participants signed up through the Psychology Department participant pool **Exclusion** Graduating seniors	**N Randomized** Total: 133 IG (UV photo plus video): 30 IG (UV photo only): 35 IG (video only): 34 CG (no photo or video): 34 **Mean Age (SD)** Total: 20.13 (3.38) Range (18-44 yrs) **% Male:** 19.5 **Race** % White Total: 45% **Family history of skin cancer** Total: 27.1% **Sun sensitivity** NR	Appearance-focused intervention, theory not specified

Study intervention	Follow-up	Intermediate outcomes	Behavioral outcomes: sun avoidance, sun protection	Behavioral outcomes: sunscreen use
Intervention <u>IG (video)</u>: 11-min videotape slide show depicting photo-aging, how UV exposure leads to photoaging, and effective practices for minimizing photoaging (protective clothing, minimum SPF 15 sunscreen) <u>IG (UV photo)</u>: UV facial photographs using instant camera modified to include a 315- to 390-mmUV filter and natural-light instant photo **Format** IG: Individual or in pairs (with partition) CG: Assessment only **Intensity** IG (video): One session, 11-min videotape slide show IG (UV photo): One session, details NR CG: Details NR **Delivery** IG/CG: Details NR	**% followup** **@ ~5 mo** 85% **@ 12mo** 80% for self-reported behaviors but only 70% for spectro-photometry readings **63% had both follow-ups** Follow-up by group(s) NR	NR	**Results presented for photoaging video groups (n=38) vs. no video groups (n=46) and UV photo (n=42) vs. no photo (n=42) at 12 months** **<u>Skin color using skin reflectance spectrophotometry</u>** *(b* higher is more tan; L* higher is lighter, , exact numbers NR)* **Video No video p-value** Higher exposure site, b* scale 0.82 (0.28) 0.90 (0.25) NS Lower exposure site, b* scale 0.32 (0.28) 0.39 (0.25) NS Higher exposure site, L* scale ~ 1.6 (NR) ~ -0.6 (NR) sig Lower exposure site, L* scale ~ 2.3 (NR) ~ 0.9 (NR) sig **Photo No photo p-value** Higher exposure site, b* scale 1.03 (0.26) 0.69 (0.26) NS Lower exposure site, b* scale 0.51 (0.26) 0.21 (0.26) NS Higher exposure site, L* scale ~ 0.9 (NR) ~ 0.2 (NR) NS Lower exposure site, L* scale ~ 2.1 (NR) ~ 1.1 (NR) NS **<u>Sun exposure z-scores adjusted for baseline (SE)</u>** **Video No video p-value** Intentional exposure -0.12 (0.16) 0.10 (0.14) NS Incidental exposure -0.23 (0.16) 0.28 (0.15) sig **Photo No photo p-value** Intentional exposure 0.21 (0.15) -0.24 (0.15) NS Incidental exposure 0.15 (0.15) -0.11 (0.15) NS	NR

Appendix B Table 1. Evidence Table for Effectiveness and Adverse Effects of Counseling for Sun Protective Behaviors

Study reference, USPSTF quality rating	Behavioral outcomes: sunlamps and tanning bed avoidance	Composite behavioral outcomes	Other behavioral outcomes	Adverse outcomes	Other positive outcomes	Comments
Young adults						
Mahler 2007[53] **Fair**	NR	**Sun protection behavior score z-scores adjusted for baseline (SE)** **Video no video p-value** Index -0.02 (0.10) -0.07 (0.09) NS **Photo no photo p-value** Index -0.05 (0.09) 0.03 (0.09) NS	Cognitive mediators	Specific harms not mentioned, no paradoxical behavior change	NR	Participants received course credit. Analyses not presented with true control, authors state "none of the primary analyses indicated any significant interactions between the two interventions." Use of Cohen d statistic to help interpret effect size.

Study reference, USPSTF quality rating	Study design, Location, Population	Participant inclusion/ exclusion criteria	Baseline demographics	Intervention theory description
Adolescents				
Norman 2007[54] **Fair**	**Study Design** RCT **Location** 6 primary care clinics and patient homes, San Diego, CA **Population** Adolescents aged 11-15	**Inclusion** Age 11-15 years attending primary care, parental consent **Exclusion** Health conditions that would limit participation with physical activity or diet recommendations	**N Randomized** Total: 819 IG: 395 CG: 424 **Mean Age (SD)** Total: 12.7 (1.3) IG: 12.7 (1.4) CG: 12.7 (1.3) **% Male** Total: 46.5 IG: 45.3 CG: 47.6 **Race** % White Total: 58.4 IG: 62.3 CG: 54.7 **SES** Highest household educational level (% with graduate/profess-ional degree) Total: 36.7 IG: 40.0 CG: 33.7 **Sun sensitvity (% with high sensitivity)** Total: 25.2 IG: 26.8 CG: 23.6	Sun Smart expert system based on the Social Cognitive Theory and the Transtheoretical Model and included assessment and feedback of the stage of change, decisional balance, self-efficacy, and the processes of change

Study intervention	Follow-up	Intermediate outcomes	Behavioral outcomes: sun avoidance, sun protection	Behavioral outcomes: sunscreen use
Intervention IG: Brief counseling by primary care providers, interactive computer sessions, phone assessments, printed tailored feedback, a brief printed manual, mailed tip sheets, and samples of SPF 15 sunscreen CG: Physical activity and diet intervention (physical activity, sedentary behavior, total intake of fat, and servings per day of fruits and vegetables) with computerized expert system kiosk in primary care provider's office, monthly phone calls,	**% follow-up** **@ 6mo** IG: 93.9 CG: 86.1 **@ 12mo** IG: 75.2 CG: 83.3 **@ 24mo** IG: 79.7	NR	**Sun Protection Behavior Scale @ 6, 12, and 24 mo** adjusted sample means: IG with statistically significant increase in sun protection scores compared with CG, with trajectory of scores flattening (but still statistically significant) between 12 and 24 months **Sun protection behaviors @ 24 mo**	**Sun protection behaviors @ 24 mo** % response "often" or "always" Use sunscreen? IG: ~55, NS CG: ~48 Use sunscreen on face? IG: ~62, CI do not overlap

Appendix B Table 1. Evidence Table for Effectiveness and Adverse Effects of Counseling for Sun Protective Behaviors

	a printed manual, and mail contact **Format** IG: Individual counseling coupled with expert system computer support CG: Expert system computer support **Intensity** IG: 2 to 3 minute counseling session, initial 20 minute Sun Smart assessment with 2 page feedback report, and subsequent 3-, 6-, 15-, and 18-month phone followup CG: No counseling session, otherwise matched intensity **Delivery** IG: Primary care provider (in person), health counselors (by phone), and computer system CG: Health counselors (by phone), and computer system	CG: 80.4		% response "often" or "always" Wear a shirt? IG: ~84, NS CG: ~85 Stay in shade? IG: ~44, NS CG: ~45 Avoid sun exposure midday? IG: ~40, CI do not overlap CG: ~30 Limit sun exposure midday? IG: ~38, CI do not overlap CG: ~31	CG: ~48 Use sunscreen on all sun exposed areas? IG: ~56, CI do not overlap CG: ~40

Study reference, USPSTF quality rating	Behavioral outcomes: sunlamps and tanning bed avoidance	Composite behavioral outcomes	Other behavioral outcomes	Adverse outcomes	Other positive outcomes	Comments
Adolescents						
Norman 2007[54] **Fair**	NR	NR	Movement to the action and maintenance stage of change	Specific harms not mentioned, no paradoxical behavior change	NR	Expert system NOT widely available. Financial incentive for completed assessments.

Study reference, USPSTF quality rating	Study design, Location, Population	Participant inclusion/ exclusion criteria	Baseline demographics	Intervention theory description
Adolescents				
Patrick 2006[55] **Rosenberg 2007[56]**	For the purposes of analyzing harms this study is a prospective cohort (one arm of a RCT)	see Norman 2007	see Norman 2007	see Norman 2007

Study intervention	Follow-up	Intermediate outcomes	Behavioral outcomes: sun avoidance, sun protection	Behavioral outcomes: sunscreen use
see Norman 2007	see Norman 2007	see Norman 2007	see Norman 2007	see Norman 2007

Behavioral outcomes: sunlamps and tanning bed avoidance	Composite behavioral outcomes	Other behavioral outcomes	Adverse outcomes	Other positive outcomes	Comments
see Norman 2007	see Norman 2007	see Norman 2007	**12 mo followup** **Sedentary behaviors, mean hours/day (SD)** *girls, pre, post, % change* IG (skin cancer): 4.2 (3.4), 4.4 (3.7), 4.8% CG (physical activity): 4.3 (3.4), 3.4 (2.6), -21% *boys, pre, post, % change* IG (skin cancer): 4.2 (2.8), 4.3 (3.5), 2.4% CG (physical activity): 4.2 (3.7), 3.2 (2.6), -24% **7 Day Physical Activity Recall (moderate and vigorous activity), mean minutes/week (SD)** *girls, pre, post, % change* IG (skin cancer): 284.3 (45.8), 313.9 (62.2), 10.4% CG (physical activity): 316.1 (49.2), 324.6 (61.5), 2.7% *boys, pre, post, % change* IG (skin cancer): 374.0 (55.0), 419.8 (79.2), 12.2% CG (physical activity): 418.4 (54.5), 486.0 (75.3), 16.2% **Active, mean days/week (SD)** *girls, pre, post, % change* IG (skin cancer): 3.1 (2.0), 3.3 (2.1), 0.06% CG (physical activity): 3.3 (2.1), 3.4 (2.1), 0.03% *boys, pre, post, % change* IG (skin cancer): 3.8 (2.1), 3.8 (2.1), 0% CG (physical activity): 4.1 (2.0), 4.4 (2.1), 7.3%	see Norman 2007	Article is same study reported in Norman 2007, but using skin cancer counseling intervention as the control. It is included because it reports on physical activity related outcomes, which were considered as potential harms. Reports outcomes by sex. Rosenberg 2007 reports on the covariation among changes in diet-ary, physical activity, and sedentary behaviors and showed that there was little covariation within or between diet, physical activity, and sedentary behavior domains.

Appendix B Table 1. Evidence Table for Effectiveness and Adverse Effects of Counseling for Sun Protective Behaviors

Study reference, USPSTF quality rating	Study design, Location, Population	Participant inclusion/ exclusion criteria	Baseline demographics	Intervention theory description
Children and parents				
Crane 2006[45] **Fair**	**Study Design** Cluster RCT (by office) **Location** 14 primary care offices of a large managed care organization, Denver/Boulder, CO **Population** Parents and their infants	**Inclusion** Parents of children born April to September 1998, parents whose children had dark skin, eye, and hair color were informed that the program may be of minimal benefit to their child **Exclusion** NR	**N, parents and their infants** Total: 728 (c) IG: 363 CG: 365 **Age, of parents (c)** % age 20-29 years Total: 29.7 IG: 28.4 CG: 31.0 % age 30-39 years Total: 58.9 IG: 59.2 CG: 58.6 **% Male, of infants, (<2% male of parents)** Total: 50.3 (c) IG: 52.1 CG: 48.5 **Race, of infants (180 missing), of parents** % White Total: 81.9, 76.1 (c) IG: 79.8, 76.0 CG: 84.1, 76.2 **SES** Parent's highest educational level (% with graduate/professional degree) (c) Total: 42.4 IG: 43.8 CG: 41.1 **Sun sensitivity** % with fair to medium white skin, of infants, of parents (c) Total: 78.3, 75.5 IG: 76.9, 77.1 CG: 79.7, 74.0 % with painful burn, no to light tan a week later, of parents (c) Total: 39.8 IG: 40.2 CG: 39.5	Sun protection promotion (Kaiser Kids Sun Care Program) based on informational, expert, and legitimate power of health care providers and the Health Belief Model, designed to be delivered at well-child visits between 2 and 36 months

Study intervention	Follow-up	Intermediate outcomes	Behavioral outcomes: sun avoidance, sun protection	Behavioral outcomes: sunscreen use
Intervention IG: Assessment and counseling by primary care providers using anticipatory guidance messages (provider orientations, boosters at luncheon meetings) + packets of information for parents including tote bag, sun hat, Skin Cancer Foundation brochures, magnet, age specific tip sheets, sunscreen samples (SPF 30), and UV protective sunglasses CG: usual care, anticipatory guidance at 6 month visit included prompt to discuss sunscreen use, offices were not given provider orientations and boosters **Format** IG: Counseling, packets of information, and samples for	**% followup @ 12mo** Total: 86.0 **@ 24mo** Total: 81.7 **@ 36mo** Total: 75.3 **Completed all 3 follow-ups** Total: 64.4 **Skin exam @ 36mo** Total: 38.5	Tanning (mean difference in b color space between exposed and non-exposed skin) IG: 4.2, p=0.14 CG: 4.6 % with freckling IG: 12.8, p=0.20 CG: 17.1 # of nevi IG: 6.30, p=0.56 CG: 5.64	**% response "frequently" or "always" @ 12, 24 and 36 mo** clothing use? IG: 51.0, 38.4, 24.2, p=0.22 CG: 43.8, 32.4, 25.5 Midday sun avoidance? IG: 70.6, 63.2, 64.2, p=0.14 CG: 64.9, 62.0, 59.0 Limit time in sun? IG: 48.9, 38.1, 32.1, p=0.97 CG: 47.5, 35.4, 34.3 Shade use? IG: 90.0, 79.2, 72.6, p=0.03	**% response "frequently" or "always" @ 12, 24 and 36 mo** sunscreen use? IG: 90.0, 92.4, 94.2, p=0.46 CG: 87.9, 92.2, 93.1

Appendix B Table 1. Evidence Table for Effectiveness and Adverse Effects of Counseling for Sun Protective Behaviors

	parents CG: Usual care **Intensity** IG: 4 well-child visits (@2, 6, 18, 36 mo) with counseling at discretion of provider, packets of information and samples CG: Usual care at well-child visits **Delivery** IG: Primary care provider (pediatrician or family physician) CG: Primary care provider (pediatrician or family physician)			CG: 87.3, 71.9, 65.2 Hat use? IG: 61.9, 61.9, 57.3, p=0.08 CG: 60.8, 56.1, 47.4 Sunglasses use? IG: 5.2, 24.2, 39.4, p=0.22 CG: 8.3, 22.3, 29.9	

Study reference, USPSTF quality rating	Behavioral outcomes: sunlamps and tanning bed avoidance	Composite behavioral outcomes	Other behavioral outcomes	Adverse outcomes	Other positive outcomes	Comments
Children and parents						
Crane 2006[45] **Fair**	NR	**Sun protection practice score** @ 12mo IG: 18.55, NS CG: 18.40 @ 24mo IG: 18.52, p=0.04 CG: 18.05 @ 36mo IG: 18.18, p=0.05 CG: 17.71 p=0.04 for overall trend	Provider delivery of sun protection advice	Specific harms not mentioned, no paradoxical behavior change	NR	No financial incentives

Study reference, USPSTF quality rating	Study design, Location, Population	Participant inclusion/ exclusion criteria	Baseline demographics		Intervention theory description
Multicomponent interventions					
Olson 2007[48]	**Study Design** Cluster RCT (by school) **Location** 10 geographically-distinct towns in New Hampshire and Vermont **Population** Children entering grades 6 to 8 at beaches or swimming pools	**Inclusion** **Towns:** separated by at least 20 miles, had not participated in earlier SunSafe project, middle school with grades 6-8 within 1 building, at least 1 primary care practice, freshwater beach or town swimming pool used primarily by local residents **Evaluation subjects:** children entering grades 6-8 who were at community beaches and swimming pools or attending a school-sponsored function with water activities between 11 am and 3 pm from June to August 2000 **Exclusion** NR	**Baseline** **N, adolescents** Total: 797 (c) IG: 357 (c) CG: 440 (c) **Age** % in 6th, 7th, and 8th grade Total: 98, 1, 1 IG: 97, 2, 1 CG: 98, 1, 1 **% Male** Total: 43 (c) IG: 44 CG: 42 **Race** % White: 94% of all middle school students **SES** NR **Sun sensitivity** % usually or always burn Total: 28 (c) IG: 28 (c) CG: 28 (c)	**Follow up: 1 yr, 2 yr** **N, adolescents** Total: 637, 493 (c) IG: 404, 352 (c) CG: 233, 141 (c) **Age** % in 6th, 7th, and 8th grade Total: 1 yr: 0, 90, 10 (c) 2 yr: 0, 0, 100 (c) IG: 1 yr: 0, 89, 11 2 yr: 0, 0, 100 CG: 1 yr: 0, 93, 7 2 yr: 0, 0, 100 **% Male** Total: 46, 45 (c) IG: 48, 44 CG: 43, 50 **Race** % White: 94% of all middle school students **SES** NR **Sun sensitivity** % usually or always burn Total: 33, 27 (c) IG: 32, 25 (c) CG: 36, 31 (c)	SunSafe multicomponent intervention aimed to (1) educate and activate adults and peers to role model and actively promote sun-protection practices and (2) create a pro-sun protection community environment Targeted school personnel, athletic coaches, lifeguards, and clinicians through schools, athletic and recreational facilities, primary care practices, and other community venues Program materials and training for adult role models emphasized protecting themselves and being an effective role model and educator for teens; teen materials emphasized being protected while having outdoor fun; community environmental cues used to increase awareness of sun protection Socioecologic approach of intervention based on social cognitive theory and education sessions for students and adult role models based on protection motivation theory

Appendix B Table 1. Evidence Table for Effectiveness and Adverse Effects of Counseling for Sun Protective Behaviors

Study reference, USPSTF quality rating	Study intervention	Follow-up	Intermediate outcomes	Behavioral outcomes: sun avoidance, sun protection	Behavioral outcomes: sunscreen use
Multicomponent interventions					
Olson 2007[48]	**Intervention** IG: Primary care practices: clinician training focused on incorporating sun-protection messages into well visits, patient-education materials, posters, temporary tattoos; Schools: curricular activies including EPA's SunWise curricular materials, interactive slide show about UV radiation, skin cancer, and sun-protection strategies, Dermascan viewing, peer-education activities led by 8th- to 12th-grade students; Athletic and recreational facilities: sun protection promotion including pool announce-ments, sun-protection breaks, team hat/sunscreen policy; Community venues: SunSafe bookmarks at libraries, sun protection posters in local stores CG: no intervention **Format** IG: Individual counseling during well visits (primary care practices), classroom curriculum and group activities (schools), announcements and team policies (athletic and recreational facilities), posted information (community venues) CG: N/A **Intensity** IG: NR (primary care practices), curriculum intensity NR, 45-minute group activity, at lease 3 activities led by "sun team" (schools), NR (athletic and recreational facilities), N/A (community venues) CG: N/A **Delivery** IG: Primary care provider (in person), teachers, 8th- to 12-grade students, athletic coaches and lifeguards CG: N/A	N/A: different sample of children at follow- up	NR	**Body surface area covered (by direct observation and interview)** Adjusted mean percentage (SE) @ baseline and 2 yr follow up IG: 71.8 (1.6), 66.1 (1.5) CG: 73.7 (1.4), 56.8 (2.3) p<0.01 for difference in means at 24 mos Means adjusted for gender, skin reaction to sun, UV level, year of observation, and temperature	**Any sunscreen use** % @ baseline, 1 yr follow-up, 2 yr follow up IG: 58.0, 47.0, 47.0 CG: 65.8, 59.6, 13.8 p value: <0.05, <0.01, <0.001

Behavioral outcomes: sunlamps and tanning bed avoidance	Composite behavioral outcomes	Other behavioral outcomes	Adverse outcomes	Other positive outcomes	Comments
NR	NR	Predictors of sun protection, number of different sources of advice about sun protection reported by adolescents	Specific harms not mentioned, no paradoxical behavior change	NR	All subjects considered baseline in first year, as were subjects entering 6th grade in subsequent years. Subjects entering 7th or 8th grade in the second year were classified as 1 yr follow up, as were subjects entering 7th grade in the third year. Subjects entering 8th grade in the third year were classified as 2 yr follow up.

Appendix B Table 1. Evidence Table for Effectiveness and Adverse Effects of Counseling for Sun Protective Behaviors

Study reference, USPSTF quality rating	Study design, Location, Population	Participant inclusion/ exclusion criteria	Baseline demographics Baseline	Baseline demographics Follow-up	Intervention theory description
Multicomponent interventions					
Dietrich 1998[47] **Dietrich 2000**[125] **Grant-Petersson 1999**[126] **Fair**	**Study Design** Cluster RCT (by community) **Location** 10 geographically-distinct, lower-income towns in New Hampshire **Population** Children visiting town freshwater beaches and their caregivers	**Inclusion** **Towns:** New Hampshire towns with populations of 4,000-15,000 that included at least 500 children ages 2-9 years; at least 20% of households with 1990 incomes below the federal poverty level; at least 1 elementary school, at least 1 nearby primary care practice serving children, and at least 1 nearby Head Start program; and a freshwater beach used primarily by local residents **Evaluation Subjects:** Children ages 2-9 years visiting town freshwater beaches between 10 am and 3 pm from last week in June to late August 1995 (upper age limit increased to 11 years for follow-up); children living in town or within 8 miles of its border **Caregivers:** Adults at beach caring for children meeting eligibility criteria **Exclusion** **Towns:** Towns that shared any school or recreational areas with towns already selected **Evaluation Subjects:** Children in water above their knees	**N, children** Total: 865 (c) IG: 456 CG: 409 **Age** % age <5 years Total: 38 (c) IG: 39 CG: 36 % age ≥5 years Total: 62 (c) IG: 61 CG: 64 **% Male** Total: 52 (c) IG: 55 CG: 49 **Race** % White:NR (implied 99%) **SES** at least 20% of households with 1990 incomes below federal poverty level **Sun sensitivity** % burn easily (caregiver report) Total: 54 (c) IG: 54 CG: 54	**N, children** Total: 1,065 (c) IG: 561 CG: 504 **Age** % age <5 years Total: 28 (c) IG: 26 CG: 31 % age ≥5 years Total: 72 (c) IG: 74 CG: 69 **% Male** Total: 48 (c) IG: 47 CG: 50 **Race** % White: NR (implied 99%) **SES** at least 20% of households with 1990 incomes below federal poverty level **Sun sensitivity** % burn easily (caregiver report) Total: 48 (c) IG: 47 CG: 49	SunSafe multicomponent intervention directed at children, their families, and other caregivers through schools, day care centers, primary care practices, and beach areas Modeled after "Slip, Slop, Slap" and SunSmart programs: all intervention components promoted the same message: avoid sun 11 am to 3 pm, cover up using hats and protective clothing, use sun block with SPF ≥15, and encourage sun protection among family and friends

Study intervention	Follow-up	Intermediate outcomes	Behavioral outcomes: sun avoidance, sun protection	Behavioral outcomes: sunscreen use
Intervention IG: Primary care practices: sun protection manual for providers, educational materials to enhance counseling, SunSafe tattoos and stickers to offer at well-child and illness visits during summer; Schools and day care centers: age- and grade-specific sun protection curriculum and 1 parent outreach program; Beach areas: poster display (daily UV index and sun protection), educational pamphlets, free sunscreen CG: No intervention **Format** IG: Individual counseling during well-child and illness visits (primary care practices), classroom curriculum (schools and day care centers), posted information and sunscreen (beach areas) CG: N/A **Intensity** IG: NR (primary care practices), min 2 class periods (schools and day care centers), N/A (beach areas) CG: N/A **Delivery** IG: Primary care provider (in person), teachers (in classroom), lifeguards (beach areas) CG: N/A	N/A: different sample of children at follow-up	NR	**Any protective clothing (by direct observation)** Mean proportions @ baseline, 12 mo IG: 0.30, 0.24 CG: 0.26, 0.18 Difference of change (IG-CG): 0.02, p=0.78 **Protection by shade (by direct observation)** Mean proportions @ baseline, 12 mo IG: 0.14, 0.14 CG: 0.18, 0.24 Difference of change (IG-CG): -0.06, p=0.38 All values corrected by age, sex, ease with which child burns, and weather conditions at time of interviews	**Sunscreen used on ≥1 body area** Mean proportions @ baseline, 12 mo IG: 0.57, 0.75 CG: 0.65, 0.66 Difference of change (IG-CG): 0.17, p=0.011 All values corrected by age, sex, ease with which child burns, and weather conditions at time of interviews

Appendix B Table 1. Evidence Table for Effectiveness and Adverse Effects of Counseling for Sun Protective Behaviors

Study reference, USPSTF quality rating	Behavioral outcomes: sunlamps and tanning bed avoidance	Composite behavioral outcomes	Other behavioral outcomes	Adverse outcomes	Other positive outcomes	Comments
Multicomponent interventions						
Dietrich 1998[47] **Dietrich 2000**[125] **Grant-Petersson 1999**[126] **Fair**	NR	**Protection on ≥1 body area by sunscreen, clothes, and/or shade** Mean proportions @ baseline, 12 mo IG: 0.78, 0.87 CG: 0.85, 0.80 Difference of change (IG-CG): 0.13, p=0.029 **Protection on all 3 body areas by any means** Mean proportions @ baseline, 12 mo IG: 0.53, 0.74 CG: 0.66, 0.72 Difference of change (IG-CG): 0.15, p=0.18 All values corrected by age, sex, ease with which child burns, and weather conditions at time of interviews	Effect of intervention on subsets of children protected by sunscreen on one or more body areas (age, sex, ease with which child burns)	Specific harms not mentioned, no paradoxical behavior change	NR	Unable to comment on intervention effect of primary care component, this is truly a community based intervention Unclear validity of results at 2y, reported in followup articles Dietrich 2000

Abbreviations: CG=control group; (c)=calculated; IG=intervention group; N/A=not applicable; NR=not reported; SES=socioeconomic status; SPF=sun protection factor.

Appendix B Table 2. Studies Excluded From the Review for Key Question 1

Reference	Reason for Exclusion
Benjes LS, Brooks DR, Zhang Z, et al. Changing patterns of sun protection between the first and second summers for very young children. *Arch Dermatol.* 2004;140:925-930.	Setting
Brandberg Y, Bergenmar M, Michelson H, et al. Six-month follow-up of effects of an information programme for patients with malignant melanoma. *Patient Educ Couns.* 1996;28:201-208.	Population
Branstrom R, Ullen H, Brandberg Y. A randomised population-based intervention to examine the effects of the ultraviolet index on tanning behaviour. *Eur J Cancer.* 2003;39:968-974.	Study design
Brodkin RH, Altman EM. Controlling malignant melanoma. A focus on pediatricians. *Am J Dis Child.* 1993;147:875-881.	Study relevance
Buller DB, Buller MK, Beach B, et al. Sunny days, healthy ways: evaluation of a skin cancer prevention curriculum for elementary school-aged children. *J Am Acad Dermatol.* 1996;35:911-922.	Setting
Buller DB, Hall JR, Powers PJ, et al. Evaluation of the "Sunny Days, Healthy Ways" sun safety CD-ROM program for children in grades 4 and 5. *Cancer Prev Control.* 1999;3:188-195.	Setting
Crane LA, Schneider LS, Yohn JJ, et al. "Block the sun, not the fun": evaluation of a skin cancer prevention program for child care centers. *Am J Prev Med.* 1999;17: 31-37.	Setting
Dey P, Collins S, Will S, et al. Randomised controlled trial assessing effectiveness of health education leaflets in reducing incidence of sunburn. *BMJ.* 1995;311:1062 -1063.	Setting
Dietrich AJ, Olson AL, Sox CH, et al. Sun protection counseling for children: primary care practice patterns and effect of an intervention on clinicians. *Arch Fam Med.* 2000;9:155-159.	Study relevance
Geller AC, Cantor M, Miller DR, et al. The Environmental Protection Agency's National SunWise School Program: sun protection education in US schools (1999-2000). *J Am Acad Dermatol.* 2002;46:683-689.	Setting
Geller AC, Sayers L, Koh HK, et al. The New Moms Project: educating mothers about sun protection in newborn nurseries. *Pediatr Dermatol.* 1999;16:198-200.	Setting
Gerbert B, Wolff M, Tschann JM, et al. Activating patients to practice skin cancer prevention: response to mailed materials from physicians versus HMOs. *Am J Prev Med.* 1997;13:214-220.	No relevant outcomes
Girgis A, Sanson-Fisher RW, Tripodi DA, et al. Evaluation of interventions to improve solar protection in primary schools. *Health Educ Q.* 1993;20:275-287.	Setting
Glanz K, Chang L, Song V, et al. Skin cancer prevention for children, parents, and caregivers: a field test of Hawaii's SunSmart program. *J Am Acad Dermatol.* 1998;38:413-417.	Setting
Harris JM Jr, Salasche SJ, Harris RB. Using the Internet to teach melanoma management guidelines to primary care physicians. *J Eval Clin Pract.* 1999;5:199-211.	Study relevance
Harris JM, Salasche SJ, Harris RB. Can Internet-based continuing medical education improve physicians' skin cancer knowledge and skills? *J Gen Intern Med.* 2001;16:50-56.	Study relevance
Harris RB, Alberts DS. Strategies for skin cancer prevention. *Int J Dermatol.* 2004;43:243-251.	Study design
Hillhouse JJ, Turrisi R. Examination of the efficacy of an appearance-focused intervention to reduce UV exposure. *J Behav Med.* 2002;25:395-409.	Study design
Hornung RL, Lennon PA, Garrett JM, et al. Interactive computer technology for skin cancer prevention targeting children. *Am J Prev Med.* 2000;18:69-76.	Setting
Jackson KM, Aiken LS. Evaluation of a multicomponent appearance-based sun-protective intervention for young women: uncovering the mechanisms of program efficacy. *Health Psychol.* 2006;25:34-46.	Setting
Johnson EY, Lookingbill DP. Sunscreen use and sun exposure. Trends in a white population. *Arch Dermatol.* 1984;120:727-731.	Study design
Kiekbusch S, Hannich HJ, Isacsson A, et al. Impact of a cancer education multimedia device on public knowledge, attitudes, and behaviors: a controlled intervention study in Southern Sweden. *J Cancer Educ.* 2000;15:232-236.	Study design

Appendix B Table 2. Studies Excluded From the Review for Key Question 1

Reference	Reason for Exclusion
Lopez-Jornet P, Camacho-Alonso F, Molina MF. Knowledge and attitude towards risk factors in oral cancer held by dental hygienists in the Autonomous Community of Murcia (Spain): a pilot study. *Oral Oncol.* 2007;43:602-606.	Study relevance
Lowe JB, Balanda KP, Stanton WR, et al. Evaluation of a three-year school-based intervention to increase adolescent sun protection. *Health Educ Behav.* 1999;26: 396-408.	Setting
Mahler HI, Kulik JA, Harrell J, et al. Effects of UV photographs, photoaging information, and use of sunless tanning lotion on sun protection behaviors. *Arch Dermatol.* 2005;141:373-380.	Study design
Mayer JA, Eckhardt L, Stepanski BM, et al. Promoting skin cancer prevention counseling by pharmacists. *Am J Public Health.* 1998;88:1096-1099.	Study design
Mayer JA, Slymen DJ, Eckhardt L, et al. Skin cancer prevention counseling by pharmacists: specific outcomes of an intervention trial. *Cancer Detect Prev.* 1998;22:367-375.	Study relevance
McCormick LK, Masse LC, Cummings SS, et al. Evaluation of a skin cancer prevention module for nurses: change in knowledge, self-efficacy, and attitudes. *Am J Health Promot.* 1999;13:282-289.	Study relevance
Mikkilineni R, Weinstock MA, Goldstein MG, et al. The impact of the basic skin cancer triage curriculum on provider's skin cancer control practices. *J Gen Intern Med.* 2001;16:302-307.	Study relevance
Miller DR, Geller AC, Wood MC, et al. The Falmouth Safe Skin Project: evaluation of a community program to promote sun protection in youth. *Health Educ Behav.* 1999;26:369-384.	Setting
O'Keefe DJ, Jensen JD. The relative persuasiveness of gain-framed and loss-framed messages for encouraging disease prevention behaviors: a meta-analytic review. *J Health Commun.* 2007;12:623-644.	Study relevance
Patrick K, Calfas KJ, Norman GJ, et al. Randomized controlled trial of a primary care and home-based intervention for physical activity and nutrition behaviors: PACE+ for adolescents. *Arch Ped Adolesc Med.* 2006;160:128-136.	No relevant outcomes
Richard MA, Martin S, Gouvernet J, et al. Humour and alarmism in melanoma prevention: a randomized controlled study of three types of information leaflet. *Br J Dermatol.* 1999;140:909-914.	No relevant outcomes
Robinson JK, Rademaker AW. Skin cancer risk and sun protection learning by helpers of patients with nonmelanoma skin cancer. *Prev Med.* 1995;24:333-341.	Study design
Robinson JK. Behavior modification obtained by sun protection education coupled with removal of a skin cancer. *Arch Dermatol.* 1990;126:477-481.	Population
Robinson JK. Compensation strategies in sun protection behaviors by a population with nonmelanoma skin cancer. *Prev Med.* 1992;21:754-765.	Population
Rosenberg DE, Norman GJ, Sallis JF, et al. Covariation of adolescent physical activity and dietary behaviors over 12 months. *J Adolesc Health.* 2007;41:472-478.	No relevant outcomes
Stanton WR, Janda M, Baade PD, et al. Primary prevention of skin cancer: a review of sun protection in Australia and internationally. *Health Promot Int.* 2004;19:369-378.	Study relevance
Turrisi R, Hillhouse J, Heavin S, et al. Examination of the short-term efficacy of a parent-based intervention to prevent skin cancer. *J Behav Med.* 2004;27:393-412.	Study design
Turrisi R, Hillhouse J, Robinson J, et al. Influence of parent and child characteristics on a parent-based intervention to reduce unsafe sun practices in children 9 to 12 years old. *Arch Dermatol.* 2006;142:1009-1014.	Study design

Appendix B Table 3. Studies Excluded From the Review for Key Question 2

Reference	Reason for exclusion
Benjes LS, Brooks DR, Zhang Z, et al. Changing patterns of sun protection between the first and second summers for very young children. *Arch Dermatol.* 2004;140:925-930.	Setting
Brandberg Y, Bergenmar M, Michelson H, et al. Six-month follow-up of effects of an information programme for patients with malignant melanoma. *Patient Educ Couns.* 1996;28:201-208.	Population
Branstrom R, Ullen H, Brandberg Y. A randomised population-based intervention to examine the effects of the ultraviolet index on tanning behaviour. *Eur J Cancer.* 2003;39:968-974.	Study design
Brodkin RH, Altman EM. Controlling malignant melanoma. A focus on pediatricians. *Am J Dis Child.* 1993;147:875-881.	Study relevance
Buller DB, Buller MK, Beach B, et al. "Sunny days, healthy ways": evaluation of a skin cancer prevention curriculum for elementary school-aged children. *J Am Acad Dermatol.* 1996;35:911-922.	Setting
Buller DB, Hall JR, Powers PJ, et al. Evaluation of the "Sunny Days, Healthy Ways" sun safety CD-ROM program for children in grades 4 and 5. *Cancer Prev Control.* 1999;3:188-195.	Setting
Crane LA, Schneider LS, Yohn JJ, et al. "Block the sun, not the fun": evaluation of a skin cancer prevention program for child care centers. *Am J Prev Med.* 1999;17:31-37.	Setting
Dey P, Collins S, Will S, et al. Randomised controlled trial assessing effectiveness of health education leaflets in reducing incidence of sunburn. *BMJ.* 1995;311:1062-1063.	Setting
Dietrich AJ, Olson AL, Sox CH, et al. Sun protection counseling for children: primary care practice patterns and effect of an intervention on clinicians. *Arch Fam Med.* 2000;9:155-159.	Study relevance
Emmons KM, Geller AC, Viswanath V, et al. The SunWise Policy intervention for school-based sun protection: a pilot study. *J Sch Nurs.* 2008;24(4):215-221.	No relevant outcomes
Falk M, Anderson C. Prevention of skin cancer in primary healthcare: an evaluation of three different prevention effort levels and the applicability of a phototest. *Eur J Gen Pract* 2008;14(2):68-75.	Quality
Geller AC, Cantor M, Miller DR, et al. The Environmental Protection Agency's National SunWise School Program: sun protection education in US schools (1999-2000). *J Am Acad Dermatol.* 2002;46:683-689.	Setting
Geller AC, Sayers L, Koh HK, et al. The New Moms Project: educating mothers about sun protection in newborn nurseries. *Pediatr Dermatol.* 1999;16:198-200.	Setting
Gerbert B, Wolff M, Tschann JM, et al. Activating patients to practice skin cancer prevention: response to mailed materials from physicians versus HMOs. *Am J Prev Med.* 1997;13:214-220.	No relevant outcomes
Girgis A, Sanson-Fisher RW, Tripodi DA, et al. Evaluation of interventions to improve solar protection in primary schools. *Health Educ Q.* 1993;20:275-287.	Setting
Glanz K, Chang L, Song V, et al. Skin cancer prevention for children, parents, and caregivers: a field test of Hawaii's SunSmart program. *J Am Acad Dermatol.* 1998;38:413-417.	Setting
Greene K, Brinn LS. Messages influencing college women's tanning bed use: statistical versus narrative evidence format and a self-assessment to increase perceived susceptibility. *J Health Commun.* 2003;8:443-461.	Study design
Harris JM Jr, Salasche SJ, Harris RB. Using the Internet to teach melanoma management guidelines to primary care physicians. *J Eval Clin Pract.* 1999;5:199-211.	Study relevance
Harris JM, Salasche SJ, Harris RB. Can Internet-based continuing medical education improve physicians' skin cancer knowledge and skills? *J Gen Intern Med.* 2001;16:50-56.	Study relevance
Harris RB, Alberts DS. Strategies for skin cancer prevention. *Int J Dermatol.* 2004;43:243-251.	Study design
Hart KM, Demarco RF. Primary prevention of skin cancer in children and adolescents: a review of the literature. *J Pediatr Oncol Nurs.* 2008;25:67-78.	Study design
Hillhouse JJ, Turrisi R. Examination of the efficacy of an appearance-focused intervention to reduce UV exposure. *J Behav Med.* 2002;25:395-409.	Study design
Hornung RL, Lennon PA, Garrett JM, et al. Interactive computer technology for skin cancer prevention targeting children. *Am J Prev Med.* 2000;18:69-76.	Setting

Appendix B Table 3. Studies Excluded From the Review for Key Question 2

Reference	Reason for exclusion
Jackson KM, Aiken LS. Evaluation of a multicomponent appearance-based sun-protective intervention for young women: uncovering the mechanisms of program efficacy. *Health Psychol.* 2006;25:34-46.	Setting
Johnson EY, Lookingbill DP. Sunscreen use and sun exposure. Trends in a white population. *Arch Dermatol.* 1984;120:727-731.	Study design
Kiekbusch S, Hannich HJ, Isacsson A, et al. Impact of a cancer education multimedia device on public knowledge, attitudes, and behaviors: a controlled intervention study in Southern Sweden. *J Cancer Educ.* 2000;15:232-236.	Study design
Lopez ML, Iglesias JM, del Valle MO, et al. Impact of a primary care intervention on smoking, drinking, diet, weight, sun exposure, and work risk in families with cancer experience. *Cancer Causes Control.* 2007;18:525-535.	Quality
Lopez-Jornet P, Camacho-Alonso F, Molina MF. Knowledge and attitude towards risk factors in oral cancer held by dental hygienists in the Autonomous Community of Murcia (Spain): a pilot study. *Oral Oncol.* 2007;43:602-606.	Study relevance
Lowe JB, Balanda KP, Stanton WR, et al. Evaluation of a three-year school-based intervention to increase adolescent sun protection. *Health Educ Behav.* 1999;26:396-408.	Setting
Mahler HI, Kulik JA, Harrell J, et al. Effects of UV photographs, photoaging information, and use of sunless tanning lotion on sun protection behaviors. *Arch Dermatol.* 2005;141:373-380.	Study design
Mahler HI, Kulik JA, Butler HA, Gerrard M, Gibbons FX. Social norms information enhances the efficacy of an appearance-based sun protection intervention. *Soc Sci Med* 2008;67(2):321-329.	Study design
Mayer JA, Eckhardt L, Stepanski BM, et al. Promoting skin cancer prevention counseling by pharmacists. *Am J Public Health.* 1998;88:1096-1099.	Study design
Mayer JA, Slymen DJ, Eckhardt L, et al. Skin cancer prevention counseling by pharmacists: specific outcomes of an intervention trial. *Cancer Detect Prev.* 1998;22:367-375.	Study relevance
McCormick LK, Masse LC, Cummings SS, et al. Evaluation of a skin cancer prevention module for nurses: change in knowledge, self-efficacy, and attitudes. *Am J Health Promot.* 1999;13:282-289.	Study relevance
Mikkilineni R, Weinstock MA, Goldstein MG, et al. The impact of the basic skin cancer triage curriculum on provider's skin cancer control practices. *J Gen Intern Med.* 2001;16:302-307.	Study relevance
Miller DR, Geller AC, Wood MC, et al. The Falmouth Safe Skin Project: evaluation of a community program to promote sun protection in youth. *Health Educ Behav.* 1999;26:369-384.	Setting
Patrick K, Calfas KJ, Norman GJ, et al. Randomized controlled trial of a primary care and home-based intervention for physical activity and nutrition behaviors: PACE+ for adolescents. *Arch Ped Adolesc Med.* 2006;160:128-136.	No relevant outcomes
Richard MA, Martin S, Gouvernet J, et al. Humour and alarmism in melanoma prevention: a randomized controlled study of three types of information leaflet. *Br J Dermatol.* 1999;140:909-914.	No relevant outcomes
Robinson JK, Rademaker AW. Skin cancer risk and sun protection learning by helpers of patients with nonmelanoma skin cancer. *Prev Med.* 1995;24:333-341.	Study design
Robinson JK. Behavior modification obtained by sun protection education coupled with removal of a skin cancer. *Arch Dermatol.* 1990;126:477-481.	Population
Robinson JK. Compensation strategies in sun protection behaviors by a population with nonmelanoma skin cancer. *Prev Med.* 1992;21:754-765.	Population
Rosenberg DE, Norman GJ, Sallis JF, et al. Covariation of adolescent physical activity and dietary behaviors over 12 months. *J Adolesc Health.* 2007;41:472-478.	No relevant outcomes
Saraiya M, Glanz K, Briss PA, et al. Interventions to prevent skin cancer by reducing exposure to ultraviolet radiation: a systematic review. *Am J Prev Med.* 2004;27:422-466.	Used as source document
Stanton WR, Janda M, Baade PD, et al. Primary prevention of skin cancer: a review of sun protection in Australia and internationally. *Health Promot Int.* 2004;19:369-378.	Study relevance
Turrisi R, Hillhouse J, Heavin S, et al. Examination of the short-term efficacy of a parent-based intervention to prevent skin cancer. *J Behav Med.* 2004;27:393-412.	Study design

Appendix B Table 3. Studies Excluded From the Review for Key Question 2

Reference	Reason for exclusion
Turrisi R, Hillhouse J, Robinson J, et al. Influence of parent and child characteristics on a parent-based intervention to reduce unsafe sun practices in children 9 to 12 years old. *Arch Dermatol.* 2006;142:1009-1014.	Study design
van Osch L, Reubsaet A, Lechner L, de Vries H. The formation of specific action plans can enhance sun protection behavior in motivated parents. *Prev.Med.* 2008;47(1):127-132.	Quality

Appendix B Table 4. Studies Excluded From the Review for Key Question 3

Reference	Reason for Exclusion
Benjes LS, Brooks DR, Zhang Z, et al. Changing patterns of sun protection between the first and second summers for very young children. *Arch Dermatol.* 2004;140:925-930.	Setting
Brandberg Y, Bergenmar M, Michelson H, et al. Six-month follow-up of effects of an information programme for patients with malignant melanoma. *Patient Educ Couns.* 1996;28:201-208.	Population
Branstrom R, Ullen H, Brandberg Y. A randomised population-based intervention to examine the effects of the ultraviolet index on tanning behaviour. *Eur J Cancer.* 2003;39:968-974.	Study design
Brodkin RH, Altman EM. Controlling malignant melanoma. A focus on pediatricians. *Am J Dis Child.* 1993;147:875-881.	Study relevance
Buller DB, Buller MK, Beach B, et al. “Sunny days, healthy ways”: evaluation of a skin cancer prevention curriculum for elementary school-aged children. *J Am Acad Dermatol.* 1996;35:911-922.	Setting
Buller DB, Hall JR, Powers PJ, et al. Evaluation of the "Sunny Days, Healthy Ways" sun safety CD-ROM program for children in grades 4 and 5. *Cancer Prev Control.* 1999;3:188-195.	Setting
Crane LA, Schneider LS, Yohn JJ, et al. "Block the sun, not the fun": evaluation of a skin cancer prevention program for child care centers. *Am J Prev Med.* 1999;17:31-37.	Setting
Dey P, Collins S, Will S, et al. Randomised controlled trial assessing effectiveness of health education leaflets in reducing incidence of sunburn. *BMJ.* 1995;311:1062-1063.	Setting
Dietrich AJ, Olson AL, Sox CH, et al. Sun protection counseling for children: primary care practice patterns and effect of an intervention on clinicians. *Arch Fam Med.* 2000;9:155-159.	Study relevance
Geller AC, Sayers L, Koh HK, et al. The New Moms Project: educating mothers about sun protection in newborn nurseries. *Pediatr Dermatol.* 1999;16:198-200.	Setting
Gerbert B, Wolff M, Tschann JM, et al. Activating patients to practice skin cancer prevention: response to mailed materials from physicians versus HMOs. *Am J Prev Med.* 1997;13:214-220.	No relevant outcomes
Girgis A, Sanson-Fisher RW, Tripodi DA, et al. Evaluation of interventions to improve solar protection in primary schools. *Health Educ Q.* 1993;20:275-287.	Setting
Glanz K, Chang L, Song V, et al. Skin cancer prevention for children, parents, and caregivers: a field test of Hawaii's SunSmart program. *J Am Acad Dermatol.* 1998;38:413-417.	Setting
Harris JM Jr, Salasche SJ, Harris RB. Using the Internet to teach melanoma management guidelines to primary care physicians. *J Eval Clin Pract.* 1999;5:199-211.	Study relevance
Harris JM, Salasche SJ, Harris RB. Can Internet-based continuing medical education improve physicians' skin cancer knowledge and skills? *J Gen Intern Med.* 2001;16:50-56.	Study relevance
Harris RB, Alberts DS. Strategies for skin cancer prevention. *Int J Dermatol.* 2004;43:243-251.	Study design
Hillhouse JJ, Turrisi R. Examination of the efficacy of an appearance-focused intervention to reduce UV exposure. *J Behav Med.* 2002;25:395-409.	Study design
Hornung RL, Lennon PA, Garrett JM, et al. Interactive computer technology for skin cancer prevention targeting children. *Am J Prev Med.* 2000;18:69-76.	Setting
Jackson KM, Aiken LS. Evaluation of a multicomponent appearance-based sun-protective intervention for young women: uncovering the mechanisms of program efficacy. *Health Psychol.* 2006;25:34-46.	Setting
Johnson EY, Lookingbill DP. Sunscreen use and sun exposure. Trends in a white population. *Arch Dermatol.* 1984;120:727-731.	No relevant outcomes
Kiekbusch S, Hannich HJ, Isacsson A, et al. Impact of a cancer education multimedia device on public knowledge, attitudes, and behaviors: a controlled intervention study in Southern Sweden. *J Cancer Educ.* 2000;15:232-236.	Study design
Lopez-Jornet P, Camacho-Alonso F, Molina MF. Knowledge and attitude towards risk factors in oral cancer held by dental hygienists in the Autonomous Community of Murcia (Spain): a pilot study. *Oral Oncol.* 2007;43:602-606.	Study relevance

Appendix B Table 4. Studies Excluded From the Review for Key Question 3

Reference	Reason for Exclusion
Lowe JB, Balanda KP, Stanton WR, et al. Evaluation of a three-year school-based intervention to increase adolescent sun protection. *Health Educ Behav.* 1999;26:396-408.	Setting
Mahler HI, Kulik JA, Harrell J, et al. Effects of UV photographs, photoaging information, and use of sunless tanning lotion on sun protection behaviors. *Arch Dermatol.* 2005;141:373-380.	Study design
Mayer JA, Eckhardt L, Stepanski BM, et al. Promoting skin cancer prevention counseling by pharmacists. *Am J Public Health.* 1998;88:1096-1099.	Study design
Mayer JA, Slymen DJ, Eckhardt L, et al. Skin cancer prevention counseling by pharmacists: specific outcomes of an intervention trial. *Cancer Detect Prev.* 1998;22:367-375.	Study relevance
McCormick LK, Masse LC, Cummings SS, et al. Evaluation of a skin cancer prevention module for nurses: change in knowledge, self-efficacy, and attitudes. *Am J Health Promot.* 1999;13:282-289.	Study relevance
Mikkilineni R, Weinstock MA, Goldstein MG, et al. The impact of the basic skin cancer triage curriculum on provider's skin cancer control practices. *J Gen Intern Med.* 2001;16:302-307.	Study relevance
Miller DR, Geller AC, Wood MC, et al. The Falmouth Safe Skin Project: evaluation of a community program to promote sun protection in youth. *Health Educ Behav.* 1999;26:369-384.	Setting
Richard MA, Martin S, Gouvernet J, et al. Humour and alarmism in melanoma prevention: a randomized controlled study of three types of information leaflet. *Br J Dermatol.* 1999;140:909-914.	No relevant outcomes
Robinson JK, Rademaker AW. Skin cancer risk and sun protection learning by helpers of patients with nonmelanoma skin cancer. *Prev Med.* 1995;24:333-341.	Study design
Robinson JK. Behavior modification obtained by sun protection education coupled with removal of a skin cancer. *Arch Dermatol.* 1990;126:477-481.	Population
Robinson JK. Compensation strategies in sun protection behaviors by a population with nonmelanoma skin cancer. *Prev Med.* 1992;21:754-765.	Population
Saraiya M, Glanz K, Briss PA, et al. Interventions to prevent skin cancer by reducing exposure to ultraviolet radiation: a systematic review. *Am J Prev Med.* 2004;27:422-466.	Used as source document
Stanton WR, Janda M, Baade PD, et al. Primary prevention of skin cancer: a review of sun protection in Australia and internationally. *Health Promot Int.* 2004;19:369-378	Study relevance
Turrisi R, Hillhouse J, Heavin S, et al. Examination of the short-term efficacy of a parent-based intervention to prevent skin cancer. *J Behav Med.* 2004;27:393-412.	Study design
Turrisi R, Hillhouse J, Robinson J, et al. Influence of parent and child characteristics on a parent-based intervention to reduce unsafe sun practices in children 9 to 12 years old. *Arch Dermatol.* 2006;142:1009-1014.	Study design

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Skin cancer Study design Location Recruitment strategy	Participant inclusion/ exclusion criteria	Baseline demographics
Trials			
Green 1999[57] Green 1994[58] Pandeya 2005[59] Nambour Skin Cancer Prevention Trial (subgroup of people from Nambour Skin Cancer Study)	**Skin cancer:** BCC & SCC **Study design:** Cohort within an RCT **Location:** Australia **Recruitment strategy:** Participants in Nambour Skin Cancer and Actinic Eye Disease Prevention Trial were randomly chosen from the 1986 Nambour electoral roll, those who could be contacted in 1992 were invited to be in the Skin Cancer Prevention Trial	**Inclusion:** Aged 20-69, resident of Nambour, Queensland from electoral roll 1986, who attended a second survey in 1992 **Exclusion:** Taking vitamin supplements containing betacarotene, already applying sunscreen on a strict daily basis	**N=** 1,621 **Mean age (SD):** IG (Sunscreen + betacarotene): 48.5 (12.9) IG (Sunscreen): 48.7 (13.6) IG (Betacarotene): 48.1 (13.6) CG: 49.8 (12.7) **Female:** IG (Sunscreen + betacarotene): 225 (55.7%) IG (Sunscreen): 233 (57.1%) IG (Betacarotene): 246 (59.1%) CG: 209 (53.2%) **Race/ethnicity:** NR **SES:** NR **Skin type:** IG (S+B) IG (S) IG (B) CG Always burn 88 (21.8%) 83 (20.3%) 92 (22.1%) 77 (19.6%) Burn/tan 270 (66.8%) 282 (69.1%) 276 (66.4%) 271 (69.0%) Only tan 46 (11.4%) 43 (10.5%) 48 (11.5%) 45 (11.4%)
van der Pols 2006[60]	See Green 1999	See Green 1999	See Green 1999

Study reference USPSTF quality	Intervention(s) evaluated (description with format, intensity, and delivery if applicable)	Followup	Main outcome measure(s)
Trials			
Green 1999[57] Green 1994[58] Pandeya 2005[59] Nambour Skin Cancer Prevention Trial (subgroup of people from Nambour Skin Cancer Study)	**Description:** IG (S+B): SPF 15+ broad-spectrum sunscreen and betacarotene tablets IG (S): SPF 15+ broad-spectrum sunscreen and placebo tablets IG (B): Betacarotene tablets plus usual sunscreen use CG: Placebo tablets plus usual sunscreen use **Intensity:** IG (S+B): sunscreen application to exposed sites every morning and reapplication if heavy sweating, bathing or prolonged exposure; 1 30mg betacarotene tablet per day for 4 years IG (S): sunscreen application to exposed sites every morning and reapplication if heavy sweating, bathing or prolonged exposure; 1 tablet per day for 4 years IG (B): 1 30mg tablet per day for 4 years CG: 1 tablet per day for 4 years **Delivery:** self-application of sunscreen and tablets self-administered. Received supplies every 3 months at followup clinic visits	4.5 years original trial 85% followup 8 additional years followup 59% active followup 41% passive followup (skin cancer through pathology records only)	**Measure** Newly treated skin lesions detected at followup clinics in 1994 and 1996 by dermatologists or participants carried treatment cards that they presented to their local doctors who recorded details. Also asked every 3 months whether they had any new skin cancers or other skin lesions treated since last contact. In 2000 they were offered a further full skin exam and followed through December 2004 **Results** *Incidence of skin cancers in terms of people treated for skin cancer and tumours treated on the head, neck, arms, and hands by sunscreen treatment group (through 1996)* Participants: Daily Sunscreen / No Sunscreen; Tumors: Daily Sunscreen / No Sunscreen **BCC** Number 65 63 153 146 Incidence/100,000 2588 2509 6092 5814 Rate ratio (95% CI) 1.03 (0.73-1.46) 1.00 1.05 (0.82-1.34) 1.0 **SCC** Number 22 25 28 46 Incidence/100,000 876 996 1115 1832 Rate ratio (95% CI) 0.88 (0.50-1.56) 1.0 0.61 (0.46-1.81) 1.0
van der Pols 2006[60]	See Green et al 1999	See Green et al1999	*Incidence per 100,000 (no.) of BCC and SCC on the head, neck, arms, and hands, by sunscreen treatment group (through 2004)* BCC: Daily Sunscreen / No Sunscreen / RR (95% CI); SCC: Daily Sunscreen / No Sunscreen / RR (95% CI) *Persons affected* 1993-2004 1,296 (121) 1,270 (119) 1.02 (0.78-1.35) 546 (51) 811 (76) 0.65 (0.45-0.94) 1996-2004 1,516 (97) 1,494 (96) 1.02 (0.75-1.37) 625 (40) 934 (60) 0.65 (0.43-0.98) 2001-2004 1,820 (55) 2,085 (63) 0.86 (0.59-1.26) 695 (21) 1,390 (42) 0.49 (0.28-0.83) *Total tumors* 1993-2004 2,474 (231) 2,840 (266) 0.87 (0.64-1.20) 868 (81) 1,516 (142) 0.59 (0.38-0.90) 1996-2004 2,422 (155) 2,770 (178) 0.89 (0.64-1.25) 953 (61) 1,587 (102) 0.62 (0.38-0.99) 2001-2004 2,548 (77) 3,408 (103) 0.75 (0.49-1.14) 960 (29) 1,952 (59) 0.49 (0.27-0.87)

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Other positive outcome measures	Adverse events	Comments
Trials			
Green 1999[57] Green 1994[58] Pandeya 2005[59] Nambour Skin Cancer Prevention Trial (subgroup of people from Nambour Skin Cancer Study)	NR	Potential harms noted: contact allergy or skin irritation with daily use of sunscreen (p.726 of Green 1999)	Pandeya 2005 *Hazard ratios obtained from the multiple-failure time models for the combined effect of sunscreen intervention on repeated occurrence of basal cell carcinoma (BCC) among 1,621 participants, Nambour Skin Cancer Prevention Trial, 1992-1996* Crude Models — HR (95% CI) — P Time to first episode — 1.03 (0.77-1.38) — 0.83 Andersen-Gill model — 0.90 (0.66-1.23) — 0.49 Wei-Lin-Weissfeld model — 0.89 (0.65-1.24) — 0.50 Prentice-Williams-Peterson — 0.91 (0.72-1.15) — 0.42 — Model
van der Pols 2006[60]	See Green et al 1999	See Green et al 1999	See Green et al 1999

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered	Followup
Cohort						
Grodstein 1995[67] Nurses' Health Study	**Skin Cancer:** SCC **Study Design:** cohort **Location:** US (11 states)	**Inclusion:** Female, registered nurse, 30-55 years of age, with first-incident invasive SCC diagnosed 1982-1990 **Exclusion:** Diagnosis of in situ SCC (Bowen's disease), any cancer before 1982, start of followup period, and each time period	**N=** 107,900 **Age:** 30-55 **Sex:** 100% Female **Skin phenotype:** NR <2% cohort African American	Sun exposure, sunscreen use Mailed questionnaires every 2 years	Age, cigarette smoking, region, natural hair color, reaction to sun, and lifetime number of sunburns	8 years 92% (calculated from person-year followup)
Hunter 1990[68] Nurses' Health Study	**Skin Cancer:** BCC **Study Design:** cohort **Location:** US (11 states)	**Inclusion:** Female, registered nurse, 30-55 years of age **Exclusion:** Diagnosis of cancer reported on 1980 or previous questionnaire, if information on one or more exposures missing on questionnaire	**N=** 73,366 **Age:** 30-55 **Sex:** 100% Female **Skin phenotype:** NR <2% cohort African American	Sun exposure, sunscreen use Mailed questionnaires every 2 years	Age, time period, region, time spent outdoors in the summer and sunscreen habit, hair color, childhood tendency to sunburn, and lifetime number of severe and painful sunburns on the face and arms	4 years 100% (because excluded women with missing data)

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Cohort		
Grodstein 1995[67] Nurses' Health Study	**Regular time outdoors and risk of SCC (95% CI) (calc)*** Cases / Age Adjusted RR / Multivariate** Adjusted RR Yes (use sunscreen) 56 (32%) 1.0 1.0 Yes (no sunscreen) 94 (54%) 0.7 (0.5-1.0) 0.9 (0.6-1.2) No 25 (14%) 0.7 (0.4-1.1) 0.7 (0.4-1.1) *Data missing for 22 ppts **Adjusted for age, cigarette smoking, region, natural hair color, reaction to sun, and lifetime number of sunburns	NR
Hunter 1990[68] Nurses' Health Study	**Regular time spent outdoors in summer (at least 8 hours/week) (95% CI)** Cases / Age Adjusted RR / Multivariate* Adjusted RR Yes (usually use sunscreen) 265 1.0 1.0 Yes (no sunscreen) 377 0.59 (0.50-0.69) 0.70 (0.60-0.82) No 129 0.71 (0.58-0.88) 0.73 (0.59-0.90) p=0.0001 p<0.0001 *Adjusted for age, time period, region, time spent outdoors in summer and sunscreen habit, hair color, childhood tendency to burn, lifetime number of severe and painful sunburns on the face and arms	NR

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Cohort			
Grodstein 1995[67] Nurses' Health Study	See measurement of sun exposure	**Number of lifetime sunburns and risk of SCC (95% CI) (calc)*** Cases / Age Adjusted RR / Multivariate** Adjusted RR None 26 (16%) 1.0 1.0 1-2 38 (23%) 1.2 (0.7-2.0) 1.1 (0.6-1.8) 3-5 39 (24%) 2.2 (1.3-3.5) 1.7 (1.0-2.8) ≥6 61 (37%) 3.4 (2.2-5.3) 2.4 (1.5-4.0) *p<0.0001* *p<0.0001* *Data missing for 33 ppts **Adjusted for age, cigarette smoking, region, natural hair color, reaction to sun, and lifetime number of sunburns	
Hunter 1990[68] Nurses' Health Study	See measurement of sun exposure	**Lifetime number of severe and painful sunburns on the face or arms (95% CI)** Cases / Age Adjusted RR / Multivariate* Adjusted RR Never 127 1.0 1.0 1-2 times 216 1.40 (1.13-1.75) 1.18 (0.94-1.48) 3-5 times 165 1.78 (1.42-2.25) 1.34 (1.05-1.71) 6+ times 263 2.91 (2.37-3.58) 1.90 (1.50-2.40) Test for trend p<0.001 p<0.001 *Adjusted for age, time period, region, time spent outdoors in summer and sunscreen habit, hair color, childhood tendency to burn, lifetime number of severe and painful sunburns on the face and arms	

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered	Followup
Cohort						
van Dam 1999[69] Health Professionals Followup Study	**Skin Cancer:** BCC **Study Design:** cohort **Location:** US	**Inclusion:** Male, health professionals, 40-75 years of age **Exclusion:** Any cancer before 1986 or at the beginning of each 2-year time period	**N=** 44,591 **Age:** 40-75 **Sex:** 100% Male **Skin phenotype:** NR 1.7% Asian 1.0% African American	Sun exposure Mailed questionnaires every 2 years	Age, time period, hair color, eye color, skin reaction to sun, ancestry, BMI, region of residence	8 years 94%
Veierod 2003[82] Norwegian-Swedish Women's Lifestyle and Health Cohort Study	**Skin Cancer:** Melanoma **Study Design:** Cohort **Location:** Norway & Sweden	**Inclusion:** Female, aged 34-49 years in Norway, aged 30-50 years residing in the Uppsala Health Care Region in Sweden, drawn from population registers **Exclusion:** women who did not return completed questionnaires or with missing data for exposure or skin type	**N=** 106,379 **Mean age (range):** 40.4 (30-50) **Sex:** 100% Female **Skin phenotype:** *Skin color after repeated skin exposure* Deep brown: 16,776 (16%) Brown: 61,423 (59%) Light brown: 23,582 (23%) Never brown: 1531 (1%)	Sun exposure, sunbed exposure Mailed questionnaires	Age, region of residence, hair color, number of sunburns, and weeks on annual summer vacations	8.1 years average 100% (because excluded women with missing data)

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Cohort		
van Dam 1999[69] Health Professionals Followup Study	**Frequency outdoors in swimsuit as teenager in summer (95% CI)*** Cases / Age Adjusted RR / Multivariate** Adjusted RR <1 time/week: 557 / 1.00 / 1.00 1 time/week: 425 / 1.28 (1.13-1.45) / 1.30 (1.14-1.47) 2 times/week: 499 / 1.29 (1.15-1.46) / 1.34 (1.19-1.52) Several times/week: 877 / 1.26 (1.13-1.40) / 1.36 (1.22-1.52) Daily: 347 / 1.29 (1.13-1.48) / 1.42 (1.24-1.63) *Data missing for 568 cases **Adjusted for age, time period, hair color, eye color, skin reaction to sun, ancestry, BMI, and region of residence	NR
Veierod 2003[82] Norwegian-Swedish Women's Lifestyle and Health Cohort Study	**Annual weeks on sunbathing vacation, ages 10-19 years** Frequencies / Cases / Age Adjusted RR / Multivariate* Adjusted RR 0: 45,298 (48%) / 77 / 1.00 / 1.00 1 wk/yr: 19,921 (21%) / 35 / 1.10 (0.74-1.65) / 1.21 (0.80-1.83) 2-3 wks/yr: 20,086 (22%) / 32 / 1.02 (0.67-1.54) / 1.09 (0.71-1.65) ≥4 wks/yr: 8,113 (9%) / 20 / 1.56 (0.95-2.55) / 1.67 (1.01-2.74) Trend: p=0.22 / p=0.12 **Annual weeks on sunbathing vacation, ages 10-39 years** Frequencies / Cases / Age Adjusted RR / Multivariate* Adjusted RR 0, 10-39 yrs: 15,799 (18%) / 21 / 1.00 / 1.00 ≥1 wk/yr, 20-29 and/or 30-39 yrs: 27,851 (31%) / 53 / 1.42 (0.86-2.36) / 1.45 (0.87-2.40) ≥1 wk/yr, 10-19 yrs: 1,751 (2%) / 3 / 1.37 (0.41-4.59) / 1.46 (0.43-4.92) ≥1 wk/yr, 10-39 yrs: 43,049 (49%) / 79 / 1.44 (0.89-2.34) / 1.56 (0.95-2.56) Trend: p=0.27 / p=0.13 *Adjusted for age, region of residence, and hair color	**Solarium use, ages 10-19 years** Frequencies / Cases / Age Adjusted RR / Multivariate* Adjusted RR Never: 84,185 (98%) / 152 / 1.00 / 1.00 Rarely or ≥1 time/mo: 1,665 (2%) / 4 / 1.65 (0.61-4.47) p=0.36 / 1.52 (0.56-4.12) p=0.44 **Solarium use, ages 10-39 years** Frequencies / Cases / Age Adjusted RR / Multivariate* Adjusted RR Never/rarely 10-39 yrs: 65,239 (82%) / 111 / 1.00 / 1.00 ≥1 1 time/mo 10-19, 20-29, or 30-39 years: 14,377 (18%) / 34 / 1.45 (0.98-2.14) / 1.55 (1.04-2.32) *Adjusted for age, region of residence, hair color, and the corresponding number of age-specific sunburns and weeks on annual summer vacations

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Cohort			
van Dam 1999[69] Health Professionals Followup Study	NR	**Number lifetime blistering sunburns (95% CI)** Cases / Age Adjusted RR / Multivariate* Adjusted RR None: 348 / 1.00 / 1.00 1-2: 616 / 1.26 (1.10-1.44) / 1.14 (1.00-1.30) 3-5: 641 / 1.45 (1.27-1.65) / 1.20 (1.05-1.38) 6-9: 403 / 1.72 (1.49-1.99) / 1.33 (1.14-1.54) ≥10: 715 / 2.06 (1.81-2.36) / 1.49 (1.30-1.71) Test for trend: p<0.0001 / p<0.0001 Data missing for 550 cases* Adjusted for age, time period, hair color, eye color, ancestry, skin reaction to sun, and BMI	

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Cohort			
Veierod 2003[82] Norwegian-Swedish Women's Lifestyle and Health Cohort Study	NR	**Annual number of sunburns, ages 10-19 years** Frequencies / Cases / Age Adjusted RR / Multivariate* Adjusted RR 0: 21,747 (23%) / 22 / 1.00 / 1.00 ≤1/year: 52,452 (55%) / 94 / 1.80 (1.13-2.86) / 1.64 (1.03-2.62) ≥2/year: 21,273 (22%) / 55 / 2.70 (1.65-4.44) / 2.42 (1.46-4.02) Trend: p<0.001 / p<0.001 **Annual number of sunburns, ages 10-39 years** Frequencies / Cases / Age Adjusted RR / Multivariate* Adjusted RR ≤1/yr, 10-39 yrs: 64,807 (72%) / 99 / 1.00 / 1.00 ≥2/yr, 20-29yrs and/or 30-39 yrs: 5,873 (6%) / 13 / 1.47 (0.82-2.62) / 1.54 (0.86-2.75) ≥2/yr, 10-19 yrs: 7,357 (8%) / 20 / 1.82 (1.13-2.95) / 1.66 (1.02-2.70) ≥2/yr, 10-39 yrs: 12,595 (14%) / 34 / 1.83 (1.24-2.70) / 1.79 (1.20-2.68) Trend: p<0.001 / p=0.002 *Adjusted for age, region of residence, and hair color	

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered	Followup
Cohort						
Cho 2005[93] Nurses' Health Study I & II, Health Professionals Followup Study	**Skin Cancer:** Melanoma **Study Design:** Prospective cohort **Location:** US (multi-state)	**Inclusion:** Participants in NHS I & II (1986) and the Health Professional Followup Study (1992) with a diagnosis of invasive melanoma including superficial spreading and nodular types **Exclusion:** Cancer other than nonmelanoma skin cancer, melanoma in situ, non-Whites, missing answers for traditional melanoma risk factors on questionnaire	**N=**178,155 **Mean age (range):** 25-75 **Sex:** 86% Female **Skin phenotype:** NR 100% White	Sun exposure, sunscreen exposure Mailed questionnaires, every 2 years	Age, family history of melanoma, number of nevi, hair color, history of severe and painful sunburn also evaluated other potential confounders (but did not make statistically significant contribution to the model): skin reaction to sun, latitude of residence at birth and age 1, and age 30, BMI, height, physical activity, reproductive factors, and use of sunscreen	Up to 14 years 100% (because excluded people with missing data)
Green 1996[65] Nambour Skin Cancer Study	**Skin Cancer:** BCC and SCC **Study Design:** Cohort **Location:** Australia	**Inclusion:** Aged 20-69, resident of Nambour, Queensland from electoral roll 1986 **Exclusion:** NR	**N=** 2,095 (baseline data provided for n=2049) **Age:** 20-39: 870 (42%) 40-59: 861 (42%) 60-69: 318 (16%) **Sex (calc):** 56% Female **Skin phenotype:** *Ability to tan (calc)* Always burn: 467 (23%) Burn then tan: 1,263 (62%) Always tan: 319 (16%)	Sun exposure Clinical examination with standardized questionnaires	Age, sex and skin color	6 years 80%

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Cohort		
Cho 2005[93] Nurses' Health Study I & II, Health Professionals Followup Study	NR	NR
Green 1996[65] Nambour Skin Cancer Study	**Relative rates of BCC and SCC according to occupational exposure** BCC (n=250) SCC (n=94) RR (95% CI) P RR (95% CI) P Mainly indoors 1.00 1.00 Indoors and outdoors 1.07 (0.79-1.46) 0.82 (0.47-1.43) Mainly outdoors 1.25 (0.88-1.78) 0.221 1.37 (0.80-2.34) 0.224 **Relative rates of BCC and SCC according to leisure exposure** BCC (n=250) SCC (n=94) RR (95% CI) P RR (95% CI) P Mainly indoors 1.00 1.00 Indoors and outdoors 0.93 (0.63-1.37) 0.81 (0.37-1.80) Mainly outdoors 0.85 (0.59-1.21) 0.342 1.29 (0.66-2.52) 0.223 Adjusted for age, sex, and skin color	NR

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Cohort			
Cho 2005[93] Nurses' Health Study I & II, Health Professionals Followup Study	"Use of sunscreen was not related to a reduced risk of melanoma" (p. 2671) when this variable was added to the multivariate model to predict risk of melanoma	**Number of severe and painful sunburns and relative risk of melanoma (calc)** N (%) Regression Coefficient SE P RR (95% CI) None 64 (12) -- -- -- 1.0 1-2 109 (20) 0.3358 0.1579 0.0334 1.40 (1.03-1.91) 3-5 107 (20) 0.4833 0.1599 0.0025 1.62 (1.19-2.22) 6-9 89 (17) 0.6683 0.1670 <0.0001 1.95 (1.41-2.71) 10+ 166 (31) 0.8574 0.1549 <0.0001 2.36 (1.74-3.19) Adjusted for sex, age, family history of melanoma, moles larger than 3mm on arms or legs, hair color	
Green 1996[65] Nambour Skin Cancer Study	NR	**Relative rates of BCC and SCC according to number of painful sunburns** BCC (n=250) SCC (n=94) RR (95% CI) P RR (95% CI) P None 1.00 1.00 1 0.91 (0.55-1.50) 1.71 (0.66-4.41) 2-5 1.10 (0.73-1.67) 3.31 (1.48-7.43) 6+ 1.68 (1.10-2.57) 0.003 3.28 (1.41-7.59) <0.001 Adjusted for sex and age	

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered	Followup
Cohort						
Neale 2007[61] Supplement to Green 1999[57]	**Skin Cancer:** BCC of head and trunk **Study Design:** Cohort from Nambour Skin Cancer Trial **Location:** Australia	**Inclusion:** Aged 20-69, resident of Nambour, Queensland from electoral roll 1986, who attended a second survey in 1992; subgroup of those with their first BCC on head and trunk only **Exclusion:** Taking vitamin supplements containing betacarotene, already applying sunscreen on a strict daily basis	**N**= 1517 **N (no lesions)=** 1248 N **(BCC head or trunk)**= 269 (head n=175, trunk n=94) **Mean age (range):** Head first: 61 Trunk first: 57 **Sex:** NR **Skin phenotype:** NR	Sun exposure	Age and sex	unclear (see Green 1999[57])

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Cohort		
Neale 2007[61] Supplement to Green 1999[57]	**Association between truncal BCC and BCC of the head and occupational type, compared to participants without lesions** Head OR (95% CI) / Trunk OR (95% CI) Mainly indoors: 1.0 / 1.0 Indoors & outdoors: 0.95 (0.60-1.49) / 1.07 (0.60-1.93) Mainly outdoors: 0.86 (0.53-1.40) / 1.12 (0.60-2.11) **Association between truncal BCC and BCC of the head and leisure type, compared to participants without lesions** Head OR (95% CI) / Trunk OR (95% CI) Mainly indoors: 1.0 / 1.0 Indoors & outdoors: 0.93 (0.64-1.35) / 1.15 (0.62-2.12) Mainly outdoors: 0.99 (0.60-1.63) / 0.84 (0.32-2.17)	NR

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
Neale 2007[61] Supplement to Green 1999[57]	NR	**Association between truncal BCC and BCC of the head and lifetime sunburns, compared to participants without lesions** Head OR (95% CI) / Trunk OR (95% CI) None: 1.0 / 1.0 1-5: 0.96 (0.61-1.53) / 1.44 (0.73-2.84) 6-10: 1.37 (0.74-2.56) / 1.75 (0.74-4.17) >10: 1.79 (0.93-3.45) / 2.49 (1.04-5.99)	

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
White 1994[72]	**Skin Cancer:** Melanoma **Study Design:** Case control **Location:** Washington	**Cases:** **Selection:** SEER cancer registry that were diagnosed between 1984-1987 in 3 counties. Only cases read in hospital pathology labs were eligible to be disclosed **Eligibility criteria:** age 25-65 years, living, white, currently residing in the 3 counties, had a telephone, and had a melanoma histology defined as eligible; excluded nodular melanoma and malignant Hutchinson's melanotic freckle **Controls:** **Selection:** age, sex, and residence matched from random digit dialing **Eligibility criteria:** otherwise NR	**Cases n=** 256 **Controls n=** 273 **Age** Cases / Controls 29-36: 52 (20%) / 31 (12%) 37-47: 78 (31%) / 52 (19%) 48-58: 82 (32%) / 124 (45%) 59-65: 44 (17%) / 66 (24%) **Sex** Cases / Controls Male: 129 (50%) / 128 (47%) **Skin phenotype** *Skin reaction to chronic sun* Cases / Controls Deep tan: 46 (18%) / 87 (32%) Moderate tan: 105 (41%) / 113 (41%) Mild tan: 66 (26%) / 64 (23%) None or freckles: 39 (15%) / 9 (4%)	Sun exposure Telephone interview	Age, sex and educational level

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Case-control		
White 1994[72]	**Average yearly sun exposure (hours) for previous 10 years** Cases / Controls / OR* (95%CI) / P 0: 97 (38%) / 126 (46%) / 1.0 1-201: 86 (34%) / 63 (23%) / 1.16 (0.72-1.87) 202-499: 47 (18%) / 48 (18%) / 0.80 (0.45-1.42) 500-2,880: 26 (10%) / 36 (13%) / 0.88 (0.47-1.64) / 0.53 **Lifetime occupational sun exposure** Cases / Controls / OR* (95% CI) / P 0: 168 (66%) / 165 (60%) / 1.00 <50%: 72 (28%) / 78 (29%) / 0.89 (0.60-1.32) ≥50%: 16 (6%) / 30 (11%) / 0.64 (0.33-1.23) / 0.13 **Sun exposure index, by skin type** Cases / Controls / OR* (95% CI) / P Poor tanners (no tan, mild tan, or freckling in response to chronic sun) *Sun exposure index, age 2-10* low: 50 (52%) / 34 (49%) / 1.00 med: 23 (24%) / 17 (24%) / 0.96 (0.43-2.18) high: 23 (24%) / 19 (27%) / 0.88 (0.39-1.96) / 0.78 *Sun exposure index, age 11-20* low: 53 (54%) / 43 (60%) / 1.00 med: 24 (25%) / 18 (25%) / 0.94 (0.42-2.08) high: 20 (21%) / 11 (15%) / 1.55 (0.61-3.99) / 0.45 Deep tanners (moderate or deep tan in response to chronic sun) *Sun exposure index, age 2-10* low: 78 (54%) / 71 (36%) / 1.00 med: 40 (28%) / 55 (28%) / 0.69 (0.40-1.21) high: 26 (18%) / 71 (36%) / 0.30 (0.17-0.55) / 0.001	NR

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

	Sun exposure index, age 11-20 low 76 (52%) 64 (32%) 1.00 med 46 (31%) 81 (41%) 0.50 (0.30-0.85) high 25 (17%) 54 (27%) 0.31 (0.16-0.59) 0.001 *Adjusted for age, sex and education	

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
White 1994[72]	NR	NR	

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Osterlind 1988[83] Osterlind 1988[129]	**Skin Cancer:** Melanoma **Study Design:** Case control **Location:** East Denmark	**Cases:** **Selection:** incident cases 1982-1985 from the Danish Cancer Registry **Eligibility criteria:** age 20-79 years, any cutaneous melanoma except lentigo maligna melanoma **Controls:** **Selection:** age, sex matched from national population register in 1984 **Eligibility criteria:** otherwise NR	**Cases n=** 474 **Controls n=** 926 **Average age at diagnosis:** 52 **Sex (calc)** Cases Controls Male 194 (41%) NR **Chronic reaction to sunlight (calc)** Cases Controls Deep tan 125 (26.4%) 326 (35.2%) Moderate tan 228 (48.1%) 429 (46.3%) Mild tan 101 (21.3%) 143 (15.4%) No tan 18 (3.8%) 24 (2.6%)	Sun exposure, sunscreen use, sunburnsmixed Telephone and in-person interviews	Constitutional factors, sex and age

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Case-control		
Osterlind 1988[83] Osterlind 1988[129]	**Sunbathing habits (calc)** Cases Controls Crude RR (95% CI) Adjusted* RR (95% CI) Never 42 (8.9%) 135 (14.6%) 1.0 1.0 At some time 432 (91.1%) 791 (85.4%) 1.8 (1.2-2.5) 1.6 (1.1-2.4) 1-9 years 16 (3.4%) 27 (2.9%) 1.9 (0.9-3.9) 10-24 years 99 (20.9%) 197 (21.3%) 1.6 (1.1-2.5) 25-39 years 161 (34.0%) 313 (33.8%) 1.7 (1.1-2.5) 40+ years 149 (31.4%) 248 (26.8%) 1.9 (1.3-2.9) *p=0.004* *Adjusted for sex, naevi, freckles and hair color **Vacations spent in sun (calc)** Cases Controls Crude RR (95% CI) Adjusted* RR (95% CI) Never 182 (38.4%) 406 (43.8%) 1.0 1.0 Sunny 229 (48.3%) 433 (46.8%) 1.2 (0.9-1.5) 1.0 (0.8-1.3) Very sunny 63 (13.3%) 84 (9.1%) 1.7 (1.2-2.4) 1.4 (1.0-2.1) *p<0.01* *p=0.138* *Adjusted for history of sunbathing and sunburning	**Ever used sunbed** Cases (calc): 66 (14%) Controls (calc): 167 (18%) RR (95% CI): 0.7 (0.5-1.0)

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
Osterlind 1988[83] Osterlind 1988[129]	NR	**Number of painful sunburns before age 15 (calc)** Never: Cases 93 (19.6%), Controls 277 (29.9%), Crude RR (95%CI) 1.0, Adjusted RR* (95% CI) 1.0 1: Cases 35 (7.4%), Controls 80 (8.6%), Crude RR (95%CI) 1.3 (0.8-2.1), Adjusted RR* (95% CI) 1.2 (0.7-1.9) 2-4: Cases 85 (17.9%), Controls 121 (13.1%), Crude RR (95%CI) 2.1 (1.5-3.0), Adjusted RR* (95% CI) 1.9 (1.3-2.9) 5+: Cases 44 (9.3%), Controls 35 (3.8%), Crude RR (95%CI) 3.7 (2.3-6.1), Adjusted RR* (95% CI) 2.7 (1.6-4.8) *p<0.001* *p<0.001* *Adjusted for sex, number of raised naevi, freckles and hair color	

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Berwick 1996[73] Lea 2007[130] Chen 1996[131]	**Skin Cancer:** Melanoma **Study Design:** Case control **Location:** Connecticut	**Cases:** **Selection:** all first incident cases from SEER cancer registry that were diagnosed between 1987-1989 **Eligibility criteria:** ≥18 years, Caucasian, invasive melanoma, excluded melanoma in situ **Controls:** **Selection:** age and sex matched, random digit dialing **Eligibility criteria:** otherwise NR	**Cases n=** 650 **Controls n=** 549 **Age:** <40: Cases 123 (19%), Controls 110 (20%) 40-70: Cases 380 (58.5%), Controls 320 (58.3%) ≥70: Cases 147 (22.6%), Controls 119 (21.7%) **Sex:** Male: Cases 343 (52.8%), Controls 316 (57.6%) **Skin phenotype*** *Acute Skin Response* Tan: Cases 201 (53%), Controls 220 (60%) Burn: Cases 179 (47%), Controls 144 (40%) *Prolonged Skin Response* Tan: Cases 233 (61%), Controls 283 (77%) No tan: Cases 147 (39%), Controls 81 (23%) *Missing information, lived aroad, lentigo maligna, and acral lentiginous melanoma excluded from analysis	Sun exposure Nurse-administered questionnaire and examination of arms and back for nevi	Berwick 1996: Age, sex, sun exposure, nevi, family history, skin type, eye color, hair color, tendency to freckle, ever severely sunburned, Lea 2007: Age, sex, sun sensitivity, number of vacations and mean number of days per year in recreational activity, cumulative UVB

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Case-control		
Berwick 1996[73] Lea 2007[130] Chen 1996[131]	**Total Sun Exposure** OR* (95% CI) / Adjusted OR** (95% CI) Light 1.00 / 1.00 Moderate 1.04 (0.65-1.66) / 1.26 (0.69-2.29) Heavy 1.80 (1.14-2.86) / 2.20 (1.21-4.01) Very heavy 2.11 (1.18-3.15) / 2.63 (1.25-5.54) *Adjusted for age and sex **Adjusted for skin self-examination, total nevi, family hx skin cancer, skin type, eye color, hair color, freckle, and ever severely sunburned **Total recreational sun exposure index*** Head/neck OR (95% CI) / Upper limb OR (95% CI) / Lower limb OR (95% CI) / Trunk OR (95% CI) Level 1 -- / -- / -- / -- Level 2 1.5 (0.7-3.3) / 0.9 (0.4-1.8) / 1.0 (0.5-2.2) / 1.7 (1.0-2.9) Level 3 1.0 (0.7-2.1) / 1.0 (0.5-2.0) / 1.2 (0.6-2.7) / 1.4 (0.7-2.2) Level 4 2.6 (1.2-5.6) / 2.4 (1.2-4.8) / 2.7 (1.2-5.8) / 2.7 (1.6-4.5) **Total years in outdoor jobs**** Head/neck OR (95% CI) / Upper limb OR (95% CI) / Lower limb OR (95% CI) / Trunk OR (95% CI) 0 -- / -- / -- / -- <5 0.8 (0.4-1.5) / 0.7 (0.4-1.4) / 0.7 (0.3-1.3) / 0.7 (0.5-1.1) 5+ 0.5 (0.2-1.1) / 0.6 (0.2-1.1) / 0.3 (0.1-0.9) / 0.9 (0.6-1.3) *Adjusted for sex, age, skin color, number of nevi on arms, and skin type **Due to missing values, 525 cases and 468 controls **Number of vacations** Cases / Controls / OR (95% CI) / P *Birth to age 15* 0 235 (61.8%) / 238 (65.4%) / 1.0 (R) 1-14 100 (26.3%) / 83 (22.8%) / 1.1 (0.8-1.7) / 0.5 15-90 45 (11.8%) / 43 (11.8%) / 0.9 (0.5-1.4) / 0.7 *10 years before interview* 0 88 (23.2%) / 93 (25.6%) / 1.0 (R) 1-3 88 (23.2%) / 93 (25.6%) / 1.1 (0.7-1.7) / 0.8 4-8 81 (21.3%) / 91 (25.0%) / 1.0 (0.6-1.6) / 0.9 9-40 123 (32.4%) / 87 (23.9%) / 1.5 (0.9-2.4) / 0.05	NR

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
Berwick 1996[73] Lea 2007[130] Chen 1996[131]	NR	**Ever severely sunburned** OR (95% CI): 1.26 (0.99-1.61) Adjusted* OR (95% CI): 0.97 (0.71-1.32) *Adjusted for skin self-examination, skin color, sun exposure, number of nevi, family history of skin cancer, skin type, eye color, hair color, and tendency to freckle before age 25	

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Chen 1998[89]	See Berwick et al 1996	See Berwick et al 1996	**Cases n=** 624 **Controls n=** 512 Sample drawn from larger case control study Berwick 1996, RM 215	Sunlamp exposure Nurse-administered questionnaires in home, at place of employment, or public place	Hair color, eye color, skin color, skin type (ability to tan), total number of nevi on arms and back, history of recreational sun exposure and history of occupational sun exposure
Weinstock 1991[87] Nurses Health Study	**Skin Cancer:** Melanoma **Study Design:** nested-Case control **Location:** US (multi-state)	**Cases:** **Selection:** members of Nurses' Health Study with dx of melanoma 1976-1984 confirmed by examination of medical records **Eligibility criteria:** born between 1921-1946; excluded ppts who were black, Asian or Hispanic, ppts with family hx of melanoma; excluded acral lentigenous melanoma or lentigo maligna **Controls**: **Selection:** 2 age-matched controls per case from same cohort **Eligibility criteria:** excluded ppts who were black, Asian, Hispanic and fam hx of melanoma	**Cases n=** 130 **Controls n=** 300 **Age:** 52.1 (mean) **Sex** Cases Controls Male 0 0 **Skin phenotype** *Depth of tan after repeated exposure (calc)* Cases Controls Deep 17 (13.1%) 75 (25.0%) Medium 52 (40.0%) 118 (39.3%) Light 51 (39.2%) 79 (26.3%) None 6 (4.6%) 17 (5.7%)	Sun exposure Mixed mailed questionnaires and telephone interviews	Birth year, cycle of questionnaire, method of data collection, sun sensitivity, and latitude of residence at ages 15-20 years

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Case-control		
Chen 1998[89]	NR	**Ever used sunlamp (calc)** Cases Controls Crude* OR (95% CI) Adjusted** OR (95% CI) No 483 (77.4%) 417 (81.4%) -- -- Yes 141 (22.6%) 95 (18.6%) 1.30 (0.97-1.74) 1.13 (0.82-1.54) **Total # sunlamp uses** Cases Controls Crude* OR (95% CI) Adjusted** OR (95% CI) Never 483 (77.4%) 417 (81.4%) -- -- <10 76 (12.2%) 50 (9.8%) 1.32 (0.91-1.92) 1.25 (0.84-1.84) ≥10 63 (10.1%) 40 (7.8%) 1.40 (0.93-2.12) 1.15 (0.60-2.20) *p=0.97* *p=0.86* **Age at first use of sunlamp** Cases Controls Crude* OR (95% CI) Adjusted** OR (95% CI) Never 483 (77.4%) 417 (81.4%) -- -- <25 74 (11.9%) 42 (8.2%) 1.58 (1.05-2.39) 1.35 (0.88-2.08) 25-45 39 (6.3%) 31 (6.1%) 1.11 (0.68-1.80) 1.02 (0.61-1.70) >45 23 (3.7%) 15 (2.9%) 1.27 (0.65-2.47) 1.13 (0.56-2.28) *Adjusted for sex and age **Adjusted for sex, age, cutaneous phenotype index, and total recreational sun exposure index

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Weinstock 1991[87] Nurses Health Study	**Annual frequency of any swimsuit use outdoors at ages 15-20 years** *Sun resistant** 0-10: 21 (44%) Cases; 37 (24%) Controls; 1.0 (R) 11-30: 17 (35%) Cases; 60 (39%) Controls; 0.6 (0.2-1.4) ≥31: 10 (21%) Cases; 57 (37%) Controls; 0.3 (0.1-0.8); P 0.02 *Sun sensitive*** 0-10: 23 (32%) Cases; 47 (44%) Controls; 1.0 (R) 11-30: 23 (32%) Cases; 39 (36%) Controls; 1.2 (0.6-2.6) ≥31: 26 (36%) Cases; 21 (20%) Controls; 3.5 (1.3-9.3); P 0.01 *A priori sun sensitivity score <0.5 **A priori sun sensitivity score ≥0.5	NR

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
Chen 1998[89]	NR	NR	
Weinstock 1991[87] Nurses Health Study	NR	NR	

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Walter 1999[90] Walter 1990[132]	**Skin Cancer:** Melanoma **Study Design:** case control **Location:** Ontario, Canada	**Cases:** **Selection:** incident cases between 1984-1986 from local lab pathology reports **Eligibility criteria:** aged 20-69; recurrent lesions excluded (lesion considered recurrent if dx within previous yr and located in same lymphatic drainage area). Blacks and non-English speaking subjects excluded **Controls**: **Selection:** age, sex, and municipality matched from property tax assessment rolls **Eligibility criteria:** Blacks and non-English speaking subjects excluded	**Cases n=** 583 **Controls n=** 608 **Age:** NR **Sex (calc)** Male: 277 (47.5%) Cases; 283 (46.5%) Controls **Skin phenotype:** NR	Sun exposure, Sunbed exposure In-person interview	Sex, age, and skin reaction to initial summer sun exposure

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Case-control		
Walter 1999[90] Walter 1990[132]	**Beach vacation past 5 years (calc)** Cases Controls Yes 295 (50.6%) 302 (49.7%) No 284 (47.7%) 303 (49.8%) Crude* OR (95%CI): 1.04 (0.82-1.32) Adjusted** OR (95% CI): 1.04 (0.82-1.32) *Adjusted for sex, age, and reaction to initial summer sun exposure **Adjusted for sex, age, reaction to initial summer sun exposure, and potential confounders	**Ever use (calc)** Cases Controls Yes 153 (26.2%) 109 (49.7%) No 431 (73.9%) 498 (81.9%) Crude* OR (95%CI): 1.61 (1.21-2.15) Adjusted** OR (95% CI): 1.54 (1.16-2.05) *Adjusted for sex, age, and reaction to initial summer sun exposure **Adjusted for sex, age, reaction to initial summer sun exposure, and potential confounders **Ever use (by sex)** Cases Controls OR (95% CI) P Males 277 (24.2%) 283 (14.5%) 1.88 (1.20-2.98) <0.01 Females 306 (27.8%) 324 (21.0%) 1.45 (0.99-2.13) 0.06 **Age-adjusted cumulative minutes use (by sex)** Cases Controls OR (95% CI) P *Males* 0 210 (77%) 242 (86%) 1.00 <180 25 (9%) 20 (7%) 1.44 (0.75-2.82) 0.31 ≥180 39 (14%) 18 (6%) 2.50 (1.34-4.80) <0.01 *Females* 0 222 (74%) 256 (80%) 1.00 <180 39 (13%) 39 (12%) 1.17 (0.70-1.95) 0.61 ≥180 38 (13%) 27 (8%) 1.62 (0.91-2.89) 0.10 **Age-adjusted age at first use (by sex)** Cases Controls OR (95% CI) P *Males* Never 210 (76%) 242 (87%) 1.00 <30 33 (12%) 19 (7%) 2.13 (1.13-4.13) 0.02 ≥30 33 (12%) 18 (6%) 2.04 (1.07-3.99) 0.03 *Females* Never 221 (73%) 256 (79%) 1.00 <30 51 (17%) 39 (12%) 1.55 (0.94-2.59) 0.09 ≥30 30 (10%) 29 (9%) 1.19 (0.66-2.13) 0.63

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
Walter 1999[90] Walter 1990[132]	NR	NR	

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Shors 2001[74] Soloman 2004[134]	**Skin Cancer:** Melanoma **Study Design:** case control **Location:** Washington	**Cases:** **Selection:** incident cases of primary invasive melanoma diagnosed in 1997 through the Seattle-Puget Sound SEER registry **Eligibility criteria:** aged 35-74, living, English-speaking; excluded for previous dx melanoma, diagnosis of melanoma in situ, Hutchinson's melanotic freckle, or lentigo maligna melanoma, non-white race or Hispanic origin **Controls:** **Selection:** random digit dialing **Eligibility criteria:** excluded those of non-white race or Hispanic origin, and those with history of melanoma	**Cases n=** 386 **Controls n=** 727 **Age:** 35-44: Cases M (n=201) 40; Controls M (n=261) 96; Cases F (n=185) 58; Control F (n=466) 185 45-54: 79; 89; 55; 134 55-64: 44; 46; 40; 90 65-74: 38; 30; 32; 57 **Sex (calc)** Male: Cases 201 (52.1%); Controls 261 (35.9%) **Skin phenotype** *Ability to tan (calc)* Deep tan: Cases 77 (19.9%); Controls 164 (22.6%) Moderate tan: 145 (37.6%); 306 (42.1%) Mild tan: 121 (31.3%); 192 (26.4%) Freckle/no tan: 42 (10.9%); 55 (7.6%)	Sun exposure Telephone interviews	Adjusted for age, income, tendency to burn, number of sunburns age 2-10, and sex

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sun exposure (cont.)
Case-control		
Shors 2001[74] Soloman 2004[134]	**Lifetime average days spent >4 hours in the sun (by quartile) (calc)** First quartile: Cases 70 (19.6%); Controls 168 (24.7%); OR (95% CI) 1.0 Second quartile: 89 (24.9%); 171 (25.2%); 1.3 (0.86-1.9) Third quartile: 95 (26.5%); 169 (24.9%); 1.4 (0.92-2.0) Fourth quartile: 104 (29.1%); 171 (25.2%); 1.4 (0.95-2.0) p for trend: p=0.10 **Age 2-10 days/month in sun (calc)** Adjusted* OR (95% CI) *Men* First quartile: Cases 24 (15.6%); Controls 41 (20.3%); 1.00 Second quartile: 34 (22.1%); 38 (18.8%); 1.53 (0.76-3.07) Third quartile: 38 (24.7%); 47 (23.3%); 1.30 (0.66-2.55) Fourth quartile: 58 (37.7%); 76 (37.6%); 1.14 (0.61-2.13) p for trend: p=0.99 *Women* First quartile: 23 (15.9%); 79 (22.7%); 1.00 Second quartile: 24 (16.6%); 80 (23.0%); 1.06 (0.55-2.05) Third quartile: 39 (26.9%); 73 (21.0%); 1.81 (0.99-3.34) Fourth quartile: 59 (40.7%); 116 (33.3%); 1.72 (0.98-3.02) p for trend: p=0.02	**Lifetime overall UV exposure (time in sun, erythemal exposure)** Adjusted* *Men* First quartile: Cases 50 (27.2%); Controls 62 (25.1%); OR (95% CI) 1.00 Second quartile: 31 (16.8%); 62 (25.1%); 0.51 (0.23-0.80) Third quartile: 38 (20.7%); 62 (25.1%); 0.67 (0.31-1.03) Fourth quartile: 65 (35.3%); 61 (24.7%); 1.24 (0.62-1.86) p for trend: p=0.28 *Women* First quartile: 35 (20.2%); 110 (25.6%); 1.00 Second quartile: 36 (20.8%); 105 (24.4%); 1.35 (0.64-2.05) Third quartile: 56 (32.4%); 107 (24.9%); 2.45 (1.23-3.68) Fourth quartile: 46 (26.6%); 108 (25.1%); 1.99 (0.95-3.03) p for trend: p=0.008 *Adjusted for age, income, tendency to burn and number of sunburns age 2-10 yrs **Age 1-10 yrs overall UV exposure (time in sun, erythemal exposure)** Adjusted* *Men* First quartile: Cases 39 (20.7%); Controls 64 (33.7%); OR (95% CI) 1.00 Second quartile: 42 (22.3%); 61 (32.1%); 0.84 (0.38-1.29)

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

	Previous 20 years days/month in sun (calc)		
	Cases	Controls	Adjusted* OR (95% CI)
Men			
First quartile	47 (23.7%)	66 (25.4%)	1.00
Second quartile	43 (21.7%)	59 (22.7%)	1.07 (0.62-1.87)
Third quartile	62 (31.3%)	47 (23.3%)	1.31 (0.78-2.20)
Fourth quartile	46 (23.2%)	67 (25.8%)	1.04 (0.60-1.79)
p for trend	p=0.69		
Women			
First quartile	39 (21.5%)	110 (23.7%)	1.00
Second quartile	35 (19.3%)	112 (24.1%)	0.97 (0.57-1.66)
Third quartile	62 (34.3%)	129 (27.8%)	1.52 (0.94-2.47)
Fourth quartile	45 (24.9%)	113 (24.4%)	1.23 (0.74-2.06)
p for trend	p=0.18		
	*Adjusted for age in the combined analysis of men and women		
Third quartile	38 (20.7%)	63 (25.1%)	0.87 (0.40-1.35)
Fourth quartile	65 (35.3%)	62 (24.7%)	1.34 (0.65-2.03)
p for trend			p=0.28
Women			
First quartile	32 (18.1%)	109 (25.2%)	1.00
Second quartile	44 (24.9%)	107 (24.8%)	1.69 (0.85-2.53)
Third quartile	51 (28.8%)	108 (25.0%)	1.69 (0.83-2.55)
Fourth quartile	50 (28.2%)	108 (25.0%)	2.14 (1.08-3.20)
p for trend			p=0.002
	*Adjusted for age in the combined analysis of men and women		

Study reference USPSTF quality	Measurement of sun exposure (cont.)	Measurement of sunlamp or sun bed exposure	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control					
Shors 2001[74] Soloman 2004[134]	**Age 11-20 overall UV exposure (time in sun, erythemal exposure)** Cases / Controls / Adjusted* OR (95% CI) *Men* First quartile 45 (23.1%) 62 (24.2%) 1.00 Second quartile 44 (22.6%) 66 (25.8%) 0.95 (0.46-1.44) Third quartile 43 (22.1%) 63 (24.6%) 0.96 (0.46-1.45) Fourth quartile 63 (32.3%) 65 (25.4%) 1.19 (0.60-1.78) p for trend p=0.56 *Women* First quartile 35 (18.9%) 118 (25.6%) 1.00 Second quartile 37 (20.0%) 112 (24.3%) 1.39 (0.68-2.09) Third quartile 59 (31.9%) 116 (25.2%) 2.37 (1.25-3.48) Fourth quartile 54 (29.2%) 115 (24.9%) 2.33 (1.19-3.46) p for trend p=0.001 *Adjusted for age in the combined analysis of men and women **Previous 20 years overall UV exposure (time in sun, erythemal exposure)** Cases / Controls / Adjusted* OR (95% CI) *Men* First quartile 44 (22.3%) 65 (25.0%) 1.00 Second quartile 40 (20.3%) 65 (25.0%) 1.00 (0.47-1.53) Third quartile 59 (29.9%) 65 (25.0%) 1.72 (0.85-2.59) Fourth quartile 54 (27.4%) 65 (25.0%) 1.53 (0.74-2.33) p for trend p=0.07 *Women* First quartile 43 (23.8%) 117 (25.2%) 1.00 Second quartile 39 (21.5%) 115 (24.8%) 1.01 (0.52-1.49) Third quartile 54 (29.8%) 116 (25.0%) 1.82 (0.96-2.68) Fourth quartile 45 (24.9%) 116 (25.0%) 1.30 (0.67-1.94) p for trend p=0.14 *Adjusted for age in the combined analysis of men and women	NR	NR	**# sunburns, age 2-10** Cases / Controls / OR (95% CI) 0 173 (47.0%) 436 (62.0%) 1.0 1 37 (10.1%) 72 (10.2%) 1.4 (0.88-2.1) 2 33 (9.0%) 64 (9.1%) 1.3 (0.81-2.1) 3+ 125 (34.0%) 131*(18.6%) 2.4 (1.8-3.4) p for trend p=0.001 *n reported as 1331, believe it is a typo **# sunburns, age 11-20** Cases / Controls / OR (95% CI) 0 93 (24.5%) 261 (36.3%) 1.0 1 63 (16.6%) 151 (21.0%) 1.3 (0.91-2.0) 2 37 (9.7%) 89 (12.4%) 1.3 (0.80-2.0) 3+ 187 (49.2%) 219 (30.4%) 2.7 (2.0-3.7) p for trend p=0.001	Controls were younger that cases for both sexes. Missing sun exposure estimates were assumed to be the same at the earliest age for which there were data. If any other data was missing, that participant was excluded from the analysis for that age period.

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Bataille 2005[91]	**Skin Cancer:** Melanoma **Study Design:** Case control **Location:** Sweden, The Netherlands, UK, Belgium, France	**Cases:** **Selection:** (varied by country) all first incident cases from dermatologists, pathologists, plastic surgeons, oncologists and melanoma databases between 1998-2001 **Eligibility criteria:** aged 18-49, Caucasian, excluded lentigo malignant melanoma or in situ melanoma **Controls:** **Selection:** (varied by country) age, sex matched, random selection from population registries, from general practices matched by geographical area, and from door-to-door search **Eligibility criteria:** otherwise NR	**Cases n=** 597 **Controls n=** 622 **Mean age (SD)** Cases: 38 (7.8) Controls: 37 (7.8) **Sex:** Cases Controls Male 219 (37%) 214 (34%) **Skin phenotype (Fitzpatrick classification)** Cases Controls IV (good tanner) 61 (10%) 118 (19%) III 194 (32%) 273 (44%) II 245 (41%) 171 (27%) I (never tan) 97 (16%) 60 (10%)	Sunbed exposure In-person interviews	Age, sex, skin type
Garbe 1989[78]	**Skin Cancer:** Melanoma **Study Design:** case control **Location:** Germany	**Cases:** **Selection:** 200 consecutive patients presenting at dermato-oncologic followup clinic in 1987 **Eligibility criteria:** German origin **Controls**: **Selection:** age and sex matched nonmelanoma patients at the clinic with any skin disease other than melanoma **Eligibility criteria:** German origin; excluded if had consultation due to pigmented nevi, or previously treated by UV radiation	**Cases n=** 200 **Controls n=** 200 **Mean age:** Cases Controls Male 50.7 51.0 Female 56.6 57.0 **Sex (calc)** Cases Controls Male 79 (39.5%) NR **Skin phenotype:** Cases Controls IV 18 (9.0%) 21 (10.5%) III 76 (38.0%) 94 (47.0%) II 71 (35.5%) 65 (32.5%) I 35 (17.5%) 20 (10.0%)	Sun exposure 20 minute interview and physical exam	NR

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Case-control		
Bataille 2005[91]	NR	**Ever used sunbed** Cases / Controls / Crude OR (95% CI) / Adjusted* OR (95% CI) <age 15: 23 (4%) / 14 (2%) / 1.74 (0.89-3.42) / 1.82 (0.92-3.62) Ever: 315 (53%) / 354 (57%) / 0.84 (0.67-1.06) / 0.90 (0.71-1.14) **Cumulative lifetime sunbed use (in hours)** Cases / Controls / Crude OR (95% CI) / Adjusted* OR (95% CI) 0: 282 (47%) / 268 (43%) / 1.00 / 1.00 <10: 163 (28%) / 168 (28%) / 0.92 (0.70-1.21) / 0.95 (0.71-1.25) 10-30: 56 (10%) / 76 (13%) / 0.70 (0.48-1.03) / 0.75 (0.50-1.11) 31-60: 25 (4%) / 37 (6%) / 0.64 (0.38-1.09) / 0.75 (0.43-1.30) 61-100: 17 (3%) / 17 (3%) / 0.95 (0.47-1.89) / 1.10 (0.55-2.24) >100: 40 (7%) / 38 (6%) / 1.00 (0.62-1.60) / 1.19 (0.73-1.93) *Adjusted for age, sex, skin phototype
Garbe 1989[78]	The skin type as well as the occupational sun exposure appeared to represent a significant increase of RR, but, the duration of the occupational sun exposure in years had no significant influence **Relative risk for occupational sun exposure to upper part of the body and/or the extremities on the occasion of sunshine** Cases / Controls / Nonadjusted RR (95% CI) / Adjusted RR (95% CI) None: 159 (79.5%) / 174 (87.0%) / 1.00 / 1.00 Sometimes: 31 (15.5%) / 24 (12.0%) / 1.41 (0.80-2.51) / 1.18 (0.56-2.48) Nearly every time: 10 (5.0%) / 2 (1.0%) / 5.47 (1.18-25.30) / 11.62 (2.13-63.33)	NR

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
Bataille 2005[91]	NR	**Sunburn before age 15** Cases / Controls / Crude OR (95%CI) / Adjusted* OR (CI 95% CI) No: 308 (52%) / 375 (61%) Yes: 289 (48%) / 247 (39%) / 1.42 (1.13-1.79) / 1.20 (0.95-1.54) *Adjusted for age, sex, and skin type	
Garbe 1989[78]	NR	NR	

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Gallagher 1986[75] Elwood 1985[135] Elwood 1984[136] Western Canada Melanoma Study	**Skin Cancer:** Melanoma **Study Design:** Case control **Location:** Western Canada	**Cases:** **Selection:** newly diagnosed from province cancer registries between 1979-1981 **Eligibility criteria:** aged 20-79 years. Excluded lentigo maligna and acral lentiginous melanoma **Controls**: **Selection:** from medical insurance plan list of subscribers, age and sex matched **Eligibility criteria:** NR	**Cases n=** 595 **Controls n=** 595 **Age (mean):** NR **Sex (calc)** Cases / Controls Male 234 (39%) / 234 (39%) **Skin phenotype (calc):** *Skin reaction to sun* Cases / Controls Tan, no burn 184 (31%) / 280 (47%) Tan with protection 77 (13%) / 60 (10%) Burn then tan 250 (42%) / 202 (34%) Burn only 83 (14%) / 60 (10%)	Sun exposure In-person interviews	Hair color, skin color, history of freckles and ethnic origin

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sun exposure (cont.)
Case-control		
Gallagher 1986[75] Elwood 1985[135] Elwood 1984[136] Western Canada Melanoma Study	**Occupational sun exposure (calc)** Equivalent hours* / Cases / Adjusted RR** <1 143 (24%) 1.0 1-99 196 (33%) 1.8 100-199 101 (17%) 1.0 200-399 89 (15%) 0.9 400+ 71 (12%) 0.9 *p<0.01* **Recreational sun exposure in summer season (calc)** Equivalent hours* / Cases / Adjusted RR** <1 173 (29%) 1.0 1-19 89 (15%) 1.1 20-79 167 (28%) 1.7 80-159 89 (15%) 1.8 160+ 77 (13%) 1.7 *p<0.01* **Vacation sun exposure in summer season (calc)** Equivalent hours* / Cases / Adjusted RR** <1 196 (33%) 1.0 1-6 149 (25%) 0.9 7-19 77 (13%) 0.9 20-39 89 (15%) 1.9 40+ 83 (14%) 1.5 *p<0.01* *1 hour of sun exposure to the whole body. Converted using estimates of proportion of body area exposed. **Adjusted for hair color, skin color, freckling, and ethnic origin	**Occupational, summer, hr/season (calc)** Cases / Controls / Crude RR / Adjusted RR* (95%CI) <1 141 (23.7%) 156 (26.2%) 1.0 (R) 1.0 1-99 195 (32.8%) 136 (22.9%) 1.6 1.8 (1.2-2.5) 100-199 100 (16.8%) 103 (17.3%) 1.1 1.0 (0.7-1.5) 200-399 87 (14.6%) 110 (18.5%) 0.9 0.9 (0.6-1.4) 400+ 72 (12.1%) 90 (15.1%) 0.9 0.9 (0.6-1.5) p<0.01 p<0.01 **Recreational, summer, hr/season (calc)** Cases / Controls / Crude RR / Adjusted RR* (95%CI) <1 172 (28.9%) 230 (38.7%) 1.0 1.0 1-19 92 (15.5%) 105 (17.6%) 1.3 1.1 (0.7-1.6) 20-79 165 (27.7%) 122 (20.5%) 2.0 1.7 (1.2-2.5) 80-159 89 (15.0%) 79 (13.3%) 1.7 1.8 (1.2-2.7) 160+ 77 (12.9%) 59 (10.0%) 2.0 1.7 (1.1-2.7) p<0.001 p<0.01 **Vacation, summer, hr/season (calc)** Cases / Controls / Crude RR / Adjusted RR* (95%CI) <1 194 (32.6%) 216 (36.3%) 1.0 1.0 1-6 151 (25.4%) 175 (29.4%) 1.0 0.9 (0.7-1.3) 7-19 79 (13.3%) 91 (15.3%) 1.0 0.9 (0.6-1.4) 20-39 90 (15.1%) 50 (8.4%) 2.1 1.9 (1.3-3.0) 40+ 81 (13.6%) 63 (10.6%) 1.5 1.5 (1.0-2.3) p<0.001 p<0.01

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure (cont.)	Measurement of sunlamp or sun bed exposure	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control					
Gallagher 1986[75] Elwood 1985[135] Elwood 1984[136] Western Canada Melanoma Study	**Sunny vacations per decade (calc)** Cases / Controls / Crude RR / Adjusted RR* (95%CI) 0: 174 (29.2%) / 189 (31.8%) / 1.0 (R) / 1.0 <1: 150 (25.%) / 187 (31.4%) / 1.1 / 1.1 (1.0-1.1) 1-3: 145 (24.4%) / 133 (22.4%) / 1.3 / 1.3 (1.1-1.5) 4+: 126 (21.2%) / 86 (14.5%) / 1.8 / 1.7 (1.2-2.3) p<0.001 / p<0.001 * Adjusted for hair color, skin color, history of freckles, and ethnic origin **Annual sun exposure, hours (calc)** Cases / Controls / RR (95% CI) <49: 36 (6.1%) / 45 (7.6%) / 1.0 50-99: 49 (8.2%) / 42 (7.1%) / 1.5 (0.8-2.7) 100-149: 64 (10.8%) / 53 (8.9%) / 1.5 (0.9-2.7) 150-199: 64 (10.8%) / 49 (8.2%) / 1.6 (0.9-2.9) 200-299: 93 (15.6%) / 116 (19.5%) / 1.0 (0.6-1.7) 300-399: 70 (11.8%) / 79 (13.3%) / 1.1 (0.6-1.9) 400-499: 76 (12.8%) / 61 (10.3%) / 1.6 (0.9-2.7) 500+: 143 (24.0%) / 150 (25.2%) / 1.2 (0.7-2.0) p<0.1	NR	NR	**Childhood sunburn (calc)** Cases / RR Crude / RR Adjusted* Rare or mild: 143 (24%) / 1.0 / 1.0 Moderate or infrequent: 161 (27%) / 1.4 / 1.1 Severe or frequent: 292 (49%) / 1.9 / 1.3 *p=NS* *Adjusted for other pigmentation factors and for freckling, childhood sunburn and ethnic origin	

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Kricker 1991[62] Kricker 1995[116] Kricker 1995[36] English 1998[63] English 1998[33]	**Skin Cancer:** BCC & SCC **Study Design:** Case-control **Location:** Western Australia	**Cases:** **Selection:** BCC or SCC diagnosed at the Geraldton prevalence survey in 1987 or within the preceding 12 months **Eligibility criteria:** 40-64 years of age, resident in Geraldton **Controls**: **Selection:** from same survey, subjects who had no diagnosis of BCC, SCC, keratocanthoma, or intraepithelial carcinoma. Stratified by sex and age **Eligibility criteria:** NR	**Cases n=** 248 (23 persons with both BCC and SCC) BCC cases n=226 SCC cases n=45 **Controls n=** 1,015 **BCC controls n=** 1,021 (6 cases of SCC) **SCC controls n=** 1,064 (49 cases of BCC) **Age (mean):** NR **Sex:** NR **Skin phenotype:** *Ability to tan (calc)* BCC: Cases / Controls; SCC: Cases / Controls Very brown: 43 (19.0%) / 369 (36.2%) / 7 (15.6%) / 320 (34.2%) Moderate tan: 100 (44.2%) / 436 (43.1%) / 19 (42.2%) / 409 (43.7%) Mild tan: 66 (29.2%) / 176 (17.3%) / 12 (26.7%) / 171 (18.3%) Freckle/no tan: 17 (7.5%) / 37 (3.6%) / 7 (15.6%) / 35 (3.7%)	Sun exposure, sunscreen exposure Interviews (location NR)	Ethnicity, pigmentary traits and sensitivity of the skin to sunlight, sun exposure, sun damage, skin conditions

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sun exposure (cont.)
Case-control		
Kricker 1991[62] Kricker 1995[116] Kricker 1995[36] English 1998[63] English 1998[33]	**Risk of BCC in relation to intermittency of sun exposure in 15-19-year-olds before diagnosis estimated from a typical week in each of the warmer and cooler months at each place of residence and adjusted for age, sex, ability to tan and total sun exposure (calc)** Cases / Controls / OR (95%CI) / P 0-40% 36 (17.9%) 177 (25.3%) 1.00 41-58% 50 (24.9%) 183 (26.1%) 1.49 (0.88-2.52) 59-99% 49 (24.4%) 156 (22.3%) 1.82 (1.01-3.28) 0.001 100% 66 (32.8%) 184 (26.3%) 3.86 (1.93-7.75) <0.001 for trend **Risk of BCC in relation to the interaction between ability to tan and intermittency of sun exposure adjusted for age, sex and total outdoor exposure for 15-19-year-olds (calc)** Cases / Controls / OR (95%CI) *Very Brown* 0-40% 3 (8.3%) 65 (27.0%) 1.00 41-58% 8 (22.2%) 64 (26.6%) 0.96 (0.36-2.54) 59-99% 8 (22.2%) 48 (20.0%) 1.09 (0.40-3.00) 100% 17 (47.2%) 64 (26.6%) 0.87 (0.26-2.99) *Moderately brown, peel, freckle* 0-40% 44 (26.7%) 120 (26.1%) 1.11 (0.52-2.38) 41-58% 45 (27.3%) 111 (24.2%) 1.91 (0.91-4.00) 59-99% 49 (29.7%) 112 (24.4%) 2.46 (1.11-5.47) 100% 27 (16.4%) 116 (25.3%) 5.89 (2.44-14.22) **Risk of BCC in relation to lifetime hours of sun exposure on holidays between 9am and 5pm when the site was exposed (calc)*** Cases / Controls / OR (95%CI) / P 0-602 40 (20.8%) 174 (24.9%) 1.00 602-2268 54 (28.1%) 176 (25.1%) 1.65 (1.01-2.70) 2268-3794 49 (25.5%) 174 (24.9%) 1.68 (1.00-2.80) 3794+ 49 (25.5%) 176 (25.1%) 1.85 (1.09-3.13) 0.09 **Risk of BCC in relation to lifetime frequency of sunbathing when the site was exposed (calc)*** Cases / Controls / OR (95%CI) / P None 95 (49.0%) 342 (48.9%) 1.00 1-200 35 (18.0%) 91 (13.0%) 1.57 (0.98-2.51) 201-700 34 (17.5%) 136 (19.4%) 1.08 (0.68-1.72) 701-9000 30 (15.5%) 131 (18.7%) 1.02 (0.63-1.64) 0.31 *Adjusted for age, sex, ability to tan, and site	**Risk of BCC in relation to accumulated hours sun exposure between 9am and 5pm estimated from a typical week in each of the warmer and cooler months at each place of residence, controlling for age, sex, and ability to tan (calc)** Cases / Controls / OR (95%CI) / P 0-40.5 50 (24.9%) 176 (25.1%) 1.00 40.5-56.4 48 (23.9%) 177 (25.3%) 0.99 (0.61-1.58) 46.4-81.6 59 (29.4%) 166 (23.7%) 1.42 (0.86-2.35) 81.6+ 44 (21.9%) 181 (25.9%) 0.77 (0.43-1.40) 0.10 **Risk of BCC in relation to measures of ambient solar radiation at places of residence for the whole year, controlling for age, sex and ability to tan (calc)** Cases / Controls / OR (95%CI) / P 0-8.8 39 (19.4%) 186 (26.6%) 1.00 8.8-10.1 52 (25.9%) 174 (24.9%) 1.32 (0.69-2.55) 10.1-11.4 54 (26.9%) 174 (24.9% 1.72 (0.72-4.09) 0.47 11.4+ 56 (27.9%) 166 (23.7%) 2.18 (0.82-5.82) 0.11 for trend **Risk of BCC in relation to accumulated sun exposure between 9am and 5pm on working days and on non-working days from 15 years of age estimated from a typical week in each of the warmer and cooler months at each place of residence, controlling for age, sex, and ability to tan (calc)** Thousands of Hours / Cases / Controls / OR (95%CI) / P 0-14.7 47 (23.4%) 179 (25.6%) 1.00 14.8-27.7 58 (28.9%) 168 (24.0%) 1.25 (0.79-1.97) 27.8-49.3 52 (25.9%) 174 (24.9%) 1.17 (0.72-1.90) 49.4+ 44 (21.9%) 179 (25.6%) 0.86 (0.50-1.51) 0.46 **Relationship of SCC to ambient sunlight in accumulated global radiance (mWh cm-2 X 105) at places of residence from birth until 1987, adjusted for age, sex, year of interview, ability to tan and propensity to burn (calc)** Cases / Controls / OR (95%CI) / P <8.8410 17 (20.7%) 249 (24.2%) 1.0 8.8410-10.1399 25 (30.5%) 236 (22.9%) 1.4 (0.51-3.6) 10.1400-11.4509 54 (65.9%) 291 (28.2%) 2.7 (0.84-8.6) 11.4510+ 36 (43.9%) 255 (24.7%) 2.3 (0.62-8.3) 0.17

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure (cont.)	Measurement of sunlamp or sun bed exposure
Case-control		
Kricker 1991[62] Kricker 1995[116] Kricker 1995[36] English 1998[63] English 1998[33]	Relationship of SCC to hours of sun exposure to the anatomic site according to whether the site was usually exposed to sunlight (calc) Cases Controls OR (95%CI) P Working days 0-11,499 15 (18.1%) 137 (25.3%) 1.0 11,500-19,999 16 (19.3%) 144 (26.6%) 0.93 (0.42-2.1) 20,000-32,999 25 (30.1%) 123 (22.7%) 1.7 (0.81-3.8) 33,000+ 27 (32.5%) 138 (25.5%) 1.3 (0.58-2.8) 0.32 Non-working days 0-4,999 14 (16.9%) 146 (26.9%) 1.0 5,000-8,499 20 (24.1%) 124 (22.9%) 2.0 (0.89-4.4) 8,500-13,999 24 (28.9%) 128 (23.6%) 1.9 (0.86-4.2) 14,000+ 25 (30.1%) 144 (26.6%) 1.3 (0.57-2.9) 0.68 Risk of SCC in relation to lifetime hours of sun exposure to the site on holidays (calc)* Cases Controls OR (95%CI) P <600 19 (18.6%) 252 (24.4%) 1.0 600-2,268 28 (27.5%) 288 (27.9%) 0.89 (0.44-1.8) 2,269-3,793 28 (27.5%) 241 (23.4%) 1.0 (0.51-2.1) 3,794+ 27 (26.5%) 250 (24.2%) 0.93 (0.44-1.9) 0.97	NR

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
Kricker 1991[62] Kricker 1995[116] Kricker 1995[36] English 1998[63] English 1998[33]	**Risk of BCC in relation to use of SPF10+ sunscreen on the site: frequency and duration of use (calc)*** Cases Controls OR (95%CI) P <half the time 117 (60.9%) 476 (68.0%) 1.00 ≥half the time 1-9 years 31 (16.1%) 75 (10.7%) 1.92 (1.17-3.13) 10+ years 44 (22.9%) 149 (21.3%) 1.25 (0.82-1.90) 0.04 *Adjusted for age, sex, ability to tan, and site	**Risk of BCC in relation to frequency of painful sunburn to the site (calc)*** Cases Controls OR (95%CI) P None 87 (45.3%) 378 (54.0%) 1.00 1-2 times 27 (14.1%) 105 (15.0%) 1.09 (0.67-1.79) 3-10 times 31 (16.1%) 77 (11.0%) 1.75 (1.08-2.85) 11+ times 47 (24.5%) 140 (20.0%) 1.50 (0.99-2.26) 0.07 *Adjusted for age, sex, ability to tan, and site **Risk of SCC in relation to frequency of painful sunburn to the site (calc)*** Cases Controls OR (95%CI) P None 53 (52.0%) 584 (56.6%) 1.0 1-2 times 9 (8.8%) 141 (13.7%) 0.84 (0.39-1.8) 3-10 times 17 (16.7%) 109 (10.6%) 1.8 (0.99-3.4) 11+ times 23 (22.5%) 197 (19.1%) 1.4 (0.82-2.5) 0.08 *Adjusted for age, sex, year of interview, and anatomic site	

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Vlajinac 2000[127]	**Skin Cancer:** BCC **Study Design:** Case-control **Location:** Yugoslavia	**Cases:** **Selection:** consecutive cases at City Departments for Skin and Venereal Diseases **Eligibility criteria:** diagnosis of BCC **Controls**: **Selection:** consecutive patients presenting at the same institutions for dermatologic diseases other than cancer **Eligibility criteria:** aged >30 years	**Cases n=** 200 **Controls n=** 399 **Age (calc):** Cases Controls ≤59 years 60 (30.0%) 114 (28.6%) ≥60 years 140 (70.0%) 285 (71.4%) **Sex** Cases Controls Male 124 (62.0%) 239 (59.9%) **Skin phenotype:** *Skin reaction to sun exposure* Cases Controls Usually burns with no or little tan 78 (39.0%) 91 (22.8%) Never or rarely burns and always tans 122 (61.0%) 308 (77.2%)	Sun exposure Physician interviews	
Fargnoli 2004[79]	**Skin Cancer:** Melanoma **Study Design:** Case-control **Location:** Central Italy	**Cases:** **Selection:** consecutive cases presenting at the Department of Dermatology of the University of L'Aquila between 2000-2001 **Eligibility criteria:** sporadic primary cutaneous melanoma of any stage either as a first diagnosis or during periodic followup. Excluded those with family history of melanoma or with visceral malignant tumors **Controls**: **Selection:** age, sex, ethnicity and residential area matched recruited consecutively from same department with allergic disorders, skin infections, psoriasis, ulcers or autoimmune diseases **Eligibility criteria:** excluded those with family history of melanoma, visceral malignant tumors, melanocytic naevi or skin cancer with a history of phototherapy	**Cases n=** 100 **Controls n=** 200 **Mean age (SD):** Cases: 48.16 (14.8) Controls: NR **Sex (calc):** Cases Controls Male 47 (47.0%) NR **Skin phenotype:** *Fitzpatrick scale* Cases Controls IV 8 (8%) 39 (19.5%) III 39 (39%) 101 (50.5%) II 49 (49%) 57 (28.5%) I 4 (4%) 3 (1.5%)	Sun exposure, use of sunscreen, sunlamp exposure Physician interviews	Hair color, eye color, skin type for pigmentation factors

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Case-control		
Vlajinac 2000[127]	**Risk of BCC in relation to number of vacations at seaside before age 10** Cases / Controls / OR (95%CI) / P 0: 162 (81.0%) / 307 (76.9%) / NR / NS 1-4: 21 (10.5%) / 41 (10.3%) / NR / NS 5-9: 17 (8.5%) / 51 (12.8%) / NR / NS not significant in adjusted analyses therefore NR **Risk of BCC in relation to average number of weeks per year spent at seaside during vacation** Cases / Controls / OR (95%CI) / P 0: 47 (23.5%) / 125 (31.3%) / NR / NS 1-6: 34 (17.0%) / 267 (66.9%) / NR / NS 7+: 19 (9.5%) / 7 (1.8%) / 1.81 (1.24-2.64) / 0.0022	NR
Fargnoli 2004[79]	**Melanoma risk associated with recreational sun exposure (h/year)** Cases / Controls / OR (95% CI) / Adjusted OR (95% CI) <60: 38 (38%) / 97 (48.5%) / 1.0 / 1.0 60-120: 26 (26%) / 63 (31.5%) / 1.053 (0.580-1.897) / 0.761 (0.420-1.378) 120-240: 18 (18%) / 29 (14.5%) / 1.584 (0.781-3.171) / 1.641 (0.799-3.370) >240: 18 (18%) / 11 (5.5%) / 4.177 (1.831-9.928) / 5.010 (2.110-11.891) **Melanoma risk associated with occupational sun exposure** Cases / Controls / OR (95% CI) / Adjusted OR (95% CI) Yes: 33 (33%) / 34 (17.0%) / 2.405 (1.377-4.207) / 2.573 (1.399-4.732) Adjusted for hair color, eye color, and skin type	**Melanoma risk associated with use of sunlamps** Cases / Controls / OR (95% CI) / Adjusted OR (95% CI) Yes: 7 (7%) / 25 (12.5%) / 0.527 (0.204-1.204) / 0.634 (0.247-1.625)

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
Vlajinac 2000[127]	NR	**Risk of BCC in relation to sunburn pain** Cases / Controls / OR (95%CI) / P Lifetime: 67 (33.5%) / 67 (16.8%) / NR / NS Before age 15: 24 (12.0%) / 21 (5.3%) / NR / NS not significant in adjusted analyses therefore NR	
Fargnoli 2004[79]	**Melanoma risk associated with use of sunscreens** Cases / Controls / OR (95% CI) / Adjusted OR (95% CI) Yes: 51 (51%) / 106 (53.0%) / 0.923 (0.570-1.494) / 0.634 (0.247-1.625)	**Melanoma risk associated with childhood sunburns** Cases / Controls / OR (95% CI) / Adjusted OR (95% CI) Yes: 62 (62%) / 113 (56.0%) / 1.256 (0.771-2.063) / 0.958 (0.554-1.655)	

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Holly 1995[80]	**Skin Cancer:** Melanoma **Study Design:** Case-control **Location:** San Francisco, CA	**Cases:** **Selection:** diagnosed with melanoma between 1981-1986 from the San Francisco Bay Area SEER database **Eligibility criteria:** women aged 25-59 years, Caucasian, able to complete interview in English **Controls:** **Selection:** Age, sex, and county matched, random digit dialing **Eligibility criteria:** women aged 25-59 years, Caucasian, lived in the same counties as the cases	**Cases (calc) n=** 452 **Controls n=** 930 **Mean age:** 42 **Sex:** Cases Controls Male 0 (0%) 0 (0%) **Skin phenotype:** NR	Sun exposure, use of sunscreen, sunlamp exposure In-person interviews	Skin phenotype

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Case-control		
Holly 1995[80]	**Risk for cutaneous malignant melanoma by time spent outdoors on weekdays with arms and legs exposed to the sun (past 10 years)** OR (95% CI) None 1.0 <1/4 of time 0.71 (0.49-1.0) 1/4 - 1/2 of time 0.83 (0.53-1.3) ≥1/2 of time 0.83 (0.46-1.5) **Risk for cutaneous malignant melanoma by time spent outdoors on weekends with arms and legs exposed to the sun (past 10 years)** OR (95% CI) None 1.0 <1/4 of time 0.72 (0.35-1.4) 1/4 - 1/2 of time 0.71 (0.37-1.4) 1/2 - 3/4 of time 0.86 (0.42-1.8) ≥3/4 of time 0.84 (0.37-1.9) **Risk for cutaneous malignant melanoma by how often subject sunbathed in a typical year (past 10 years)** OR (95% CI) Never 1.0 <Once/month 0.75 (0.52-1.1) Once/month 0.57 (0.36-0.89) 2-3 times/month 0.67 (0.46-0.98) ≥Once/week 0.79 (0.56-1.1) crude odds ratios only	**Risk for cutaneous malignant melanoma by use of sunlamp** OR (95% CI) Never used 1.0 Ever used 0.94 (0.74-1.2) crude odds ratios only

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
Holly 1995[80]	**Risk of cutaneous malignant melanoma by use of sunscreen (before diagnosis)** OR (95% CI) P Adjusted* OR (95% CI) Almost always 1.0 1.0 Sometimes 1.3 (0.93-1.8) 1.5 (1.1-2.2) Never 1.6 (1.2-2.1) 0.002 2.1 (1.5-3.0) *Adjusted for history of sunburn up to age 12 years, skin's reaction after a few days of exposure to the sun, hair color, number of large nevi, complexion, maternal ethnicity, history of skin cancer, and age	**Risk for cutaneous malignant melanoma by number of painful sunburns during elementary school** OR (95% CI) P None 1.0 1-3 1.3 (0.96-1.7) 4-6 2.2 (1.5-3.1) ≥7 2.0 (1.4-2.9) <0.001 **Risk for cutaneous malignant melanoma by number of painful sunburns during high school** OR (95% CI) P None 1.0 1-3 1.2 (0.87-1.5) 4-6 1.6 (1.2-2.3) ≥7 2.4 (1.6-3.5) <0.001 **Risk for cutaneous malignant melanoma by history of sunburn up to age 12 years** Adjusted* OR (95% CI) Rare, mild, and/or no burns 1.0 Moderate and/or infrequent burns 1.7 (1.2-2.3) Severe and/or frequent burns 1.9 (1.2-3.0) *Adjusted for use of sunscreen, skin's reaction after a few days of exposure to the sun, hair color, number of large nevi, complexion, maternal ethnicity, history of skin cancer, and age	When sun exposure on weekends and weekdays was adjusted for skin phenotype, all risk estimates were at 1.0 or slightly above (specific data NR)

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Gallagher 1995[66] Bajdik 1996[128]	**Skin Cancer:** SCC **Study Design:** Case-control **Location:** Alberta, Canada	**Cases:** **Selection:** newly diagnosed SCC in males between 1983-1984 from the Alberta Cancer Registry **Eligibility criteria:** men aged 25-79 years **Controls:** **Selection:** age and sex matched, from the Alberta Health Care Insurance Plan **Eligibility criteria:** no previous diagnosis of nonmelanocytic skin cancer	**Cases n=** 180 **Controls n=** 406 **Mean age:** NR **Sex:** Cases Controls Male 100% 100% **Skin phenotype:** *Skin reaction to 1-week sun exposure (calc)* Cases Controls Tan without burning 58 (32%) 155 (37%) Tan with protection 6 (3%) 14 (3%) Burn then tan 77 (43%) 193 (48%) Burn, never tan 39 (22%) 43 (11%)	Sun exposure, sunlamp use In-home interviews	Age, pigment, and phenotype

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sun exposure (cont.)
Case-control		
Gallagher 1995[66] Bajdik 1996[128]	**Mean recreational sun exposure per year, ages 0-19 years, and risk of SCC (calc)** Cases / Controls / Adjusted* OR (95% CI) <100/y WBE, <3.8 h/wk summer: 52 (29%) / 97 (24%) / 1.0 100-199/y WBE, 3.8-7.4 h/wk summer: 49 (27%) / 113 (28%) / 1.2 (0.6-2.5) 200-332/y WBE, 7.5-12.4 h/wk summer: 36 (20%) / 101 (25%) / 1.1 (0.5-2.6) 333+/y WBE, 12.5+ h/wk summer: 25 (14%) / 76 (19%) / 1.6 (0.6-4.5) *p (trend) = NS* **Mean recreational sun exposure per year, lifetime, and risk of SCC (calc)** Cases / Controls / Adjusted* OR (95% CI) <75/y WBE, <2.8 h/wk summer: 38 (21%) / 75 (18%) / 1.0 75-149/y WBE, 2.8-5.5 h/wk summer: 43 (24%) / 106 (26%) / 0.6 (0.3-1.1) 150-224/y WBE, 5.6-8.4 h/wk summer: 32 (18%) / 72 (18%) / 0.8 (0.3-1.8) 225+/y WBE, 8.5+ h/wk summer: 23 (13%) / 73 (18%) / 0.3 (0.1-0.9) *p (trend) = 0.09* **Mean recreational sun exposure per year, last 10 years, and risk of SCC (calc)** Cases / Controls / Adjusted* OR (95% CI) <65/y WBE, <2.4 h/wk summer: 53 (29%) / 75 (18%) / 1.0 65-119/y WBE, 2.4-4.4 h/wk summer: 29 (16%) / 99 (24%) / 0.4 (0.2-0.7) 120-199/y WBE, 4.5-7.4 h/wk summer: 60 (33%) / 115 (28%) / 0.7 (0.4-1.2) 200+/y WBE, 7.5+ h/wk summer: 25 (14%) / 83 (20%) / 0.4 (0.2-0.7) *p (trend)=0.06* WBE-whole body equivalent is 1 h of sun exposure to the whole surface of the body *Adjusted for effects of mother's ethnic origin, hair color, and skin color **Mean occupational sun exposure per year, lifetime, and risk of SCC (calc)** Cases / Controls / Adjusted* OR (95% CI) <15/y WBE, 3.5 h/wk summer: 26 (14%) / 87 (21%) / 1.0 15-59/y WBE, 3.5-13.9 h/wk summer: 36 (20%) / 105 (26%) / 0.8 (0.3-2.0) 60-104/y WBE, 14.0-24.9 h/wk summer: 42 (23%) / 86 (21%) / 1.5 (0.6-4.2) 105+/y WBE, 25.0 h/wk summer: 76 (42%) / 128 (32%) / 1.4 (0.4-4.3) p (trend)=NS	**Mean occupational sun exposure per year, last 10 years, and risk of SCC (calc)** Cases / Controls / Adjusted* OR (95% CI) 0/y WBE, 0 h/wk summer: 61 (34%) / 161 (40%) / 1.0 1-29/y WBE, <7.0 h/wk summer: 18 (10%) / 45 (11%) / 1.9 (0.6-5.6) 30-99/y WBE, 7.0-22.9 h/wk summer: 46 (26%) / 113 (28%) / 2.2 (0.8-6.4) 100+/y WBE, 23+ h/wk summer: 55 (31%) / 87 (21%) / 4.0 (1.2-13.1) p (trend)<0.05 **Mean cumulative sun exposure per year, lifetime, and risk of SCC (calc)** Cases / Controls / Adjusted* OR (95% CI) <120/y WBE, <11.5 h/wk summer: 32 (18%) / 85 (21%) / 1.0 120-189/y WBE, 11.5-18.9 h/wk summer: 47 (26%) / 84 (21%) / 1.8 (0.9-3.3) 190-279/y WBE, 19.0-27.9 h/wk summer: 35 (19%) / 90 (22%) / 1.2 (0.6-2.3) 280+/y WBE, 28+ h/wk summer: 22 (12%) / 67 (17%) / 1.0 (0.4-2.1) p (trend)=NS **Mean cumulative sun exposure per year, last 10 years, and risk of SCC (calc)** Cases / Controls / Adjusted* OR (95% CI) <100/y WBE, 9.5 h/wk summer: 41 (23%) / 107 (26%) / 1.0 100-159/y WBE, 9.5-15.9 h/wk summer: 45 (25%) / 88 (22%) / 1.5 (0.9-2.7) 160-239/y WBE, 16.0-23.9 h/wk summer: 43 (24%) / 78 (19%) / 1.7 (0.9-3.1) 240+/y WBE, 24+ h/wk summer: 38 (21%) / 99 (24%) / 1.1 (0.6-2.1) p (trend)=NS WBE-whole body equivalent is 1 h of sun exposure to the whole surface of the body *Adjusted for effects of mother's ethnic origin, hair color, and skin color

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sunlamp or sunbed exposure	Measurement of sunscreen use	Measurement of sunburn	Comments
Gallagher 1995[66] Bajdik 1996[128]	**Use of sunlamps and risk of SCC (calc)** Cases / Controls / Adjusted* OR (95% CI) Never 162 (90%) / 371 (91%) / 1.0 Ever 18 (10%) / 33 (8%) / 1.4 (0.7-2.7) *Adjusted for age, ethnic origin, skin and hair color, and lifetime occupational sun exposure	NR	**Sunburn history, age 5-15 years, and risk of SCC (calc)** Cases / Controls / Adjusted* OR (95% CI) Never burned 66 (37%) / 175 (43%) / 1.0 Rare or mild burns 27 (15%) / 86 (21%) / 0.8 (0.5-1.6) Moderate burns 52 (29%) / 92 (23%) / 1.3 (0.7-2.2) Frequent or severe burns 35 (19%) / 53 (13%) / 0.6 (0.6-1.4) *p (trend)=NS* **Sunburn pain ≥2 days, age 5-15 years, and risk of SCC (calc)** Cases / Controls / Adjusted* OR (95% CI) Never 150 (83%) / 375 (92%) / 1.0 Once per year 14 (8%) / 24 (6%) / 1.9 (0.8-4.4) Twice or more per year 16 (9%) / 7 (2%) / 10.5 (2.9-38.0) *p (trend)=0.001* **Sunburn pain ≥2 days, lifetime, and risk of SCC (calc)** Cases / Controls / Adjusted* OR (95% CI) Never 121 (67%) / 291 (72%) / 1.0 Ever 59 (33%) / 115 (28%) / 1.2 (0.8-1.8) *p (trend)=NS* *Adjusted for age, mother's ethnic origin, hair color, and skin color	

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Gallagher 1995[70] Bajdik 1996[128]	**Skin Cancer:** BCC **Study Design:** Case-control **Location:** Alberta, Canada	**Cases:** **Selection:** newly diagnosed BCC in males between 1983-1984 from the Alberta Cancer Registry **Eligibility criteria:** men aged 25-79 years **Controls:** **Selection:** age and sex matched, from the Alberta Health Care Insurance Plan **Eligibility criteria:** no previous diagnosis of skin cancer	**Cases n=**226 **Controls n=**406 **Mean age:** NR **Sex:** Cases / Controls Male 100% / 100% **Skin phenotype:** *Skin reaction to 1 week of exposure (calc)* Cases / Controls Tan without burning 72 (32%) / 155 (38%) Tan with protection 9 (4%) / 14 (3%) Burn, then tan 100 (56%) / 193 (48%) Burn, never tan 45 (25%) / 43 (11%)	Sun exposure, sunlamp exposure In-home interviews	Age, mother's ethnic origin, skin color, and hair color

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Case-control		
Gallagher 1995[70] Bajdik 1996[128]	**Mean recreational sun exposure per year, ages 0-19 years, and risk of BCC (calc)** Cases / Controls / Adjusted* OR (95% CI) <100/y WBE, <3.8 h/wk summer: 49 (22%) / 97 (24%) / 1.0 100-199/y WBE, 3.8-7.4 h/wk summer: 56 (25%) / 113 (28%) / 1.1 (0.6-2.0) 200-332/y WBE, 7.5-12.4 h/wk summer: 54 (24%) / 101 (25%) / 1.4 (0.7-3.0) 333+/y WBE, 12.5+ h/wk summer: 57 (25%) / 76 (19%) / 2.6 (1.1-6.5) *p (trend)=0.03* **Mean recreational sun exposure per year, lifetime, and risk of BCC (calc)** Cases / Controls / Adjusted* OR (95% CI) <75/y WBE, <2.8 h/wk summer: 47 (21%) / 75 (18%) / 1.0 75-149/y WBE, 2.8-5.5 h/wk summer: 65 (29%) / 106 (26%) / 0.9 (0.5-1.7) 150-224/y WBE, 5.6-8.4 h/wk summer: 42 (19%) / 72 (18%) / 0.6 (0.3-1.3) 225+/y WBE, 8.5+ h/wk summer: 32 (14%) / 73 (18%) / 0.4 (0.2-1.0) *p (trend)=0.03* **Mean occupational sun exposure per year, lifetime, and risk of BCC (calc)** Cases / Controls / Adjusted* OR (95% CI) <15/y WBE, <3.5 h/wk summer: 56 (25%) / 87 (21%) / 1.0 15-59/y WBE, 3.5-13.9 h/wk summer: 56 (25%) / 105 (26%) / 1.0 (0.6-1.8) 60-104/y WBE, 14.0-24.9 h/wk summer: 46 (20%) / 86 (21%) / 1.3 (0.8-2.3) 105+/y WBE, 25+ h/wk summer: 68 (30%) / 128 (32%) / 1.4 (0.8-2.4) *p (trend)=NS*	**Sunlamp use and risk of BCC (calc)** Cases / Controls / Adjusted* OR (95% CI) Never: 203 (90%) / 371 (91%) / 1.0 Ever: 23 (10%) / 33 (8%) / 1.2 (0.7-2.2) *Adjusted for age, ethnic origin, skin and hair color, and lifetime occupational sun exposure

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
Gallagher 1995[70] Bajdik 1996[128]	NR	**Sunburn, age 5-15 years, and risk of BCC (calc)** Cases / Controls / Adjusted* OR (95% CI) Never burned: 77 (34%) / 175 (43%) / 1.0 Rare or mild burns: 29 (13%) / 86 (21%) / 0.8 (0.5-1.4) Moderate burns: 68 (30%) / 92 (23%) / 1.3 (0.8-2.1) Frequent or severe burns: 25 (11%) / 53 (13%) / 1.6 (1.0-2.7) *p=0.05* **Sunburn pain ≥2 days, age 5-15 years, and risk of BCC (calc)** Cases / Controls / Adjusted* OR (95% CI) Never: 188 (83%) / 375 (92%) / 1.0 Once per year: 22 (10%) / 24 (6%) / 1.7 (0.9-3.4) 2+ per year: 16 (7%) / 7 (2%) / 4.5 (1.7-12.3) *p<0.001* **Sunburn pain ≥2 days, lifetime, and risk of BCC (calc)** Cases / Controls / Adjusted* OR (95% CI) Never: 160 (71%) / 291 (72%) / 1.0 Ever: 66 (29%) / 115 (28%) / 0.9 (0.6-1.3) *p=NS;* *Adjusted for age, mother's ethnic origin, skin color, and hair color	

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/ exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Han 2006[71] Nurses' Health Study	**Skin Cancer:** SCC, BCC & melanoma **Study Design:** Nested case-control **Location:** US (11 states)	**Cases:** **Selection:** newly diagnosed SCC, BCC or melanoma in females between 1989-1998/2000 from the Nurses' Health Study, who gave blood specimen **Eligibility criteria:** Caucasian women **Controls:** **selection:** women from the NHS who gave a blood sample in 1989-90, matched by birth year (±1 year) **Eligibility criteria:** free of diagnosed skin cancer up to and including the questionnaire cycle in which the case was diagnosed	**Cases n=**758 (melanoma n=200, SCC n=275, BCC n=283) **Controls n=**804 **Mean age:** 58.7 (range: 43-68) **Sex:** Male: Cases 0%, Controls 0% **Skin phenotype:** *Skin reaction* Practically none: Melanoma 12 (6.6%), SCC 12 (4.8%), BCC 17 (6.7%), Control 92 (13.0%) Some redness: Melanoma 62 (33.9%), SCC 94 (37.3%), BCC 82 (32.2%), Control 327 (46.3%) Burn: Melanoma 72 (39.3%), SCC 81 (32.1%), BCC 91 (35.7%), Control 201 (28.4%) Painful burn: Melanoma 37 (20.2%), SCC 65 (25.8%), BCC 65 (25.5%), Control 87 (12.3%)	Sun exposure, sun lamp/bed exposure Mailed questionnaire	Age, family history of skin cancer, number of lifetime severe sunburns which blistered, sunlamp use or tanning salon attendance, geographic region, sun exposure while wearing a bathing suit

Study reference USPSTF quality	Measurement of sun exposure
Case-control	
Han 2006[71] Nurses' Health Study	**Risk for skin cancer according to cumulative sun exposure while wearing a bathing suit (tertile)**

	Melanoma			SCC			BCC			Control
	N(%)	Age-adjusted OR (95% CI)	Multivariate OR (95% CI)	N(%)	Age-adjusted OR (95% CI)	Multivariate OR (95% CI)	N(%)	Age-adjusted OR (95% CI)	Multivariate OR (95% CI)	N(%)
Low	37(20.6)	1.00	1.00	58(23.7)	1.00	1.00	55(21.5)	1.00	1.00	227(33.2)
Intermediate	47(26.1)	1.25 (0.78-2.00)	1.20 (0.73-1.97)	74(30.2)	1.28 (0.87-1.90)	1.28 (0.85-1.93)	92(35.9)	1.66 (1.13-2.43)	1.71 (1.14-2.56)	228(33.4)
High	96(53.3)	2.58 (1.69-3.94)	2.37 (1.51-3.73)	113(46.1)	1.97 (1.37-2.85)	2.15 (1.45-3.19)	109(42.6)	1.95 (1.34-2.83)	2.05 (1.38-3.06)	228(33.4)
Trend		<0.001	<0.001		<0.001	<0.001		<0.001	<0.001	
LRT			<0.001			<0.001			<0.001	

P=0.15; adjusted for: age, constitutional susceptibility, family history of skin cancer, number of lifetime severe sunburns which blistered, sunlamp use or tanning salon attendance, geographic region

Interaction between constitutional susceptibility score and sun exposure with a bathing suit on melanoma risk

Susceptibility score (tertile)	Sun exposure with a bathing suit (tertile) Low	Intermediate	High
Low			
Cases (%)	5 (20.0)	12 (48.0)	8 (32.0)
Controls (%)	62 (27.9)	70 (31.5)	90 (40.5)
OR (95% CI)	1.00	1.92 (0.63-5.90)	0.97 (0.30-3.16)
Intermediate			
Cases (%)	11 (21.2)	12 (23.1)	29 (55.8)
Controls (%)	78 (33.3)	86 (36.8)	70 (29.9)
OR (95% CI)	1.73 (0.56-5.32)	1.39 (0.46-4.23)	4.13 (1.47-11.61)
High			
Cases (%)	21 (20.4)	23 (22.3)	59 (57.3)
Controls (%)	87 (38.3)	72 (31.7)	68 (30.0)
OR (95% CI)	2.65 (0.93-7.60)	3.02 (1.06-8.62)	8.37 (3.07-22.84)

adjusted for: age, family history of skin cancer, number of lifetime severe sunburns which blistered, sunlamp use or tanning salon attendance, geographic region

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sunlamp or sunbed exposure
Case-control	
Han 2006[71] Nurses' Health Study	**Risk for skin cancer according to sunlamp use or tanning salon attendance** Melanoma: N(%) / Age-adjusted OR (95% CI) / Multivariate OR (95% CI) SCC: N(%) / Age-adjusted OR (95% CI) / Multivariate OR (95% CI) BCC: N(%) / Age-adjusted OR (95% CI) / Multivariate OR (95% CI) Control: N(%) No: 140(76.9) / 1.00 / 1.00 / 212(83.8) / 1.00 / 1.00 / 215(83.0) / 1.00 / 1.00 / 625(87.8) Yes: 42(23.1) / 1.98 (1.30-3.02) / 2.06 (1.30-3.26) / 41(16.2) / 1.47 (0.98-2.22) / 1.44 (0.93-2.24) / 44(17.0) / 1.45 (0.97-2.16) / 1.32 (0.87-2.03) / 87(12.2) LRT: 0.01 / 0.24 / 0.35 *P=0.15* LRT- likelihood ratio test. Adjusted for: age, constitutional susceptibility, family history of skin cancer, number of lifetime severe sunburns which blistered, cumulative sun exposure while wearing a bathing suit, geographic region

Study reference USPSTF quality	Measurement of sun-screen use	Measurement of sunburn	Comments
Case-control			
Han 2006[71] Nurses' Health Study	NR	**Risk for skin cancer according to lifetime severe sunburns which blistered** Melanoma: N(%) / Age-adjusted OR (95% CI) / Multivariate OR (95% CI) SCC: N(%) / Age-adjusted OR (95% CI) / Multivariate OR (95% CI) BCC: N(%) / Age-adjusted OR (95% CI) / Multivariate OR (95% CI) Control: N(%) None: 29(17.1) / 1.00 / 1.00 / 46(20.0) / 1.00 / 1.00 / 49(20.1) / 1.00 / 1.00 / 231(34.5) 1-4: 48(28.2) / 1.63(0.99-2.68) / 1.43(0.85-2.42) / 80(34.8) / 1.85(1.23-2.79) / 1.65(1.08-2.53) / 82(33.6) / 1.70(1.14-2.54) / 1.38(0.90-2.11) / 226(33.7) 5-9: 33(19.4) / 2.57(1.48-4.48) / 1.75(0.97-3.16) / 46(20.0) / 2.47(1.53-3.98) / 1.88(1.14-3.11) / 49(20.1) / 2.33(1.47-3.71) / 1.55(0.95-2.55) / 98(14.6) ≥10: 60(35.3) / 3.90(2.36-6.47) / 2.24(1.30-3.84) / 58(25.2) / 2.72(1.73-4.29) / 1.67(1.02-2.72) / 64(26.2) / 2.62(1.69-4.06) / 1.37(0.84-2.21) / 115(17.2) Trend: <0.001 / 0.003 / <0.001 / 0.04 / <0.001 / 0.15 LRT: 0.04 / 0.01 / 0.37 *P=0.43* LRT- likelihood ratio test. Adjusted for: age, constitutional susceptibility, family history of skin cancer, cumulative sun exposure while wearing a bathing suit, sunlamp use or tanning salon attendance, geographic region	

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Tabenkin 1999[76]	**Skin Cancer:** Melanoma **Study Design:** Case-control **Location:** Israel	**Cases:** **Selection:** People with malignant melanoma living in kibbutzim who participated in a health survey conducted in 1992 were recruited by the kibbutz nurses **Eligibility criteria:** Level 1 non-invasive melanomas and all other histological forms of melanoma **Controls:** **Selection:** People living in kibbutzim who participated in a health survey conducted in 1992 were recruited by the kibbutz nurses **Eligibility criteria:** Sex and age matched (±3 years)	**Cases n=** 168 **Controls n=** 325 **Mean age (SD):** Cases: 53.5 (13.9) Controls: 53.1 (13.6) **Sex:** Male: Cases 75 (44.6%); Controls 144 (44.3%) **Skin phenotype:** *Skin sensitivity** Sensitive: Cases 151 (91.5%); Controls 242 (76.3%) Not sensitive: Cases 14 (8.5%) (c); Controls 75 (23.7%) *These numbers don't add up to 168 and 325	Sun exposure Structured questionnaire	NR

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Case-control		
Tabenkin 1999[76]	**Number of hours of sun exposure, age 6-13 (calc)** Cases: 3+ hours/day 34 (20.0%); Controls: 40 (12.3%) *p<0.05* **Number of hours of sun exposure, age 14-18, 18-21, and above 21** *p=NS* *in conditional logistic regression, exposure to sun at various ages was not significantly associated with malignant melanoma (results not shown), only hair color, skin sensitivity and other skin lesions were independently associated with malignant melanoma* **Odds ratios and exposure to sun at work from age 21 (number of years at work x number of hours per day exposed) (calc)** None: Cases 8 (5%); Controls 33 (10%); OR (95% CI) 2.44 (1.01-5.91); P <0.05 1+: NR	NR

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
Tabenkin 1999[76]	NR	NR	

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Green 1985[77] Green 1986[133] Green 1985[140] Green 1984[141]	**Skin Cancer:** Melanoma **Study Design:** Case-control **Location:** Queensland, Australia	**Cases:** **Selection:** First primary cutaneous melanoma diagnosed between 1979-80 in residents of Queensland from pathology laboratories throughout the state **Eligibility criteria:** excluded those with acral lentiginous melanoma and lentigo maligna melanoma analyzed separately (not included in the 183 cases) **Controls:** **Selection:** Sex, age (±5 years), and area of residence matched from Electoral Roll **Eligibility criteria:** NR	**Cases n=** 183 (excludes lentigo maligna) **Controls n=** 183 **Mean age:** NR Age range: Controls only (183 controls) <35: 46 (25%) 35-49: 58 (32%) 50+: 79 (43%) **Sex:** NR **Skin phenotype:** *Propensity to sunburn* Cases / Controls Tan only: 12 (7%) / 31 (17%) Burn, then tan: 41 (22%) / 58 (32%) Burn, then peel: 130 (71%) / 94 (71%)	Sun exposure Interviewed at home, work, or hospital out-patient departments using a standard questionnaire	Age, presence of nevi on the arms, hair color, sunburn propensity

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Case-control		
Green 1985[77] Green 1986[133] Green 1985[140] Green 1984[141]	**Relative risk of melanoma and number of cumulative hours of sun exposure - excluding cases of lentigo malignant melanoma (calc)** Cases / Controls / Crude RR / Adjusted* RR (95% CI) <2,000: 12 (6.6%) / 21 (11.5%) / 1.0 / 1.0 2,000-: 78 (42.6%) / 78 (42.6%) / 1.8 20,000-: 53 (29.0%) / 53 (29.0%) / 1.8 / 3.2 (0.9-12.4) 50,000-100,000: 31 (16.9%) / 24 (13.1%) / 2.3 >100,000: 9 (4.9%) / 7 (3.8%) / 2.3 / 5.3 (0.9-30.8) *Adjusted for exact age, presence of nevi on the arms, hair color, and sunburn propensity **Relative risk of melanoma and cumulative hours sun exposure (calc)** Cases / Controls / Crude RR / Adjusted* RR (95% CI) *Whole of life* <2000: 12 (9.9%) / 21 (17.1%) / 1.0 / 1.0 2000-: 78 (64.5%) / 78 (63.4%) / 1.7 / 2.3 (1.0-5.1) 50,000-: 31 (25.6%) / 24 (19.5%) / 2.3 / 1.7 (0.4-7.8) *Ages 10-19 years* <500: 42 (27.5%) / 52 (34.2%) / 1.0 / 1.0 500-: 70 (45.8%) / 81 (52.6%) / 1.1 / 1.0 (0.5-2.0) 5000-: 41 (26.8%) / 21 (13.6%) / 1.8 / 4.4 (1.8-184.5) The *5 years prior to diagnosis* <500: 87 (49.2%) / 74 (42.0%) / 1.0 / 1.0 500-: 78 (44.1%) / 92 (52.3%) / 0.7 / 0.9 (0.5-1.6) 5000-: 12 (6.8%) / 10 (5.7%) / 0.9 / 1.2 (0.5-2.9) *Adjusted for age and presence of naevi on arms **Recreational hours spent on the beach in the sun during different life periods and associated risk of melanoma, crude and adjusted for presence of naevi on the arms and age** Life period / Hours / Cases / Controls / Crude RR / Adjusted RR (95% CI) Whole life / 0 / 18 (9.8%) / 13 (7.1%) / 1.0 / 1.0 1- / 79 (43.2%) / 72 (39.3%) / 0.8 / 0.6 (0.2-1.4) 500- / 70 (38.3%) / 92 (50.3%) / 0.5 / 0.3 (0.1-0.8) 5000- / 16 (8.7%) / 6 (3.3%) / 1.9 / 1.3 (0.4-4.3) Ages 10-19 / 0 / 54 (29.5%) / 64 (35.0%) / 1.0 / 1.0 1- / 99 (54.1%) / 85 (46.4%) / 1.4 / 1.1 (0.6-2.0) 500- / 30 (16.4%) / 34 (18.6%) / 1.0 / 0.8 (0.4-1.9) The 5 years prior to dx / 0 / 61 (33.3%) / 49 (26.8%) / 1.0 / 1.0 1- / 104 (56.8%) / 122 (66.7%) / 0.7 / 0.6 (0.0-1.0) 500- / 18 (9.8%) / 12 (6.6%) / 1.2 / 0.9 (0.3-3.1)	NR

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
Green 1985[77] Green 1986[133] Green 1985[140] Green 1984[141]	NR	**Risk of melanoma in relation to experience of severe sunburns in life** Unadjusted RR # sunburns / Unmatched / Matched / Adjusted RR* (95% CI) 0-1: 1.0 / 1.0 / 1.0 2-5: 2.4 / 1.9 / 1.5 (0.7-3.2) ≥6: 3.3 / 5.0 / 2.4 (1.0-6.1) *Adjusted for presence of naevi on the arms and exact age	

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Zanetti 1992[84] Rosso 2008[142]	**Skin Cancer:** Melanoma **Study Design:** Case-control **Location:** Turin, Italy	**Cases:** **Selection:** All new cases of cutaneous malignant melanoma diagnosed between 1984-86 in residents of Turin, Italy from the local Cancer Registry **Eligibility criteria:** NR **Controls:** **Selection:** From the roster of the National Health Service of Turin **Eligibility criteria:** NR	**Cases n=** 260 **Controls n=** 416 **Mean age:** Cases: 56, range 19-92 Controls: 55, range 17-92 **Sex:** Cases Controls Male 74 (28.5%) 211 (50.7%) **Skin phenotype:** NR	Sun exposure Interviewed by trained interviewers using a standard questionnaire	Sex and age in decades

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Case-control		
Zanetti 1992[84] Rosso 2008[142]	**Odds ratios of melanoma and number of weeks of sunny vacation (beach holiday), childhood and teenage (calc)** Cases Controls OR* (95% CI) 0 182 (79.5%) 326 (78.7%) 1.0 1-59 42 (18.3%) 37 (8.9%) 2.8 (1.6-4.6) ≥60 35 (18.3%) 51 (12.3%) 1.7 (1.0-2.9) *p=0.003* **Odds ratios of melanoma and number of sunny vacations (beach holidays) in lifetime (calc)** Cases Controls OR* (95% CI) 0 74 (28.9%) 148 (36.3%) 1.0 1-29 25 (9.8%) 62 (15.2%) 0.9 (0.5-1.6) 30-59 34 (13.3%) 50 (12.3%) 1.6 (0.9-2.8) 60-89 36 (14.1%) 51 (12.5%) 1.6 (0.9-2.9) 90-119 28 (10.9%) 42 (10.3%) 1.5 (0.8-2.7) ≥120 59 (23.0%) 55 (13.5%) 2.3 (1.4-3.8) *p=0.001* *Adjusted for sex and age in decades **Hazard ratios for risk of DEATH FOR MELANOMA and number of weeks of on the beach during childhood and adulthood, HR (95% CI)** # weeks on beach adulthood # weeks on beach childhood 0 1-59 >60 0 ref 1.87 (0.49, 7.2) 0.75 (0.10, 5.7) 1-59 0.40 (0.17, 0.94) 0.14 (0.02, 0.96) 0.13 (0.01, 5.1) >60 0.42 (0.18, 0.98) 0.36 (0.10, 1.3) 0.68 (0.25, 1.9) *Adjusted for age, sex, education and follow-up period	**NR**

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
Zanetti 1992[84] Rosso 2008[142]	**NR**	**Odds ratios of melanoma by sunburns in childhood (calc)** Cases / Controls / OR* (95% CI) Never 186 (71.5%) / 382 (92.3%) / 1.0 Sometimes 48 (18.5%) / 26 (6.3%) / 4.4 (2.5-7.5) Often 26 (10.0%) / 6 (1.4%) / 12.0 (4.6-31.0) *p<0.001* **Odds ratios of melanoma by severe sunburns lifelong (calc)** Cases / Controls / OR* (95% CI) Never 180 (70.9%) / 328 (80.0%) / 1.0 1 50 (19.7%) / 53 (12.9%) / 1.7 (1.1-2.6) ≥2 24 (9.4%) / 29 (7.1%) / 1.5 (0.8-2.7) *p=0.04* *Adjusted for sex and age in decades	Long-term follow-up mortality data from Rosso 2008, it was not possible to identify the cause of death in 17% of deaths (22/128)

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Rosso 1999[64]	**Skin Cancer:** SCC and BCC **Study Design:** Case-control **Location:** Valais, Switzerland	**Cases:** **Selection:** All new cases of SCC and BCC diagnosed between 1994-96 from the Sion Cancer Registry **Eligibility criteria:** Aged 20-75 years **Controls:** **Selection:** Recruited from lists of contributors and supporters of the Swiss League for the Fight Against Cancer and volunteer associations of blood donors (approx. 65% of population) **Eligibility criteria:** Age and sex matched	**Cases n=** 146 **Controls n=** 144 **Mean age:** NR **Sex (calc):** Cases / Controls Male 76 (52.4%) / NR **Skin phenotype:** *Skin reaction to sun exposure* BCCs / SCCs / Controls Tan no burn 16(13.3%) / 7(28.0%) / 41(28.5%) Rare burn then tan 48(40.0%) / 8(32.0%) / 62(43.1%) Often burn then tan 35(29.2%) / 6(24.0%) / 31(21.5%) Burn never tan 16(13.3%) / 2(8.0%) / 10(6.9%) Missing data 5(4.2%) / 2(8.0%) / 0(0%)	Sun exposure, sunlamp exposure, sunscreen exposure Interviewed by trained interviewers using the standard questionnaire from the HELIOS study	Age and sex

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Case-control		
Rosso 1999[64]	**Odds ratio of BCC and SCC by lifetime hours of outdoor work (calc)** BCC / SCC / Controls / BCC OR* (95% CI) / SCC OR* (95% CI) Never: 61 (51.3%) / 7 (28.0%) / 69 (47.9%) / 1.0 / 1.0 -12,000: 19 (16.0%) / 3 (12.0%) / 19 (13.2%) / 0.98 (0.58-1.66) / 1.84 (0.30-11.09) -47,900: 19 (16.0%) / 2 (8.0%) / 19 (13.2%) / 1.30 (0.69-2.46) / -77,200: 12 (10.1%) / 9 (7.6%) / 19 (13.2%) / 0.78 (0.52-1.19) / 2.02 (0.60-6.78) 77,200+: 8 (6.7%) / 4 (16.0%) / 18 (12.5%) / 0.90 (0.51-1.59) / 1.88 (0.30-11.70) **Odds ratio of BCC and SCC by lifetime hours at the beach on vacation (calc)** BCC / SCC / Controls / BCC OR* (95% CI) / SCC OR* (95% CI) Never: 50 (41.7%) / 15 (60.0%) / 75 (52.1%) / 1.0 / 1.0 <300: 24 (20.0%) / 2 (8.8%) / 19 (13.2%) / 1.46 (0.52-4.07) / -1,140: 15 (12.5%) / 3 (12.0%) / 16 (11.1%) / 1.39 (0.72-2.66) / -2,260: 7 (5.8%) / 2 (8.8%) / 16 (11.1%) / 0.92 (0.44-1.91) / 2,260+: 24 (20.0%) / 3 (12.0%) / 18 (12.5%) / 1.20 (0.61-2.34) / 0.78 (0.26-2.40) **Odds ratio of BCC and SCC by lifetime hours of sun exposure (calc)** BCC / SCC / Controls / BCC OR* (95% CI) / SCC OR* (95% CI) <5,000: 33 (27.5%) / 5 (20.0%) / 37 (25.7%) / 1.0 / 1.0 -15,800: 37 (30.8%) / 2 (8.0%) / 36 (25.0%) / 1.09 (0.62-1.92) / -64,200: 33 (27.5%) / 9 (36.0%) / 36 (25.0%) / 0.99 (0.35-2.79) / 1.78 (0.18-17.67) 64,200+: 17 (14.2%) / 9 (36.0%) / 35 (24.3%) / 0.70 (0.20-2.39) / 1.42 (0.53-3.85) *Adjusted for sex and age	**Odds ratio of BCC and SCC by use of a sunlamp (calc)** Never / Yes BCC: 110 (91.7%) / 10 (8.3%) SCC: 25 (100%) / 0 (0%) Controls: 135 (93.8%) / 9 (6.2%) BCC OR* (95% CI): 1.0 / 1.24 (0.53-2.88) SCC OR* (95% CI): 1.0 / -- *Adjusted for sex and age

Study reference USPSTF quality	Measurement of sunscreen use
Case-control	
Rosso 1999[64]	**Odds ratio for BCC and SCC by use of sunscreens (calc)** BCC / SCC / Controls / BCC OR* (95% CI) / SCC OR* (95% CI) Never: 56 (46.7%) / 16 (64.0%) / 93 (64.6%) / 1.0 / 1.0 Yes: 64 (53.3%) / 9 (36.0%) / 51 (35.4%) / 1.69 (1.14-2.05) / 1.63 (0.41-6.53) *Adjusted for sex and age

Study reference USPSTF quality	Measurement of sunburn	Comments
Case-control		
Rosso 1999[64]	**Odds ratio of BCC and SCC by number of painful sunburns in a lifetime (calc)** BCC / SCC / Controls / BCC OR* (95% CI) / SCC OR* (95% CI) Never: 82 (68.3%) / 23 (92.0%) / 119 (82.6%) / 1.0 / 1.0 1: 14 (11.7%) / 2 (8.0%) / 19 (13.2%) / 0.97 (0.59-1.59) / not estimable (sparse data) 2: 5 (4.2%) / 0 (0%) / 3 (2.1%) / 1.26 (0.41-3.86) / -- 3+: 14 (11.7%) / 0 (0%) / 3 (2.1%) / 2.42 (1.74-3.36) / -- *Adjusted for sex and age	

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Karagas 2002[88]	**Skin Cancer:** BCC and SCC **Study Design:** Case-control **Location:** New Hampshire and bordering regions	**Cases:** **Selection:** Newly diagnosed BCC and SCC between 1993-95 from a collaborative network of dermatologists and pathology laboratories throughout New Hampshire and its bordering regions **Eligibility criteria:** Aged 25-74 years **Controls:** **Selection:** New Hampshire residents from the New Hampshire Department of Transportation listing and the Medicare Program of the Centers for Medicare and Medicaid Services **Eligibility criteria:** Age and sex matched	**Cases n=** 896 (BCC n=603, SCC n=293) **Controls n=** 540 **Mean age:** NR **Sex (calc):** Cases Controls Male 527 (59%) 325 (60.3%) **Skin phenotype:** NR	Sunlamp exposure Structured personal interviews	Age, sex, skin sensitivity
LeMarchand 2006[81]	**Skin Cancer:** Melanoma **Study Design:** Case-control **Location:** Hawaii	**Cases:** **Selection:** Oahu residents diagnosed with melanoma 1986-87 (prevalent cases) or newly diagnosed 1988-92 (incident cases) from the Hawaii SEER database **Eligibility criteria:** Four grandparents of pure Caucasian origin, aged 18-79 years, invasive or in situ malignant melanoma. Excluded those with previous history of melanoma **Controls:** **Selection:** From a list of Caucasian Oahu residents interviewed by the Hawaii State Department of Health as part of a health survey of a 2% random sample of state households **Eligibility criteria:** Age and sex matched, four grandparents of pure Caucasian origin	**Cases n=** 278 **Controls n=** 278 **Mean age (SD):** Cases: 53.7 (15.0) Controls: 52.1 (15.0) **Sex (calc):** Cases Controls Male 167 (60.1%) 167 (60.1%) **Skin phenotype:** *Propensity to sunburn (calc)* Cases Controls Tan only 19 (6.9%) 34 (12.4%) Mild burn and tanning 135 (49.1%) 139 (50.5%) Severe burn and peeling 102 (37.1%) 84 (30.5%) Severe burn and blistering 19 (6.9%) 18 (6.5%)	Sun exposure In-home interviews by trained interviewers	Height, education, hair color, ability to tan, and drinking status

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure
Case-control	
Karagas 2002[88]	NR
LeMarchand 2006[81]	**Risk of melanoma and number of hours during summer in bathing suit, age 8-10 years** Males: No. / Cases / Controls / OR (95% CI) 0 / 74 (44.3%) / 88 (52.7%) / 1.0 1-32 / 32 (19.2%) / 30 (18.0%) / 1.2 (0.6-2.3) 33-80 / 27 (16.2%) / 31 (18.6%) / 0.9 (0.4-1.8) ≥80 / 34 (20.4%) / 18 (10.8%) / 2.0 (0.9-4.4) *p=0.14* Females: No. / Cases / Controls / OR (95% CI) 0 / 35 (31.8%) / 52 (47.3%) / 1.0 1-20 / 28 (25.5%) / 17 (15.5%) / 2.1 (0.8-5.4) 21-64 / 21 (19.1%) / 23 (20.9%) / 1.4 (0.5-3.7) ≥65 / 26 (23.6%) / 18 (16.4%) / 3.4 (1.2-9.1) *p=0.03* **Risk of melanoma and number of hours during summer in bathing suit, past 5 years** Males: No. / Cases / Controls / OR (95% CI) 0 / 86 (51.5%) / 108 (64.7%) / 1.0 1-12 / 29 (17.4%) / 26 (15.6%) / 1.4 (0.6-3.0) 13-24 / 23 (13.8%) / 16 (9.6%) / 1.9 (0.8-4.4) ≥25 / 29 (17.4%) / 17 (10.2%) / 2.5 (1.2-5.4) *p=0.01* Females: No. / Cases / Controls / OR (95% CI) 0 / 31 (28.2%) / 56 (50.9%) / 1.0 1-8 / 31 (28.2%) / 26 (15.6%) / 2.1 (0.8-5.6) 9-20 / 25 (22.7%) / 13 (11.8%) / 4.8 (1.7-13.4) ≥21 / 23 (20.9%) / 15 (13.6%) / 3.3 (1.1-10.10) *p=0.01* **Risk of melanoma and number of hours worked outdoors over lifetime** Males: No. / Cases / Controls / OR (95% CI) ≤438 / 42 (25.1%) / 42 (25.1%) / 1.0 439-1,644 / 41 (24.6%) / 43 (25.7%) / 1.0 (0.5-2.0) 1,645-3,360 / 38 (22.8%) / 46 (27.5%) / 0.7 (0.4-1.5) ≥3,361 / 46 (27.5%) / 36 (21.6%) / 1.3 (0.7-2.7) *p=0.36* Females: No. / Cases / Controls / OR (95% CI) 0 / 45 (40.9%) / 58 (52.7%) / 1.0 1-330 / 17 (15.5%) / 16 (14.5%) / 1.3 (0.6-3.8) 331-864 / 22 (20.0%) / 13 (11.8%) / 1.8 (0.8-4.2) ≥865 / 18 (16.4%) / 15 (13.6%) / 1.2 (0.5-3.0) *p=0.59*

Study reference USPSTF quality	Measurement of sunlamp or sunbed exposure
Case-control	
Karagas 2002[88]	**Odds ratios for BCC and SCC associated with tanning device use** BCC / SCC / Controls / BCC OR (95% CI) / SCC OR (95% CI) No / 474 (78.9%) / 229 (78.4%) / 464 (86.1%) / 1.0 / 1.0 Yes / 127 (21.1%) / 63 (21.6%) / 75 (13.9%) / 1.5 (1.1-2.1) / 2.5 (1.7-3.8) effects similar in men and women (data not shown) **Odds ratios for BCC and SCC associated with age at first tanning device use** BCC / SCC / Controls / BCC OR (95% CI) / SCC OR (95% CI) No use / 474 (78.9%) / 229 (78.4%) / 464 (86.1%) / 1.0 / 1.0 <20 / 46 (7.7%) / 24 (8.2%) / 23 (4.3%) / 1.8 (1.0-3.0) / 3.6 (1.9-6.9) 20-35 / 42 (7.0%) / 20 (6.9%) / 26 (4.8%) / 1.4 (0.8-2.3) / 2.8 (1.4-5.5) >35 / 39 (6.5%) / 19 (6.5%) / 26 (4.8%) / 1.4 (0.8-2.3) / 1.7 (0.9-3.2) Test for trend / *p=0.46* / *p=0.15*
LeMarchand 2006[81]	NR

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
Karagas 2002[88]	NR	NR	
LeMarchand 2006[81]	NR	**Risk of melanoma and number of blistering sunburns age 0-9** Males: No. Cases / Controls / OR (95% CI): 0 — 130 (77.8%) / 131(78.4%) / 1.0; 1-4 — 19 (11.4%) / 16 (9.6%) / 0.9 (0.4-2.2); ≥5 — 18 (10.8%) / 20 (18.2%) / 0.7 (0.4-1.5); *p=0.34* Females: No. Cases / Controls / OR (95% CI): 0 — 83 (75.5%) / 91 (82.7%) / 1.0; 1-3 — 10 (9.1%) / 8 (7.3%) / 1.2 (0.3-4.4); ≥4 — 17 (15.5%) / 11 (10.0%) / 1.2 (0.4-3.8); *p=0.58* **Risk of melanoma and number of blistering sunburns age 10-17** Males: No. Cases / Controls / OR (95% CI): 0 — 94 (56.3%) / 111 (66.5%) / 1.0; 1-4 — 27 (16.2%) / 23 (13.8%) / 1.2 (0.6-2.2); 5-12 — 22 (13.2%) / 18 (10.8%) / 1.2 (0.6-2.6); ≥13 — 24 (14.4%) / 15 (9.0%) / 2.0 (0.9-4.6); *p=0.09* Females: No. Cases / Controls / OR (95% CI): 0 — 50 (45.5%) / 73 (66.4%) / 1.0; 1-3 — 25 (22.7%) / 13 (11.8%) / 2.4 (0.9-6.2); 4-10 — 15 (13.6%) / 12 (10.9%) / 3.3 (1.0-10.0); ≥11 — 20 (18.2%) / 12 (10.9%) / 1.9 (0.7-6.7); *p=0.13*	

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Westerdahl 1994[86] Westerdahl 1994[40] Westerdahl 1995[41]	**Skin Cancer:** Melanoma **Study Design:** Case-control **Location:** Sweden	**Cases:** **Selection:** First diagnosis of malignant melanoma between 1988-1990 from the South Swedish Health Care Region Tumour Registry **Eligibility criteria:** Aged 15-75 years, physician consented **Controls:** **Selection:** Randomly selected from the National Population Registry of residents of the South Swedish Health Care Region **Eligibility criteria:** Parish-, sex-, and age- (within a year) matched	**Cases n=** 400 **Controls n=** 640 **Mean age (SD):** NR **Sex (calc):** Male — Cases 48.8% / Controls 48.9% **Skin phenotype:** NR	Sun exposure, sunlamp exposure, sunscreen exposure Mailed questionnaires	History of sunburns, blond hair color, red hair color, raised nevi, outdoor employment during the summer, eye color, freckling, and history of frequent sunbathing during the summer
Westerdahl 2000[85]	**Skin Cancer:** Melanoma **Study Design:** Case-control **Location:** Sweden	**Cases:** **Selection:** First diagnosis of cutaneous invasive malignant melanoma between 1995-1997 from the South Swedish Health Care Region Tumour Registry **Eligibility criteria:** Aged 16-80, physician consented **Controls:** **Selection:** Random sample from the National Population Registry of residents of the South Swedish Health Care Region **Eligibility criteria:** Sex-, age- (within a year), and parish-matched	**Cases n=** 558 **Controls n=** 891 **Mean age (calc):** 18-50 — Cases NR / Controls 292 (32.8%); 51-80 — Cases NR / Controls 599 (67.2%) **Sex (calc):** Male — Cases NR / Controls 443 (49.7%) **Skin phenotype:** III-IV — Cases NR / Controls 588 (68.1%); I-II — Cases NR / Controls 276 (31.9%)	Sun exposure, sunbed exposure, sunscreen exposure Mailed questionnaires	Hair color, history of sunburns, skin phototype, history of sunbathing, and number of raised naevi

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Case-control		
Westerdahl 1994[86] Westerdahl 1994[40] Westerdahl 1995[41]	The frequency of sunbathing or the duration of the practice of sunbathing was not related to melanoma risk (data not shown) **Odds ratios for developing malignant melanoma in relation to sunbathing frequently during the summer (April-September) (calc)** Cases / Controls / Adjusted* OR (95% CI) No 301 (75.3%) 501 (78.3%) 1.0 Yes 99 (24.7%) 139 (21.7%) 1.2 (0.9-1.7) *p=0.25* *Adjusted for exposure to sunbeds or sunlamps, history of sunburns, hair color, number of raised nevi, and history of malignant melanoma in immediate family	**Odds ratio of malignant melanoma in individuals younger than age 30 by sunbed or sunlamp exposure** Cases / Controls / Adjusted* OR (95% CI) Never 8 (32%) 19 (54%) 1.0 Ever 17 (68%) 16 (46%) 2.7 (0.7-9.8) *Adjusted for history of sunburns, blond hair color, red hair color, raised nevi, and history of frequent sunbathing during the summer **Odds ratios for developing malignant melanoma in relation to use of sunbeds or sunlamps (times/year) in different age groups (calc)** Cases / Controls / Adjusted* OR (95% CI) / p value / Test for trend p value *<30 years* Never 8 (32.0%) 19 (54.3%) 1.0 1-10 9 (36.0%) 13 (37.1%) 2.0 (0.5-8.0) >10 8 (32.0%) 3 (8.6%) 7.7 (1.0-63.6) 0.09 0.02 *30-60 years* Never 142 (65.4%) 230 (65.5%) 1.0 1-10 51 (23.5%) 90 (25.6%) 1.0 (0.7-1.6) 10 24 (11.1%) 31 (8.8%) 1.4 (0.7-2.7) 0.21 0.69 *Adjusted for history of sunburns, blond/fair and red hair color, raised nevi, and history of frequent sunbathing during the summer
Westerdahl 2000[85]	**Odds ratios for developing malignant melanoma in relation to frequency of sunbathing April-September by use of sunscreen** OR (95% CI) Use of sunscreen Never / Ever; OR* (95% CI) Use of sunscreen Never / Ever <15 times 1.0 1.3 (1.0-1.9) 1.0 1.3 (0.8-2.2) ≥15 times 0.8 (0.5-1.3) 1.1 (0.8-1.6) 0.9 (0.5-1.8) 1.2 (0.7-2.0) *Adjusted for sunburns after age 19 years, skin phototype, and hair color	NR

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
Westerdahl 1994[86] Westerdahl 1994[40] Westerdahl 1995[41]	**Odds ratios for developing malignant melanoma in relation to use of sunscreen (calc)** Cases / Controls / Crude OR(95% CI) / Adjusted* OR(95% CI) / P Never 84(21.5%) 182(28.8%) 1.0 1.0 Sometimes 208(53.2%) 334(52.8%) 1.4(1.0-2.0) 1.3(0.9-1.9) Almost always 99(25.3%) 116(18.4%) 2.1(1.4-3.2) 1.8(1.1-2.8) 0.01 *Adjusted for history of sunburns, history of frequent sunbathing during the summer, outdoor employment during the summer, and host factors (i.e. raised naevi, hair colour, eye colour, and freckling)	**Relative risk of malignant melanoma according to number of painful sunburns in different age groups (calc)** Cases / Controls / Adjusted RR (95% CI) / Crude RR (95% CI) / Test for trend p value *Before age 15* Never 143(42.2%) 259(47.3%) 1.0 1.0 1-5 149(44.0%) 224(40.9%) 1.4(1.0-1.9) 1.0(0.6-1.5) >5 47(13.9%) 65(11.9%) 1.6(1.0-2.6) 1.0(0.5-2.1) >0.05 *Ages 15-19* Never 108(29.4%) 209(39.7%) 1.0 1.0 1-5 213(58.0%) 312(59.3%) 1.4(1.0-1.9) 1.3(0.8-2.0) >5 46(12.5%) 65(12.4%) 1.6(1.0-2.5) 0.9(0.4-2.1) >0.05 adjusted for raised nevi, red hair color, and blond/fair hair color	

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
Westerdahl 2000[85]	**Odds ratios for developing malignant melanoma in relation to sunscreen use (calc)** Cases / Controls / OR (95% CI) / Adjusted* OR (95% CI) *Use of sunscreens* Never 145(26.0%) 275(30.9%) 1.0 1.0 Sometimes 269(48.2%) 409(45.9%) 1.3(1.0-1.7) 1.3(0.9-1.9) Always initially sometimes +52 (9.3%) 104 (11.7%) 1.0 (0.7-1.5) 0.9 (0.6-1.5) Always 92(16.5%) 103(11.6%) 1.9(1.3-2.7) 1.8(1.1-2.9) *Number of years of regular use* None 145(61.2%) 275(72.8%) 1.0 1.0 1-20 48(20.3%) 40(10.6%) 3.8(1.5-9.6) 4.3(0.8-21.9) >20 44(18.6%) 63(16.7%) 1.3(0.6-2.7) 1.7(0.5-5.6) *Adjusted for hair color, history of sunburns, frequency of sunbathing during the summer, and the duration of each sunbathing occasion	NR	

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Westerdahl 2000[42]	See Westerdahl et al 2000[85]	See Westerdahl et al 2000[85]	**Cases n**= 571 **Controls n**= 913 **Mean age (calc):** Cases / Controls 18-35 NR 87 (9.6%) 36-60 NR 381(41.9%) 61-80 NR 442 (48.6%) **Sex:** Cases / Controls Male 49.7% 49.2% **Skin phenotype (calc):** skin reaction to sun exposure Cases / Controls Tan/noburn NR 118 (13.0%) Moderate tan NR 479 (52.6%) Light tan NR 272(29.9%) No tan NR 10 (1.1%)	See Westerdahl et al 2000[85]	See Westerdahl et al 2000[85]

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Case-control		
Westerdahl 2000[42]	NR	**Odds ratios for developing cutaneous malignant melanoma in relation to sunbed use (calc)** Cases / Controls / OR (95% CI) / Adjusted* OR (95% CI) / Test for trend P-value *Exposure to sunbed* Never 319 (56.1%) / 538 (59.1%) / 1.0 / 1.0 Sometimes 162 (28.5%) / 270 (29.7%) / 1.1 (0.8-1.4) / 1.1 (0.8-1.4) Regular 88 (15.5%) / 102 (11.2%) / 1.6 (1.1-2.4) / 1.8 (1.2-2.7) / 0.05 *Total number of sunbed uses* None 319 (78.6%) / 538 (84.3%) / 1.0 / 1.0 1-125 22 (4.1%) / 32 (5.0%) / 1.7 (0.8-3.7) / 2.8 (1.0-7.8) 126-250 34 (8.4%) / 31 (4.9%) / 2.2 (1.1-4.4) / 3.1 (1.3-7.1) >250 31 (7.6%) / 37 (5.8%) / 1.3 (0.7-2.5) / 1.5 (0.7-3.2) / 0.26 *Age at first exposure* Never 319 (78.4%) / 538 (84.3%) / 1.0 / 1.0 ≤35 50 (12.3%) / 56 (8.8%) / 2.0 (1.2-3.5) / 2.3 (1.2-4.2) >35 38 (9.3%) / 44 (6.9%) / 1.6 (0.9-2.5) / 1.6 (0.9-2.9) / NR *Adjusted for hair color, number of raised naevi, skin type, and number of sunburns

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
Westerdahl 2000[42]	NR	NR	

Study reference USPSTF quality	Skin cancer Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Measurement of exposure	Confounders considered
Case-control					
Clough-Gorr 2008[92]	**Skin Cancer:** Melanoma **Study Design:** Case-control **Location:** New Hampshire, US	**Cases:** **Selection:** First diagnosis of cutaneous malignant melanoma between 1995-1998 from the New Hampshire State Cancer Registry **Eligibility criteria:** Aged 20-69 years, working telephone number, English speaking, physician of record consent **Controls:** **Selection:** Randomly selected from the New Hampshire Department of Motor Vehicles **Eligibility criteria:** sex-, and age- (within 5 year age groups) matched	**Cases n=** 423 **Controls n=** 678 **Mean age (SD):** Cases: 50.1 (12.2) Controls: 50.3 (11.6) **Sex:** Cases / Controls Male 223 (52.7%) / 348 (51.3%) **Skin phenotype:** *Sun sensitivity from acute exposure* Cases / Controls Tan only 14 (3.3%) / 68 (10.0%) Sunburn, then tan 185 (43.8%) / 286 (41.6%) Sunburn, peeling/freckling 20 (4.7%) / 42 (6.2%) Sunburn, then no tan 204 (48.2%) / 282 (42.2%)	Sun sunbed exposure Telephone interview	Age, sex, education level, family history of melanoma, pigmentary characteristics, sunburn history, solar exposure history

Appendix C Table 1. Evidence Table for the Association Between Sun Exposure, Indoor Tanning, or Sunscreen Use and Skin Cancer

Study reference USPSTF quality	Measurement of sun exposure	Measurement of sunlamp or sunbed exposure
Case-control		
Clough-Gorr 2008[92]	NR	**Odds ratios for developing cutaneous malignant melanoma in relation to sunlamp use** Cases / Controls / Adjusted* OR (95% CI) / Adjusted** OR (95% CI) / Test for trend P-value *Exposure to sunlamp* Never 337 (79.7%) 576 (85.1%) 1.0 1.0 Ever 86 (20.3%) 102 (15.0%) 1.46 (1.06-2.01) 1.39 (1.00-1.96) *Frequency of sunlamp use* Never 337 (79.9%) 576 (85.1%) 1.0 1.0 p=0.02 <6 times 52 (11.6%) 67 (9.4%) 1.33 (0.89-1.98) 1.29 (0.84-1.99) 6+ times 33 (8.5%) 34 (5.5%) 1.69 (1.05-2.73) 1.54 (0.93-2.57) *Age at first use* Never 337 (79.9%) 576 (85.1%) 1.0 1.0 p=0.05 ≤20 52 (12.3%) 67 (9.9%) 1.34 (0.91-1.98) 1.23 (0.81-1.88) >20 33 (7.8%) 34 (5.0%) 1.70 (1.03-2.80) 1.71 (1.00-2.92) **Odds ratios for developing cutaneous malignant melanoma in relation to tanning bed use** Cases / Controls / OR (95% CI) / Adjusted* OR (95% CI) / Test for trend P-value *Exposure to tanning bed* Never 326 (77.1%) 536 (79.1%) 1.0 1.0 Ever 97 (22.9%) 142 (20.9%) 1.15 (0.83-1.58) 1.14 (0.80-1.61) *Frequency of tanning bed use* Never 326 (77.1%) 536 (79.1%) 1.0 1.0 p=0.42 <10 times 43 (10.2%) 78 (12%) 0.93 (0.62-1.41) 1.05 (0.67-1.64) 10+ times 54 (12.7%) 63 (9%) 1.46 (0.96-2.21) 1.25 (0.79-1.98) *Age at first use* Never 326 (77.1%) 536 (79.2%) 1.0 1.0 p=0.65 ≤20 18 (4.3%) 17 (2.5%) 1.89 (0.90-3.97) 1.78 (0.76-4.15) >20 79 (18.6%) 124 (18.3%) 1.07 (0.78-1.51) 1.08 (0.75-1.55) *Adjusted for age and gender **Adjusted for age, gender, family history of melanoma, hair color, freckles, sun sensitivity, and total sun exposure hours

Study reference USPSTF quality	Measurement of sunscreen use	Measurement of sunburn	Comments
Case-control			
Clough-Gorr 2008[92]	NR	NR	

Abbreviations: BCC=basal cell carcinoma; SCC=squamous cell carcinoma; RCT=randomized controlled trial; IG=intervention group; CG=control group; S=sunscreen; B=betacarotene; (S+B)=sunscreen and betacarotene; ppt=participant; CI=confidence interval; NR=not reported; RR=relative risk; BMI=body mass index; NHS=Nurses' Health Study; OR=odds ratio; dx=diagnosis; fam hx=family history; SPF=sun protection factor; NS=not significant; LRT=likelihood ratio test; (c)=calculated.

Appendix C Table 2. Studies Excluded From the Review for Key Question 4

Reference	Reason for exclusion
Abdulla FR, Feldman SR, Williford PM, Krowchuk D, Kaur M. Tanning and skin cancer. *Pediatr Dermatol.* 2005;22:501-512.	Study design
Adam SA, Sheaves JK, Wright NH, Mosser G, Harris RW, Vessey MP. A case-control study of the possible association between oral contraceptives and malignant melanoma. *Br J Cancer* 1981;44(1):45-50.	Quality
Almahroos M, Kurban AK. Ultraviolet carcinogenesis in nonmelanoma skin cancer part II: review and update on epidemiologic correlations. *Skinmed.* 2004;3:132-139.	Study design
Araki K, Nagano T, Ueda M, et al. Incidence of skin cancers and precancerous lesions in Japanese—risk factors and prevention. *J Epidemiol.* 1999;9(6 Suppl):S14-21.	No relevant outcomes
Aubry F, MacGibbon B. Risk factors of squamous cell carcinoma of the skin. A case-control study in the Montreal region. *Cancer.* 1985;55:907-911.	Study design
Autier P, Dore JF, Cattaruzza MS, et al. Sunscreen use, wearing clothes, and number of nevi in 6- to 7-year-old European children. European Organization for Research and Treatment of Cancer Melanoma Cooperative Group. *J Natl Cancer Inst.* 1998;90:1873-1880.	Study design
Autier P, Dore JF, Gefeller O, et al. Melanoma risk and residence in sunny areas. EORTC Melanoma Cooperative Group. European Organization for Research and Treatment of Cancer. *Br J Cancer.* 1997;76:1521-1524.	Study design
Autier P, Dore JF, Lejeune F, et al. Cutaneous malignant melanoma and exposure to sunlamps or sunbeds: an EORTC multicenter case-control study in Belgium, France and Germany. EORTC Melanoma Cooperative Group. *Int J Cancer.* 1994;58:809-813.	Study design
Autier P, Dore JF, Schifflers E, et al. Melanoma and use of sunscreens: an EORTC case-control study in Germany, Belgium and France. EORTC Melanoma Cooperative Group. *Int J Cancer.* 1995;61:749-755.	Study design
Autier P. Cutaneous malignant melanoma: facts about sunbeds and sunscreen. *Expert Rev Anticancer Ther.* 2005;5:821-833.	Study design
Autier P. Perspectives in melanoma prevention: the case of sunbeds. *Eur J Cancer.* 2004;40:2367-2376.	Study design
Bajdik CD, Gallagher RP, Hill GB, Fincham S. Sunlight exposure, hat use, and squamous cell skin cancer on the head and neck. *J Cutan Med Surg.* 1998;3:68-73.	Outcome/exposure of interest not reported
Bakos L, Wagner M, Bakos RM, et al. Sunburn, sunscreens, and phenotypes: some risk factors for cutaneous melanoma in southern Brazil. *Int J Dermatol.* 2002;41:557-562.	Study design
Bastuji-Garin S, Diepgen TL. Cutaneous malignant melanoma, sun exposure, and sunscreen use: epidemiological evidence. *Br J Dermatol.* 2002;146(Suppl 61):24-30.	Study design
Bataille V, Winnett A, Sasieni P, Newton Bishop JA, Cuzick J. Exposure to the sun and sunbeds and the risk of cutaneous melanoma in the UK: a case-control study. *Eur J Cancer.* 2004;40:429-435.	Study design
Beitner H, Norell SE, Ringborg U, Wennersten G, Mattson B. Malignant melanoma: aetiological importance of individual pigmentation and sun exposure. *Br J Dermatol.* 1990;122:43-51.	Study design
Beral V, Evans S, Shaw H, Milton G. Malignant melanoma and exposure to fluorescent lighting at work. *Lancet.* 1982;2:290-293.	Study design
Beral V, Robinson N. The relationship of malignant melanoma, basal and squamous skin cancers to indoor and outdoor work. *Br J Cancer.* 1981;44:886-891.	No relevant outcomes
Berwick M, Armstrong BK, Ben-Porat L, et al. Sun exposure and mortality from melanoma. *J Natl Cancer Inst.* 2005;97:195-199.	Study design
Berwick M, Wiggins C. The current epidemiology of cutaneous malignant melanoma. *Front Biosci.* 2006;11:1244-1254.	Study design
Boniol M, Autier P, Dore JF. Photoprotection. *Lancet.* 2007;370:1481-1482.	Study design
Boscoe FP, Schymura MJ. Solar ultraviolet-B exposure and cancer incidence and mortality in the United States, 1993-2002. *BMC Cancer.* 2006;6:264.	Study design
Boyd AS, Shyr Y, King LE Jr. Basal cell carcinoma in young women: an evaluation of the association of tanning bed use and smoking. *J Am Acad Dermatol.* 2002;46:706-709.	Quality

Appendix C Table 2. Studies Excluded From the Review for Key Question 4

Reference	Reason for exclusion
Carey FA, Hogan JM. The relationship of sun exposure and solar elastosis to skin cancer in a high risk population. *Ir J Med Sci.* 1990;159:44-47.	Study design
Cho E, Rosner BA, Colditz GA. Risk factors for melanoma by body site. *Cancer Epidemiol Biomarkers Prev.* 2005;14:1241-1244.	No relevant outcomes
Cockburn M, Black W, McKelvey W, Mack T. Determinants of melanoma in a case-control study of twins (United States). *Cancer Causes Control.* 2001;12:615-625.	No relevant outcomes. Measures of sun exposure are very different from other studies
Cooke KR, Skegg DC, Fraser J. Socio-economic status, indoor and outdoor work, and malignant melanoma. *Int J Cancer.* 1984;34:57-62.	No relevant outcomes
Corona R, Dogliotti E, D'Errico M, et al. Risk factors for basal cell carcinoma in a Mediterranean population: role of recreational sun exposure early in life. *Arch Dermatol.* 2001;137:1162-1168.	Study design
Cress RD, Holly EA, Ahn DK. Cutaneous melanoma in women, V: characteristics of those who tan and those who burn when exposed to summer sun. *Epidemiology.* 1995;6:538-543.	Outcome/exposure of interest not reported
Dal H, Boldemann C, Lindelof B. Does relative melanoma distribution by body site 1960-2004 reflect changes in intermittent exposure and intentional tanning in the Swedish population? *Eur J Dermatol.* 2007;17:428-434.	Study relevance
Dennis LK, Beane Freeman LE, VanBeek MJ. Sunscreen use and the risk for melanoma: a quantitative review. *Ann Intern Med.* 2003;139:966-978.	Used as source document
Dixon A. Arc welding and the risk of cancer. *Aust Fam Physician.* 2007;36:255-256.	Study design
Dubin N, Moseson M, Pasternack BS. Epidemiology of malignant melanoma: pigmentary traits, ultraviolet radiation, and the identification of high-risk populations. *Recent Results Cancer Res.* 1986;102:56-75.	Study design
Dubin N, Moseson M, Pasternack BS. Sun exposure and malignant melanoma among susceptible individuals. *Environ Health Perspect.* 1989;81:139-151.	Study design
Dubin N, Pasternack BS, Moseson M. Simultaneous assessment of risk factors for malignant melanoma and non-melanoma skin lesions, with emphasis on sun exposure and related variables. *Int J Epidemiol.* 1990;19:811-819.	Study design
Dunn-Lane J, Herity B, Moriarty MJ, Conroy R. A case control study of malignant melanoma. *Ir Med J.* 1993;86:57-59.	Study design
el Khwsky F, Bedwani R, D'Avanzo B, et al. Risk factors for non-melanomatous skin cancer in Alexandria, Egypt. *Int J Cancer.* 1994;56:375-378.	Study design
Elwood JM, Jopson J. Melanoma and sun exposure: an overview of published studies. *Int J Cancer.* 1997;73:198-203.	Used as source document
Elwood JM, Williamson C, Stapleton PJ. Malignant melanoma in relation to moles, pigmentation, and exposure to fluorescent and other lighting sources. *Br J Cancer.* 1986;53:65-74.	Study design
Engel A, Johnson ML, Haynes SG. Health effects of sunlight exposure in the United States. Results from the first National Health and Nutrition Examination Survey, 1971-1974. *Arch Dermatol.* 1988;124:72-79.	Study design
English DR, Armstrong BK, Kricker A, Fleming C. Sunlight and cancer. *Cancer Causes Control.* 1997;8:271-283.	Study design
English DR, Milne E, Simpson JA. Sun protection and the development of melanocytic nevi in children. *Cancer Epidemiol Biomarkers Prev.* 2005;14:2873-2876.	No relevant outcomes
Espinosa AJ, Sanchez Hernandez JJ, Bravo FP, et al. Cutaneous malignant melanoma and sun exposure in Spain. *Melanoma Res.* 1999;9:199-205.	Study design
Evans RD, Kopf AW, Lew RA, et al. Risk factors for the development of malignant melanoma, I: review of case-control studies. *J Dermatol Surg Oncol.* 1988;14:393-408.	Study design
Farmer KC, Naylor MF. Sun exposure, sunscreens, and skin cancer prevention: a year-round concern. *Ann Pharmacother.* 1996;30:662-673.	Study design
Faurschou A, Wulf HC. Ecological analysis of the relation between sunbeds and skin cancer. *Photodermatol Photoimmunol Photomed.* 2007;23:120-125.	Study design
Fears TR, Gail MH. Analysis of a two-stage case-control study with cluster sampling of controls: application to nonmelanoma skin cancer. *Biometrics.* 2000;56:190-198.	Study relevance

Appendix C Table 2. Studies Excluded From the Review for Key Question 4

Reference	Reason for exclusion
Fears TR, Scotto J, Schneiderman MA. Mathematical models of age and ultraviolet effects on the incidence of skin cancer among whites in the United States. *Am J Epidemiol.* 1977;105:420-427.	Study design
Freedman DM, Zahm SH, Dosemeci M. Residential and occupational exposure to sunlight and mortality from non-Hodgkin's lymphoma: composite (threefold) case-control study. *BMJ.* 1997;314:1451-1455.	No relevant outcomes
Fritschi L, Siemiatycki J. Melanoma and occupation: results of a case-control study. *Occup Environ Med.* 1996;53:168-173.	No relevant outcomes
Gafa L, Filippazzo MG, Tumino R, Dardanoni G, Lanzarone F, Dardanoni L. Risk factors of nonmelanoma skin cancer in Ragusa, Sicily: a case-control study. *Cancer Causes Control.* 1991;2:395-399.	Quality
Gallagher RP, Rivers JK, Lee TK, Bajdik CD, McLean DI, Coldman AJ. Broad-spectrum sunscreen use and the development of new nevi in white children: a randomized controlled trial. *JAMA.* 2000;283:2955-2960.	No relevant outcomes
Gallagher RP, Spinelli JJ, Lee TK. Tanning beds, sunlamps, and risk of cutaneous malignant melanoma. *Cancer Epidemiol Biomarkers Prev.* 2005;14:562-566.	Used as source document
Gamble JF, Lerman SE, Holder WR, Nicolich MJ, Yarborough CM. Physician-based case-control study of non-melanoma skin cancer in Baytown, Texas. *Occup Med (Lond).* 1996;46:186-196.	Quality
Gandini S, Sera F, Cattaruzza MS, et al. Meta-analysis of risk factors for cutaneous melanoma, III: family history, actinic damage and phenotypic factors. *Eur J Cancer.* 2005;41:2040-2059.	Study relevance
Gandini S, Sera F, Cattaruzza MS, et al. Meta-analysis of risk factors for cutaneous melanoma, I: common and atypical naevi. *Eur J Cancer.* 2005;41:28-44.	Study relevance
Gandini S, Sera F, Cattaruzza MS, et al. Meta-analysis of risk factors for cutaneous melanoma, II: sun exposure. *Eur J Cancer.* 2005;41:45-60.	Used as source document
Garbe C, Weiss J, Kruger S, et al. The German melanoma registry and environmental risk factors implied. *Recent Results Cancer Res.* 1993;128:69-89.	Quality
Gefeller O, Pfahlberg A. Sunscreen use and melanoma: a case of evidence-based prevention? *Photodermatol Photoimmunol Photomed.* 2002;18:153-156.	Study design
Geller AC, Colditz G, Oliveria S, et al. Use of sunscreen, sunburning rates, and tanning bed use among more than 10,000 US children and adolescents. *Pediatrics.* 2002;109:1009-1014.	No relevant outcomes
Giles GG, Marks R, Foley P. Incidence of non-melanocytic skin cancer treated in Australia. *BMJ.* 1988;296:13-17.	Study design
Goodman KJ, Bible ML, London S, Mack TM. Proportional melanoma incidence and occupation among white males in Los Angeles County (California, United States). *Cancer Causes Control.* 1995;6:451-459.	No relevant outcomes
Gorham ED, Mohr SB, Garland CF, Chaplin G, Garland FC. Do sunscreens increase risk of melanoma in populations residing at higher latitudes? *Ann Epidemiol.* 2007;17:956-963.	Used as source document
Graham S, Marshall J, Haughey B, et al. An inquiry into the epidemiology of melanoma. *Am J Epidemiol.* 1985;122:606-619.	Study design
Green A, Battistutta D. Incidence and determinants of skin cancer in a high-risk Australian population. *Int J Cancer.* 1990;46:356-361.	Study design
Green A, Beardmore G, Hart V, Leslie D, Marks R, Staines D. Skin cancer in a Queensland population. *J Am Acad Dermatol.* 1988;19:1045-1052.	Study design
Green A, McCredie M, MacKie R, et al. A case-control study of melanomas of the soles and palms (Australia and Scotland). *Cancer Causes Control.* 1999;10:21-25.	Study relevance
Green AE, Findley GB Jr, Klenk KF, Wilson WM, Mo T. The ultraviolet dose dependence of non-melanoma skin cancer incidence. *Photochem Photobiol.* 1976;24:353-362.	Study design
Hakansson N, Floderus B, Gustavsson P, Feychting M, Hallin N. Occupational sunlight exposure and cancer incidence among Swedish construction workers. *Epidemiology.* 2001;12:552-557.	No relevant outcomes
Harvey I, Frankel S, Marks R, Shalom D, Nolan-Farrell M. Non-melanoma skin cancer and solar keratoses, II: analytical results of the South Wales Skin Cancer Study. *Br J Cancer.* 1996;74:1308-1312.	No relevant outcomes

Appendix C Table 2. Studies Excluded From the Review for Key Question 4

Reference	Reason for exclusion
Harvey I, Frankel S, Marks R, Shalom D, Nolan-Farrell M. Non-melanoma skin cancer and solar keratoses, I: methods and descriptive results of the South Wales Skin Cancer Study. *Br J Cancer.* 1996;74:1302-1307.	No relevant outcomes
Heckmann M, Zogelmeier F, Konz B. Frequency of facial basal cell carcinoma does not correlate with site-specific UV exposure. *Arch Dermatol.* 2002;138:1494-1497.	Study design
Herity B, O'Loughlin G, Moriarty MJ, Conroy R. Risk factors for non-melanoma skin cancer. *Ir Med J.* 1989;82:151-152.	Study design
Herzfeld PM, Fitzgerald EF, Hwang SA, Stark A. A case-control study of malignant melanoma of the trunk among white males in upstate New York. *Cancer Detect Prev.* 1993;17(6):601-608.	Quality
Hogan DJ, Lane PR, Gran L, Wong D. Risk factors for squamous cell carcinoma of the skin in Saskatchewan, Canada. *J Dermatol Sci.* 1990;1:97-101.	No relevant outcomes
Hogan DJ, To T, Gran L, Wong D, Lane PR. Risk factors for basal cell carcinoma. *Int J Dermatol.* 1989;28:591-594.	Quality
Holly EA, Kelly JW, Shpall SN, Chiu SH. Number of melanocytic nevi as a major risk factor for malignant melanoma. *J Am Acad Dermatol.* 1987;17:459-468.	No relevant outcomes
Holman CD, Armstrong BK, Heenan PJ, et al. The causes of malignant melanoma: results from the West Australian Lions Melanoma Research Project. *Recent Results Cancer Res.* 1986;102:18-37.	Population
Holman CD, Armstrong BK, Heenan PJ. Relationship of cutaneous malignant melanoma to individual sunlight-exposure habits. *J Natl Cancer Inst.* 1986;76:403-414.	Population
Holman CD, Armstrong BK. Pigmentary traits, ethnic origin, benign nevi, and family history as risk factors for cutaneous malignant melanoma. *J Natl Cancer Inst.* 1984;72:257-266.	Population
Huncharek M, Kupelnick B. Use of topical sunscreens and the risk of malignant melanoma: a meta-analysis of 9067 patients from 11 case-control studies. *Am J Public Health.* 2002;92:1173-1177.	Used as source document
Ibrahim SF, Brown MD. Tanning and cutaneous malignancy. *Dermatol Surg.* 2008;34:460-474.	Study design
Ivry GB, Ogle CA, Shim EK. Role of sun exposure in melanoma. *Dermatol Surg.* 2006;32:481-492.	Study design
John EM, Dreon DM, Koo J, Schwartz GG. Residential sunlight exposure is associated with a decreased risk of prostate cancer. *J Steroid Biochem Mol Biol.* 2004;89-90:549-552.	Study design
Karagas MR, Greenberg ER, Spencer SK, Stukel TA, Mott LA. Increase in incidence rates of basal cell and squamous cell skin cancer in New Hampshire, USA. New Hampshire Skin Cancer Study Group. *Int J Cancer.* 1999;81:555-559.	Study relevance
Kaskel P, Sander S, Kron M, Kind P, Peter RU, Krahn G. Outdoor activities in childhood: a protective factor for cutaneous melanoma? Results of a case-control study in 271 matched pairs. *Br J Dermatol.* 2001;145:602-609.	Quality
Klepp O, Magnus K. Some environmental and bodily characteristics of melanoma patients. A case-control study. *Int J Cancer.* 1979;23:482-486.	Study design
Kricker A, Armstrong BK, English DR. Sun exposure and non-melanocytic skin cancer. *Cancer Causes Control.* 1994;5:367-392.	Study design
Kricker A, Armstrong BK, Goumas C, et al. Ambient UV, personal sun exposure and risk of multiple primary melanomas. *Cancer Causes Control.* 2007;18:295-304.	Study design
Landi MT, Baccarelli A, Calista D, et al. Combined risk factors for melanoma in a Mediterranean population. *Br J Cancer.* 2001;85:1304-1310.	Quality
Lazovich D, Sweeney C, Weinstock MA, Berwick M. A prospective study of pigmentation, sun exposure, and risk of cutaneous malignant melanoma in women. *J Natl Cancer Inst.* 2004;96:335-338.	Study design
Lear JT, Harvey I, de Berker D, Strange RC, Fryer AA. Basal cell carcinoma. *J R Soc Med.* 1998;91:585-588.	Study design
Lee JA, Strickland D. Malignant melanoma: social status and outdoor work. *Br J Cancer.* 1980;41:757-763.	No relevant outcomes
Leiter U, Garbe C. Epidemiology of melanoma and nonmelanoma skin cancer—the role of sunlight. *Adv Exp Med Biol.* 2008;624:89-103.	Study design

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Reference	Reason for exclusion
Lim JL, Stern RS. High levels of ultraviolet B exposure increase the risk of non-melanoma skin cancer in psoralen and ultraviolet A-treated patients. *J Invest Dermatol.* 2005;124:505-513.	Population
Lock-Andersen J, Drzewiecki KT, Wulf HC. Eye and hair colour, skin type and constitutive skin pigmentation as risk factors for basal cell carcinoma and cutaneous malignant melanoma. A Danish case-control study. *Acta Derm Venereol.* 1999;79:74-80.	No relevant outcomes
Lock-Andersen J, Drzewiecki KT, Wulf HC. Naevi as a risk factor for basal cell carcinoma in Caucasians: a Danish case-control study. *Acta Derm Venereol.* 1999;79:314-319.	No relevant outcomes
Loria D, Matos E. Risk factors for cutaneous melanoma: a case-control study in Argentina. *Int J Dermatol.* 2001;40:108-114.	Study design
Lovatt TJ, Lear JT, Bastrilles J, et al. Associations between UVR exposure and basal cell carcinoma site and histology. *Cancer Lett.* 2004;216:191-197.	Study design
MacKie RM, Freudenberger T, Aitchison TC. Personal risk-factor chart for cutaneous melanoma. *Lancet.* 1989;2:487-490.	Study design
Maia M, Proenca NG, de Moraes JC. Risk factors for basal cell carcinoma: a case-control study. *Rev Saude Publica.* 1995;29:27-37.	Quality
Marks R, Jolley D, Dorevitch AP, Selwood TS. The incidence of non-melanocytic skin cancers in an Australian population: results of a five-year prospective study. *Med J Aust.* 1989;150:475-478.	No relevant outcomes
Marks R, Ponsford MW, Selwood TS, Goodman G, Mason G. Non-melanotic skin cancer and solar keratoses in Victoria. *Med J Aust.* 1983;2:619-622.	Study design
Marks R, Rennie G, Selwood T. The relationship of basal cell carcinomas and squamous cell carcinomas to solar keratoses. *Arch Dermatol.* 1988;124:1039-1042.	Study design
Memon AA, Tomenson JA, Bothwell J, Friedmann PS. Prevalence of solar damage and actinic keratosis in a Merseyside population. *Br J Dermatol.* 2000;142:1154-1159.	Study design
Moore DH, Patterson HW, Hatch F, et al. Case-control study of malignant melanoma among employees of the Lawrence Livermore National Laboratory. *Am J Ind Med.* 1997;32:377-391.	Quality
Morales Suarez-Varela M, Llopis GA, Ferrer CE. Non-melanoma skin cancer: an evaluation of risk in terms of ultraviolet exposure. *Eur J Epidemiol.* 1992;8:838-844.	Study design
Naldi L, Altieri A, Imberti GL, et al. Cutaneous malignant melanoma in women. Phenotypic characteristics, sun exposure, and hormonal factors: a case-control study from Italy. *Ann Epidemiol.* 2005;15:545-550.	Study design
Naldi L, Altieri A, Imberti GL, et al. Sun exposure, phenotypic characteristics, and cutaneous malignant melanoma. An analysis according to different clinico-pathological variants and anatomic locations (Italy). *Cancer Causes Control.* 2005;16:893-899.	Study design
Naldi L, DiLandro A, D'Avanzo B, Parazzini F. Host-related and environmental risk factors for cutaneous basal cell carcinoma: evidence from an Italian case-control study. *J Am Acad Dermatol.* 2000;42:446-452.	Study design
Naldi L, Gallus S, Imberti GL, Cainelli T, Negri E, La Vecchia C. Sunlamps and sunbeds and the risk of cutaneous melanoma. Italian Group for Epidemiological Research in Dermatology. *Eur J Cancer Prev.* 2000;9:133-134.	Study design
Naldi L, Gallus S, Imberti GL, Cainelli T, Negri E, La Vecchia C. Sunscreens and cutaneous malignant melanoma: an Italian case-control study. *Int J Cancer.* 2000;86:879-882.	Study design
Naylor MF, Boyd A, Smith DW, Cameron GS, Hubbard D, Neldner KH. High sun protection factor sunscreens in the suppression of actinic neoplasia. *Arch Dermatol.* 1995;131:170-175.	No relevant outcomes
Nelemans PJ, Groenendal H, Kiemeney LA, Rampen FH, Ruiter DJ, Verbeek AL. Effect of intermittent exposure to sunlight on melanoma risk among indoor workers and sun-sensitive individuals. *Environ Health Perspect.* 1993;101:252-255.	No relevant outcomes
Nelemans PJ, Rampen FH, Ruiter DJ, Verbeek AL. An addition to the controversy on sunlight exposure and melanoma risk: a meta-analytical approach. *J Clin Epidemiol.* 1995;48:1331-1342.	Used as source document

Appendix C Table 2. Studies Excluded From the Review for Key Question 4

Reference	Reason for exclusion
Nijsten T, Leys C, Verbruggen K, et al. Case-control study to identify melanoma risk factors in the Belgian population: the significance of clinical examination. *J Eur Acad Dermatol Venereol.* 2005;19:332-339.	Study design
Nikolaou NA, Sypsa V, Stefanaki I, et al. Risk associations of melanoma in a Southern European population: results of a case/control study. *Cancer Causes Control* 2008;19(7):671-679.	Quality
Oliveria SA, Saraiya M, Geller AC, Heneghan MK, Jorgensen C. Sun exposure and risk of melanoma. *Arch Dis Child.* 2006;91:131-138.	Used as source document
Pelucchi C, Di Landro A, Naldi L, La Vecchia C; Oncology Study Group of the Italian Group for Epidemiologic Research in Dermatology (GISED). Risk factors for histological types and anatomic sites of cutaneous basal-cell carcinoma: an italian case-control study. *J Invest Dermatol.* 2007;127:935-944.	Study design
Pion IA, Rigel DS, Garfinkel L, Silverman MK, Kopf AW. Occupation and the risk of malignant melanoma. *Cancer.* 1995;75:637-644.	No relevant outcomes
Prawer SE. Sun-related skin diseases. *Postgrad Med.* 1959;89:51-54.	Study design
Pukkala E, Saarni H. Cancer incidence among Finnish seafarers, 1967-92. *Cancer Causes Control.* 1996;7:231-239.	Study relevance
Purdue MP, From L, Armstrong BK, et al. Etiologic and other factors predicting nevus-associated cutaneous malignant melanoma. *Cancer Epidemiol Biomarkers Prev.* 2005;14:2015-2022.	Study design
Rafnsson V, Hrafnkelsson J, Tulinius H, Sigurgeirsson B, Olafsson JH. Risk factors for malignant melanoma in an Icelandic population sample. *Prev Med.* 2004;39:247-252.	Study design
Ramos J, Villa J, Ruiz A, Armstrong R, Matta J. UV dose determines key characteristics of nonmelanoma skin cancer. *Cancer Epidemiol Biomarkers Prev.* 2004;13:2006-2011.	Study design
Robinson JK, Rademaker AW. Relative importance of prior basal cell carcinomas, continuing sun exposure, and circulating T lymphocytes on the development of basal cell carcinoma. *J Invest Dermatol.* 1992;99:227-231.	Study design
Rodenas JM, Gado-Rodriguez M, Herranz MT, Tercedor J, Serrano S. Sun exposure, pigmentary traits, and risk of cutaneous malignant melanoma: a case-control study in a Mediterranean population. *Cancer Causes Control.* 1996;7:275-283.	Study design
Rosso S, Zanetti R, Martinez C, et al. The multicentre south European study "Helios," II: different sun exposure patterns in the aetiology of basal cell and squamous cell carcinomas of the skin. *Br J Cancer.* 1996;73:1447-1454.	Study design
Rosso S, Zanetti R, Pippione M, Sancho-Garnier H. Parallel risk assessment of melanoma and basal cell carcinoma: skin characteristics and sun exposure. *Melanoma Res.* 1998;8:573-583.	Study design
Sahl WJ, Glore S, Garrison P, Oakleaf K, Johnson SD. Basal cell carcinoma and lifestyle characteristics. *Int J Dermatol.* 1995;34:398-402.	Quality
Saladi RN, Persaud AN. The causes of skin cancer: a comprehensive review. *Drug Today.* 2005;41:37-53.	Study design
Schmieder GJ, Yoshikawa T, Mata SM, Streilein JW, Taylor JR. Cumulative sunlight exposure and the risk of developing skin cancer in Florida. *J Dermatol Surg Oncol.* 1992;18:517-522.	Quality
Scrivener Y, Grosshans E, Cribier B. Variations of basal cell carcinomas according to gender, age, location and histopathological subtype. *Br J Dermatol.* 2002;147:41-47.	No relevant outcomes
Shah CP, Weis E, Lajous M, Shields JA, Shields CL. Intermittent and chronic ultraviolet light exposure and uveal melanoma: a meta-analysis. *Ophthalmology.* 2005;112:1599-1607.	Study relevance
Singh B, Bhaya M, Shaha A, Har-El G, Lucente FE. Presentation, course, and outcome of head and neck skin cancer in African Americans: a case-control study. *Laryngoscope.* 1998;108:t-63.	Study design
Siskind V, Aitken J, Green A, Martin N. Sun exposure and interaction with family history in risk of melanoma, Queensland, Australia. *Int.J.Cancer* 2002;97(1):90-95.	Quality
Stender IM, Andersen JL, Wulf HC. Sun exposure and sunscreen use among sunbathers in Denmark. *Acta Derm Venereol.* 1996;76:31-33.	Study design

Appendix C Table 2. Studies Excluded From the Review for Key Question 4

Reference	Reason for exclusion
Strickland PT, Vitasa BC, West SK, Rosenthal FS, Emmett EA, Taylor HR. Quantitative carcinogenesis in man: solar ultraviolet B dose dependence of skin cancer in Maryland watermen. *J Natl Cancer Inst.* 1989;81:1910-1913.	Study design
Suarez-Varela MM, Llopis GA, Ferrer CE. Non-melanoma skin cancer: a case-control study on risk factors and protective measures. *J Environ Pathol Toxicol Oncol.* 1996;15:255-261.	Study design
Sunscreen use in children may lower risk of developing future skin cancer. *Oncology (Williston Park).* 2005;19:1139-1140.	No relevant outcomes
Swerdlow AJ, English JS, MacKie RM, et al. Fluorescent lights, ultraviolet lamps, and risk of cutaneous melanoma. *BMJ.* 1988;297:647-650.	Study design
The association of use of sunbeds with cutaneous malignant melanoma and other skin cancers: a systematic review. *Int J Cancer.* 2007;120:1116-1122.	Used as source document
Thompson SC, Jolley D, Marks R. Reduction of solar keratoses by regular sunscreen use. *N Engl J Med.* 1993;329:1147-1151.	No relevant outcomes
Ting W, Schultz K, Cac NN, Peterson M, Walling HW. Tanning bed exposure increases the risk of malignant melanoma. *Int J Dermatol.* 2007;46(12):1253-1257.	Quality
Vagero D, Ringback G, Kiviranta H. Melanoma and other tumors of the skin among office, other indoor and outdoor workers in Sweden 1961-1979. *Br J Cancer.* 1986;53:507-512.	No relevant outcomes
Vainio H, Bianchini F. Cancer-preventive effects of sunscreens are uncertain. *Scand J Work Environ Health.* 2000;26:529-531.	Study design
Vainio H, Miller AB, Bianchini F. An international evaluation of the cancer-preventive potential of sunscreens. *Int J Cancer.* 2000;88:838-842.	Study design
Vajdic CM, Kricker A, Giblin M, et al. Artificial ultraviolet radiation and ocular melanoma in Australia. *Int J Cancer.* 2004;112:896-900.	Study relevance
van-der-Pols JC, Williams GM, Neale RE, Clavarino A, Green AC. Long-term increase in sunscreen use in an Australian community after a skin cancer prevention trial. *Prev Med.* 2006;42:171-176.	No relevant outcomes
Vitaliano PP, Urbach F. The relative importance of risk factors in nonmelanoma carcinoma. *Arch Dermatol.* 1980;116:454-456.	Study design
Vitaliano PP. The use of logistic regression for modelling risk factors: with application to non-melanoma skin cancer. *Am J Epidemiol.* 1978;108:402-414.	Study relevance
Vitasa BC, Taylor HR, Strickland PT, et al. Association of nonmelanoma skin cancer and actinic keratosis with cumulative solar ultraviolet exposure in Maryland watermen. *Cancer.* 1990;65:2811-2817.	Study design
Walther U, Kron M, Sander S, et al. Risk and protective factors for sporadic basal cell carcinoma: results of a two-centre case-control study in southern Germany. Clinical actinic elastosis may be a protective factor. *Br J Dermatol.* 2004;151:170-178.	Study design
Weinstock MA, Colditz GA, Willett WC, et al. Moles and site-specific risk of nonfamilial cutaneous malignant melanoma in women. *J Natl Cancer Inst.* 1989;81:948-952.	No relevant outcomes
Weinstock MA. Do sunscreens increase or decrease melanoma risk: an epidemiologic evaluation. *J Invest Dermatol Sym Proc.* 1999;4:97-100.	Study design
Weinstock MA. Sunscreen use can reduce melanoma risk. *Photodermatol Photoimmunol Photomed.* 2001;17:234-236.	Study design
Whiteman DC, Stickley M, Watt P, Hughes MC, Davis MB, Green AC. Anatomic site, sun exposure, and risk of cutaneous melanoma. *J Clin Oncol.* 2006;24:3172-3177.	Study design
Whiteman DC, Valery P, McWhirter W, Green AC. Risk factors for childhood melanoma in Queensland, Australia. *Int J Cancer.* 1997;70:26-31.	Study design
Whiteman DC, Whiteman CA, Green AC. Childhood sun exposure as a risk factor for melanoma: a systematic review of epidemiologic studies. *Cancer Causes Control.* 2001;12:69-82.	Used as source document
Wiecker TS, Luther H, Buettner P, Bauer J, Garbe C. Moderate sun exposure and nevus counts in parents are associated with development of melanocytic nevi in childhood: a risk factor study in 1,812 kindergarten children. *Cancer.* 2003;97:628-638.	No relevant outcomes

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Reference	Reason for exclusion
Wolf P, Quehenberger F, Mullegger R, Stranz B, Kerl H. Phenotypic markers, sunlight-related factors and sunscreen use in patients with cutaneous melanoma: an Austrian case-control study. *Melanoma Res.* 1998;8:370-378.	Quality
Woolley T, Buettner PG, Lowe J. Sun-related behaviors of outdoor working men with a history of non-melanoma skin cancer. *J Occup Environ Med.* 2002;44:847-854.	Study design
Xu LY, Koo J. Predictive value of phenotypic variables for skin cancer: risk assessment beyond skin typing. *Int J Dermatol.* 2006;45:1275-1283.	Study relevance
Youl P, Aitken J, Hayward N, et al. Melanoma in adolescents: a case-control study of risk factors in Queensland, Australia. *Int J Cancer.* 2002;98:92-98.	Population
Zanetti R, Rosso S, Martinez C, et al. The multicentre south European study "Helios," I: skin characteristics and sunburns in basal cell and squamous cell carcinomas of the skin. *Br J Cancer.* 1996;73:1440-1446.	Study design

Appendix C Table 3. Evidence Table for Adverse Effects of Sun-Protective Behaviors

Study reference USPSTF quality	Study objective	Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Intervention description (if trial)
Vitamin D deficiency					
Marks 1995[98] Fair	To determine whether the regular use of sunscreens in the normal adult population may put individuals at risk of vitamin D deficiency (measures of 25 and 1,25 OHD)	RCT Victoria, Australia General population undergoing longitudinal intervention study on the effect of regular sunscreen use in people with solar keratoses	Age 40 yr or more, White, with 1-30 solar keratoses	**N:** 153 randomized, 113 analyzed IG: 58 CG:55 **Age**: 52% under age 70 yr **Sex:** 41% men **Skin phenotype:** 27% burn 50% burn/tan 23% tan	**IG:** SPF 17 sunscreen, participants were given specific instructions on the application of sunscreen; in addition they were given other 'sun protective behavior' instructions **CG:** placebo cream, given same instructions
Brot 2001[99] Fair	To assess the prevalence of vitamin D insufficiency in a population of normal perimenopausal women, to estimate the relative influences of sun exposure and vitamin D intake on the concentration of 25OHD and to examine the relationship between PTH and 25OHD	Prospective cohort from larger multicenter RCT Denmark General perimenopausal women	Age 45-58 years and 3-24 months past last menstrual bleeding or perimenopausal symptoms and elevated FSH; if hysterectomized, age 45-52 with elevated FSH Excluded women with osteo-porotic fractures, metabolic bone disease, current estrogen use, hyper or hypothyroidism, newly diagnosed or uncontroll-ed chronic disease, liver disease, unstable cardiac disease, current or past malignant disease, hospital-ization for alcohol or drug abuse, history of deep thrombophlebitis or stroke	**N:** 2016 **Age range:** 45-58 yr **Sex:** 0% men **Skin phenotype:** NR	N/A

Study reference USPSTF quality	Measurement of exposure (or intervention if applicable)	Confounders considered (if observational study)	Followup	Measurement of adverse outcomes	Comments
Vitamin D deficiency					
Marks 1995[98] Fair	All participants given diaries to record sunscreen use and sunscreen container were weighed to determine amount of cream used In addition, participants were also given polysulfone film badges and diaries to record sun exposure	Age, sex, self-reported skin type; NOT adjusted for UV exposure, but trial reports not detectable difference in UV exposure between the two groups	7 months: 74%	**(Table 2) change in 25 and 1,25 OHD at 7 mo** *25 OHD (nmol/L) mean change, [95% CI], % change, p-value* IG: 11.8, [7.6, 15.9], 21% CG: 12.8, [8.4, 17.1], 25% p=0.75 *1,25 OHD (nmol/L) mean change, [95% CI], % change, p-value* IG: 1.3, [-2.3, 4.9], 1% CG: 10.8, [6.7, 14.8], 14% p=0.0009 **(Table 3) change in 25 and 1,25 OHD at 7 mo by age, sex, and skin type** No statistically significant changes Also reported "no person using sunscreen developed serum vitamin D levels below the reference range over the period of the study"	These vitamin D levels appear to be low

Appendix C Table 3. Evidence Table for Adverse Effects of Sun-Protective Behaviors

Study reference USPSTF quality	Measurement of exposure (or intervention if applicable)	Confounders considered (if observational study)	Followup	Measurement of adverse outcomes	Comments
Vitamin D deficiency					
Brot 2001[99] Fair	All participants were interviewed by 2 physicians to determine sun exposure (never, occasionally, regularly); and sunbed use (no, yes)	Dietary vitamin D, and vitamin D supplementation (no, yes); did NOT assess for sunscreen use	2.5 years: unclear, 95% with diet records	**(Table 2) prevalence of low vit D status during winter and spring according to sun exposure and vitamin supplementation** *mean serum 25OHD (nmol/L) no vitamin supplement, vitamin supplement* Never: 36.5, 45.3 Occasionally: 41.5, 49.3 Regularly: 53.5, 62.3 *Percent of subgroup with low vitamin D status, 25 OHD ≤25nmol/L* Never: 32.8, 12.9 Occasionally: 17.6, 10.7 Regularly: 9.8, 2.8	

Study reference USPSTF quality	Study objective	Study design Location Population	Participant inclusion/ exclusion criteria	Baseline demographics	Intervention description (if trial)
Decreased physical activity (see KQ3 which has one trial in addition to Milne 2007)					
Milne 2007[94] Fair	To determine if adherence to the sun safety message could inadvertently have a detrimental effect on children's body mass index (BMI)	Cluster CCT by school (non-randomized to minimize contamination) Perth, Australia General grade school children	Children, age 5 or 6 in 1995 attending participating schools (schools within 30km of Perth with 50 or more first-grade students)	**N:** 33 schools randomized, **N:** 1615 children analyzed **IG high:** 8 schools **IG moderate:** 11 schools **CG:** 14 schools **Age:** 5-6 yrs at entry; 11-12 years at last followup **Sex:** NR **Skin phenotype:** 100% of European ethnicity	**IG high and moderate:** specially designed sun protection curriculum that was administered over 4 consecutive years beginning at age 6, curriculum integrated into a range of subjects, including physical education; children in the high intervention group were sent program materials over the summer vacation and offered low-cost sun protective swimwear **CG:** standard Western Australian health education curriculum

Study reference USPSTF quality	Measurement of exposure (or intervention if applicable)	Confounders considered (if observational study)	Followup	Measurement of adverse outcomes	Comments
Decreased physical activity (see KQ3 which has one trial in addition to Milne 2007)					
Milne 2007[94] Fair	Parents of children were sent self-administered questionnaire to determine total time spent outdoors	Random effects model for school, and adjusted for study group, total time spent outdoors at baseline, gender, ethnicity, parental education level, and tendency to sunburn	4 years: 90% 6 years: 69%	**(Table 3) adjusted differences in z scores (BMI for age), adjusted for sex, ethnicity, parent education, z score at baseline** *@ 4 years, z-score [95%CI]* IG high: -0.08 [-0.22, 0.06] IG moderate: 0.01 [-0.12, 0.14] CG: ref *@ 6 years, z-score [95%CI]* IG high: -0.11 [-0.27, 0.05] IG moderate: 0.05 [-0.09, 0.20] CG: ref **Adjusted relative difference, total time spent otudoors, adjusted for sex, ethnicity, parent education, tendency to burn, and total time spent outdoors at baseline** *@ 4 years, relative difference [95%CI]* IG high: 0.90 [0.78, 1.05] IG moderate: 1.0 [0.87, 1.15] CG: ref *@ 6 years, relative difference [95%CI]* IG high: 0.98 [0.83, 1.15] IG moderate: 0.94 [0.81, 1.09] CG: ref	Non-randomized, were differences at baseline among children; time spent outdoors is a proxy for physical activity, lack of adjustment for nutritional intake

Appendix C Table 3. Evidence Table for Adverse Effects of Sun-Protective Behaviors

Study reference USPSTF quality	Study objective	Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Intervention description (if trial)
Increased sun exposure (with sunscreen use)					
Autier 1999[95] Good	To determine if sunscreen use encourages longer sun exposure duration	RCT Lyon, France and Lausanne, Switzerland Healthy volunteers from universities	Age 18-24 years, positive history of sunburn in the past and regular sunscreen users intending to have at least 15 days of holiday in sunny areas during the next 2 months Excluded persons with current or history of skin diseases that lasted for more than 1 year, pregnant women, persons with chronic physical illness, persons taking photosensitizing medication	**N:** 87 **IG1:** 44 **IG2:** 43 (42 analyzed) **Age range:**18-24 years **Sex:** 41% men **Skin phenotype:** 2% skin type I, burns 33% skin type II, burns/tans 65% skin type III, tans 0% skin type IV, tans/never burns	**IG1:** SPF 10 sunscreen **IG2:** SPF 30 sunscreen

Study reference USPSTF quality	Measurement of exposure (or intervention if applicable)	Confounders considered (if observational study)	Followup	Measurement of adverse outcomes	Comments
Increased sun exposure (with sunscreen use)					
Autier 1999[95] Good	Daily diary to record detailed data about sun exposure (hours and type of sun exposure, amount of clothing, number of sunscreen applications, time of application, and sunburn or skin-reddening experience, as well as use of other sunscreen products (if applicable)	Skin phenotype, lifetime sun exposure habits, sunburn experience, sunscreen use	2 months: 99%	**(Table 2) mean total hours of sun exposure per participant** *@ 2 months mean hours, [95%CI], p-value* IG1: 58.2 [52.0, 64.4] IG2: 72.6 [63.5, 81.7] p=0.011 *@ 2 months mean hours daily sun exposure, [95%CI], p-value* IG1: 4.0 [3.3, 4.7] IG2: 4.6 [3.9, 5.3] p=<0.0001 *@ 2 months mean hours daily outdoor activity, [95%CI], p-value* IG1: 3.6 [2.9, 4.3] IG2: 3.8 [3.0, 4.6] p=0.62 *@ 2 months mean hours daily sunbathing, [95%CI], p-value* IG1: 2.6 [2.1, 3.1] IG2: 3.1 [2.5, 3.7] p=0.0013 **Number of sunburn or skin-reddening episodes, p-value** IG1: 159 IG2: 159 p=0.99 **Number of sunburns, p-value** IG1: 42 IG2: 34 p=0.90	

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Study reference USPSTF quality	Study objective	Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Intervention description (if trial)
Increased sun exposure (with sunscreen use)					
Autier 2000[96] Good	To determine if sunscreen use encourages longer sun exposure duration, and sunbathing in particular	RCT Paris and Thionville, France and Brussels, Belgium Healthy volunteers from hospitals	Age 18-24 years, positive history of sunburn in the past and regular sunscreen users intending to have at least 15 days of holiday in sunny areas during the next 2 months Excluded persons with current or history of skin diseases that lasted for more than 1 year	**N:** 62 randomized, 58 analyzed **IG1:** 29 **IG2:** 29 **Age range:** 18-24 years **Sex:** 26% men **Skin phenotype:** 5% skin type I, burns 53% skin type II, burns/tans 41% skin type III, tans 0% skin type IV, tans/never burns	**IG1:** SPF 10 sunscreen **IG2:** SPF 30 sunscreen

Study reference USPSTF quality	Measurement of exposure (or intervention if applicable)	Confounders considered (if observational study)	Followup	Measurement of adverse outcomes	Comments
Increased sun exposure (with sunscreen use)					
Autier 2000[96] Good	Daily diary to record detailed data about sun exposure and personal dosimeters (n=50) to measure UVA and UVB exposure	Sunscreen use (SPF and quantity), in-trial sunburn experience, skin phenotype	After particpants' summer holiday: 94% (only 71% for dosimeters)	**(Table 2) median hours daily sunbathing, [95%CI], % change, p-value** IG1: 2.4 [NR] IG2: 3.0 [NR] +25% p=0.054 M**edian UVB exposure (Joules/m2) per day with sunbathing, [95%CI], % change, p-value** IG1: 841 [NR] IG2: 984 [NR] +17% p=0.15 **Median UVA exposure (KJoules/m2) per day with sunbathing, [95%CI], % change, p-value** IG1: 136 [NR] IG2: 125 [NR] -8% p=0.50	

Study reference USPSTF quality	Study objective	Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Intervention description (if trial)
Increased sun exposure (with sunscreen use)					
Dupuy 2005[97] Fair	To determine whether high-SPF sunscreens have an impact on the sun-exposure behavior in people spending family holidays; and to determine the impact of the actual high protection and the impact of the impression of being well protected	RCT French Mediterranean and Atlantic coasts Healthy volunteers from holiday resorts	Adults on holiday who considered themselves sunscreen users Excluded persons with history of skin cancer, recent history of severe sunburn, contraindication to sun exposure, known contact dermatitis to sunscreen, pregnancy or breast feeding, participation of another family member in the study	**N:** 367 randomized, 359 analyzed **IG1:** 122 **IG2:** 121 **CG:** 124 **Mean age:** 39 ± yr **Sex:** 18% men **Skin phenotype:** 35% fair complexion: blond, red, or light brown hair 15% neither fair nor dark complexion 49% dark complexion; dark hair	**IG1:** High protection label, SPF 40 sunscreen **IG2:** Basic protection label, SPF 40 sunscreen **CG:** Basic protection label, SPF 12 sunscreen

Appendix C Table 3. Evidence Table for Adverse Effects of Sun-Protective Behaviors

Study reference USPSTF quality	Study objective	Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Intervention description (if trial)
Increased sun exposure (with sunscreen use)					
Green 1999[57,108] Good	To investigate the effectiveness of daily sunscreen application and dietary betacarotene supplement in reducing the incidence of BCC and SCC; secondary endpoint reported in "letter to editor" included sun exposure behaviors, self reported and dosimetry (in a random sub-sample)	RCT Queensland, Australia Community sample	Adults age 20-69, residents of Nambour, Queensland from electoral roll 1986, who attended a second survey in 1992 Excluded persons taking vitamin supplements containing betacarotene, already applying sunscreen on a strict daily basis	**N=** 1,621 **IG1:** 404 **IG2:** 408 **IG3:** 416 **CG:** 393 **Mean age:** IG1: 48.5 (12.9) IG2: 48.7 (13.6) IG3: 48.1 (13.6) CG: 49.8 (12.7) **Sex: (% men)** IG1: 44.3 IG2: 42.9 IG3: 40.9 CG: 46.8 **Skin type:** IG1 IG2 IG3 CG % Burn 22 20 22 20 %Burn/tan 67 69 66 69 % Tan 11 11 12 11	**IG1:** Sunscreen, SPF 15 plus betacarotene **IG2:** Sunscreen, SPF 15 and placebo tablet **IG3:** Betacarotene 30mg, and placebo cream **CG:** no sunscreen and placebo tablet

Study reference USPSTF quality	Measurement of exposure (or intervention if applicable)	Confounders considered (if observational study)	Followup	Measurement of adverse outcomes	Comments
Increased sun exposure (with sunscreen use)					
Dupuy 2005[97] Fair	Daily self-administered questionnaire to record details of sun exposure, final exit interview to detail occurrences of sunburn or painful skin reddening, and sunscreen consumption by weighing sunscreen tubes	Sunscreen use, center, week, skin phenotype	1 week: 95%	**(Table 2) mean total hours of sun exposure per participant** *@ 1 week mean hours while sunbathing, [SD], p-value* IG1: 14.2 [7.6] IG2: 12.9 [7.2] CG: 14.6 [6.7] Label comparison (IG1 vs. IG2): p=0.13; SPF Comparison (IG2 vs. CG): p=0.06 *@ 1 week proportion of persons with sunburn, [SD], p-value; OR [95%CI]* IG1: 0.15 [NR] IG2: 0.14 [NR] CG: 0.24 [NR] Label comparison (IG1 vs. IG2): p=0.80; SPF Comparison (IG2 vs. CG): p=0.06 Label comparison (IG1 vs. IG2): OR 0.91 [0.43, 1.91]; SPF comparison (IG2 vs. CG): OR 1.96 [0.98, 3.92]	
Green 1999[57,108] Good	7 day diaries to record refquency of sun exposure habits and ambient ultraviolet light by polysulphone badges (dosimetry) in the penultimate year of the trial in a random sub-sample of 175 participants		4.5 years: 85% For sub-sample of persons with dosimetry: 98%	**Spent less than 50% of time outdoors on weekends in the previous summer** @ 4.5 years IG1 and IG2: 79.3% (549/692), p value NR IG3 and CG: 77.4% (535/691) **Median (range) % of ambient UV exposure received by polysuphone badges** Over summer IG1 and IG2: 2.8 (0-32.2), p=0.55 IG3 and CG: 3.5 (0-23.8) Over winter IG1 and IG2: 6.5 (0-36.2), p=0.36 IG3 and CG: 7.1 (1.0-35.8)	

Appendix C Table 3. Evidence Table for Adverse Effects of Sun-Protective Behaviors

Study reference USPSTF quality	Study objective	Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Intervention description (if trial)
Increased sun exposure (with sunscreen use)					
Gallagher 2002[109] Fair	To determine whether use of broad-spectrum, high SPF sunscreen attenuates development of nevi in White children; secondary endpoint included sun exposure	RCT British Columbia, Canada White children	Children in grades 1 (ages 6 and 7), and 4 (ages 9 and 10) and their parents from six Vancouver area elementary schools in 1993 Excluded non-White children after randomization	**N:** 458 randomized, 309 analyzed **IG1:** 222, 145 **CG:** 236, 164 **Mean age:** 50.9% ages 6-7, 49.1% ages 9-10 **Sex:** NR **Skin phenotype:** IG CG % skin reflectance (c) Dark 33% 34% Medium 32% 34% Light 35% 32%	**IG:** SPF 30 sunscreen plus advice **CG:** no advice, no placebo
Bauer 2005[110] Fair	To determine if children receiving education or education and sunscreen develop less incident nevi; secondary endpoint included sun exposure and sun protection habits	Cluster RCT Stuttgart and Bochum, Germany White children, skin type I-IV	Children age 2-7 in public nursery schools and their parents in two cities in Germany with similar latitude Excluded parents who did not attend the first educational session, non-White children, or children with skin Type V or VI, immunosurpressed children, or those who refused skin exam	**N:** 1887 **IG1:** 626 **IG2:** 624 **CG:** 637 **Mean age:** 4.3 years **Sex:** 51.4% boys **Skin phenotype:** 10.1% skin Type I	**IG1:** education (see below) and sunscreen (SPF 25) with instructions on how to apply sunscreen **IG2:** education only, letter three times a year with more detailed information on proper sunscreen use and sun protection, and melanoma **CG:** control, initial educational session only

Study reference USPSTF quality	Measurement of exposure (or intervention if applicable)	Confounders considered (if observational study)	Followup	Measurement of adverse outcomes	Comments
Increased sun exposure (with sunscreen use)					
Gallagher 2002[109] Fair	Activity-based questionnaire at the end of each summer vacation, and after the Christmas and spring breaks each year Minimal erythemal dose (MED) information for clear sky conditions by latitude and month were obtained from standard tables	Clothing adjustment based on type of activity and clothing preference	3 years: 67.5%	**Median UV exposure from 1993 to 1996** **Time spent outdoors** IG: 357.0, p value NR CG: 361.5 **Vacation sun exposure (MED)** IG: 962.5, p value NR CG: 962.5 **Total sunlight exposure for whole body, adjusted for clothing coverage (MED)** IG: 1252.2 p value NR CG: 1214.3	
Bauer 2005[110] Fair	Questionnaire at approximately 3 year follow-up	Multivariate analysis done for nevi, but unclear if conducted for sun exposure	3 years: 65.3%	**Sun exposure 2001 and changes between 1998-2001** **Median weeks on holidays in sunny climates (IQR)** IG1: 4 (2,7.5), p=0.021 IG2: 6 (2,8) CG: 5 (2,8) **Median difference in h/day in sun during sunny holidays (IQR)** IG1: 0 (-1,1), p=0.061 IG2: 0 (-1,1) CG: 0 (-1,1) **Mean difference of h/day outside at home (SD)** IG1: 0.15 (1.12), p=0.353 IG2: 0.14 (1.13) CG: 0.24 (1.09)	

Appendix C Table 3. Evidence Table for Adverse Effects of Sun-Protective Behaviors

Study reference USPSTF quality	Study objective	Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Intervention description (if trial)
Cancer risk					
John 1999[100] Fair	To examine the possible protective role of vitamin D (sun exposure and dietary and supplemental vitamin D) on breast cancer risk	Retrospective cohort (information collected prospectively, but analytic cohort for this study was established retrospectively) US General, non-institutionalized, population (from NHANES)	Adult women ages 25-74 from the NHANES I cohort, those who participated in at least one of four follow-up surveys Excluded women with personal history of cancer, women without dietary or dermatological data, and non-White women	**N**=5009 (analytic cohort derived from larger cohort n=8596) **Age:** range: 25-74 yr **Sex:** 0% men **Skin phenotype:** NR, however all women were White	N/A

Study reference USPSTF quality	Measurement of exposure (or intervention if applicable)	Confounders considered (if observational study)	Followup	Measurement of adverse outcomes	Comments
Cancer risk					
John 1999[100] Fair	In-person interviews, medical examinations to determine usual sunlight exposure, sun-induced skin damage, residential sulight exposure, and dietary and supplemental intake of vitamin D	Age, education, income, age at menarche, age at menopause, nulliparity/age at first birth, BMI, measure of physical activity, frequency of alcohol consumption, and family history of breast cancer	17-21 years (average 17.3): cannot calculate followup	**(Table 1) sun exposure and breast cancer risk** *Recreational sun exposure, # ca cases, age-adj RR, [95%CI], multivar-adj RR, [95%CI]* Rare or never: 40, 1.0 [n/a], 1.0 [n/a] Occasional: 55, 0.70 [0.46, 1.06], 0.65 [0.43, 0.98] Frequent: 60, 0.70 [0.47, 1.05], 0.66 [0.44, 0.99] p-value (trend): 0.12, 0.08 *Occupational sun exposure, # ca cases, age-adj RR, [95%CI], multivar-adj RR, [95%CI]* Rare or never: 81, 1.0 [n/a], 1.0 [n/a] Occasional: 44, 1.05 0.73, 1.51], 1.06 [0.73, 1.53] Frequent: 29, 0.60 [0.39, 0.91], 0.64 [0.41, 0.98] p-value (trend): 0.03, 0.07 *Combined recreational and occupational sun exposure, # cases, age-adj RR, [95%CI], multivar-adj RR, [95%CI]* Low: 32, 1.0 [n/a], 1.0 [n/a] Medium: 99, 0.67 [0.45, 1.01], 0.81 [0.56, 1.17] High: 23, 0.50 [0.29, 0.86], 0.67 [0.42, 1.06] p-value (trend): 0.01, 0.06 **(Table 3) sunlight exposure by region of residence (low, medium, or high solar radiation)** *Combined recreational and occupational sun exposure, # cases, multivar-adj RR, [95%CI]* Low: 15, 1.0 [n/a] / Medium: 9, 1.0 [n/a] / High: 8, 1.0 [n/a] Low: 44, 0.53 [0.29, 0.97] / Medium: 34, 0.83 [0.39, 1.76] / High: 19, 0.54 [0.23, 1.25] Low: 9, 0.40 [0.17, 0.94] / Medium: 10, 0.77 [0.31, 1.93] / High: 4, 0.35 [0.10, 1.20] **(Table 5) vitamin D from sun exposure and diet (sun exposure as determined by physician)** *Sun exposure and dietary vit D, # ca cases, age-adj RR, [95%CI], multivar-adj RR, [95%CI]* Low sun and <200IU: 71, 1.0 [n/a], 1.0 [n/a] Low sun and ≥ 200IU: 18, 0.79 [0.57, 1.11], 0.75 [0.54, 1.06] High sun and <200IU: 65, 0.78 [0.46, 1.31], 0.77 [0.46, 1.29] High sun and ≥ 200IU: 22, 0.72 [0.45, 1.17], 0.71 [0.44, 1.14] p-value (trend): 0.11, 0.08 Multi-var adj for age, education, age at menarche, age at menopause, BMI, alcohol consumption, physical activity, and calcium	Did not adjust for skin phenotype

Appendix C Table 3. Evidence Table for Adverse Effects of Sun-Protective Behaviors

Study reference USPSTF quality	Study objective	Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Intervention description (if trial)
Cancer risk					
Kampman 2000[101] Fair	To evaluate potential sources of inconsistencies of the association between calcium and vitamin D (dietary or sun exposure) and colon cancer	Case-control Multi-state, US General population from large HMO	**Cases:** diagnosis of first primary colon cancer from HMO database, identified from Oct 1991 through Sep 1994, age 30-79 at diagnosis, English speaking, and mentally competent; cases with tumors of the rectum, rectosigmoid, history of familial adenomatous polyposis, ulcerative colitis, or Crohn's disease were excluded **Controls:** age, sex matched persons from HMO database; same criteria as cases, and in addition without a history of colon cancer	Men Women Cases Controls Cases Controls **N**: 1095 1286 888 1114 **Age (SD):** 65 (9.8) 64 (10.3) 65 (10.0) 65 (10.3) **Sex:** n/a **Skin phenotype:** NR Text states that population was 91.3% White, but skin phenotype is not otherwise recorded/reported	N/A
Hughes 2004[103] Hughes 2004[102] Fair	To determine whether high sun exposure is associated with an increased risk of NHL	Case-control New South Wales, Australia General population from regional cancer registry and electoral rolls	**Cases:** Diagnosis of NHL from regional cancer registry (and dx independently validated), identified from Jan 1990 through Aug 2001, age 20-74, English speaking, and able to complete a 60 min telephone interview; cases with chronic lymphocytic leukemia, plama cell meyloma, precursor B and T lymphoblastic leukemia, and lymphomatoid granulomatosis grades 1 and 2, or history of immunosupression for organ transplantation or HIV infection were excluded **Controls:** Age, sex, and residence matched persons from electoral roles, with same exclusion criteria, although HIV status was not asked of controls	Cases Controls **N:** 704 694 **Age (%<50):** 73.9 73.3 **Sex (% men):** 26.6 26.1 **Skin phenotype:** *Skin color (%)* Brown or olive 31.5 31.1 Fair 53.7 57.6 Very fair 14.8 11.2 *Ability to tan (%)* Deep tan 27.0 29.1 Moderate tan 43.6 42.1 Mild tan 20.9 22.8 No tan 8.1 5.8 (skin phenotype calculated from Table 2, I1a)	N/A

Study reference USPSTF quality	Measurement of exposure (or intervention if applicable)	Confounders considered (if observational study)	Followup	Measurement of adverse outcomes	Comments
Cancer risk					
Kampman 2000[101] Fair	In-person interviews to recall behaviors 2 years before the date of selection to determine dietary intake, supplement use, and sun exposure	Adjusted for age, BMI, family history of colorectal cancer, lifetime vigorous physical activity, total energy intake, dietary fiber, and regular use of ASA or NSAIDs, and calcium intake Additionally all analyses were stratified by sex, age at diagnosis, location of cancer, and family history of colon cancer	Response rate: 76% cases, 64% controls Additional attrition after interview due to ineligibility and missing data: 66% cases, 62% controls	**(Table 2) association between sun exposure (per quintile) and colon cancer** *Quintile of sun exposure, # cases/controls, multivar-adj OR, [95%CI]* men women Low 236, 260, 1.0 [n/a] 196, 239, 1.0 [n/a] 2 224, 264, 1.0 [0.8, 1.3] 198, 203, 1.3 [1.0, 1.7] 3 230, 252, 1.1 [0.8, 1.4] 155, 231, 0.9 [0.7, 1.2] 4 211, 273, 0.9 [0.7, 1.2] 171, 216, 1.1 [0.8, 1.5] High 185, 235, 0.9 [0.7, 1.1] 160, 216, 1.0 [0.8, 1.4] Multi-var adj for age, BMI, family history, aspirin or NSAIDs, energy intake, physical activity, fiber and calcium	Did not adjust for skin phenotype

Appendix C Table 3. Evidence Table for Adverse Effects of Sun-Protective Behaviors

Study reference USPSTF quality	Measurement of exposure (or intervention if applicable)	Confounders considered (if observational study)	Followup	Measurement of adverse outcomes	Comments
Cancer risk					
Hughes 2004[103] Hughes 2004[102] Fair	Brief paper questionnaire and telephone interview to determine sun exposure In addition three measures of ambient solar irradiance were assigned to each residential location for each subject using latitude/longitude coordinates, SES assessed using census data	Adjusted for age, sex, state of residence, skin phenotype, and ethnicity	Response rate: 85% cases, 61% controls	**(Table 1) risk of NHL with sun exposure (per quartile)** *Sun exposure during the decade years, multivar-adj OR, [95% CI]* Lowest: 1.0 [n/a] 25-50%: 0.72 [0.53, 0.98] 50-75%: 0.66 [0.48, 0.91] Highest: 0.65 [0.46, 0.91] p-value (trend): 0.01 *Lifetime occupational sun exposure, multivar-adj OR, [95% CI]* Lowest: 1.0 [n/a] 25-50%: 1.03 [0.76, 1.40] 50-75%: 1.04 [0.76, 1.43] Highest: 1.21 [0.87, 1.69] p-value (trend): 0.30 **(Table 2) risk of NHL with vacation sun exposure** *Sun exposure during the decade years, multivar-adj OR, [95% CI]* Lowest: 1.0 [n/a] 25-50%: 0.98 [0.72, 1.32] 50-75%: 0.82 [0.60, 1.12] Highest: 0.60 [0.43, 0.85] p-value (trend): 0.003 Multi-var adj for age, sex, state, ethnicity, skin colour and ability to tan	Baseline data from I1a Hughes 2004, RM 4564

Study reference USPSTF quality	Study objective	Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Intervention description (if trial)
Cancer risk					
Smedby 2005[104] Fair	To determine whether exposure to UV radiation increases lymphoma risk	Case-control Denmark and Sweden General population from SCALE study (Scandinavian lymphoma etiology) and population registers	**Cases:** Diagnosis of lymphoma from national pathology registries (and diagnosis independently validated in random subsample), identified from October1999/June 2000 through April/August 2002, ages 18-74, Danish or Swedish speaking, and able to complete telephone interview; cases with other hematopeietic malignancy or with history of immunosupression for organ transplantation or HIV infection were excluded **Controls:** Age, sex, and country matched persons from comprehensive population registers	Cases / Controls **N:** 3740 / 3187 **Age (median):** 59 / 59 **Sex (% men):** 58 / 55 **Skin phenotype (%):** Type I, burns 17 / 15 Type II, burns/tans 20 / 25 Type III, tans 28 / 31 Type IV, tans/never burns 32 / 29	N/A

Appendix C Table 3. Evidence Table for Adverse Effects of Sun-Protective Behaviors

Study reference USPSTF quality	Measurement of exposure (or intervention if applicable)	Confounders considered (if observational study)	Followup	Measurement of adverse outcomes	Comments
Cancer risk					
Smedby 2005[104] Fair	Telephone interview to determine host factors and exposure (sun, and sunbed/lamps), as well as self-reported skin cancers	Adjusted for skin type, occupational exposure to pesticides	Response rate: 81-91% of cases, 71% of controls	**(Table 3) risk of lymphoma with sun exposure** *Sunbathing past 5-10 years, multivar-adj OR, [95%CI]* Never: # controls 799; NHL 946, 1.0 [n/a]; Hodgkin 122, 1.0 [n/a] Once/wk or less: 1013; 938, 0.9 [0.7, 1.0]; 236, 0.8 [0.6, 1.0] 2-3x/week: 666; 555, 0.8 [0.7, 0.9]; 141, 0.7 [0.5, 1.0] 4x/week or more: 666; 581, 0.7 [0.6, 0.9]; 118, 0.7 [0.5, 1.0] p-value (trend): NHL <0.001; Hodgkin 0.06 *Sunbathing @20 years old, multivar-adj OR, [95%CI]* Never: # controls 434; NHL 568, 1.0 [n/a]; Hodgkin 49, 1.0 [n/a] Once/wk or less: 931; 918, 0.8 [0.7, 0.9]; 84, 0.8 [0.5, 1.2] 2-3x/wk: 674; 635, 0.7 [0.6, 0.9]; 50, 0.6 [0.4, 1.0] 4x/wk or more: 653; 642, 0.7 [0.6, 0.9]; 73, 0.9 [0.6, 1.4] p-value (trend): NHL 0.001; Hodgkin 0.84 *Sun vacations abroad, multivar-adj OR, [95%CI]* Never: # controls 830; NHL 910, 1.0 [n/a]; Hodgkin 146, 1.0 [n/a] 1-5x: 1002; 1000, 1.0 [0.9, 1.1]; 234, 0.8 [0.6, 1.0] 6-20x: 919; 822, 0.9 [0.8, 1.0]; 177, 0.7 [0.5, 0.9] >20x: 410; 305, 0.7 [0.6, 0.8]; 60, 0.8 [0.6, 1.2] p-value (trend): NHL <0.001; Hodgkin 0.06 *Sunbed/sunlamp use, multivar-adj OR, [95%CI]* Never: # controls 1254; NHL 1317, 1.0 [n/a]; Hodgkin 203, 1.0 [n/a] <10x: 742; 790, 1.0 [0.9, 1.2]; 134, 0.8 [0.6, 1.0] 10-49x: 765; 643, 0.9 [0.8, 1.0]; 161, 0.7 [0.5, 0.9] 50+x: 377; 270, 0.8 [0.7, 1.0]; 116, 0.7 [0.5, 0.9] p-value (trend): NHL 0.01; Hodgkin 0.004	

Study reference USPSTF quality	Study objective	Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Intervention description (if trial)
Cancer risk					
John 2005[105] Fair	To determine whether measures of sun exposure is associated with an increased risk of advanced prostate cancer	Case-control California General population from SEER cancer registry, random digit dialing, and beneficiaries of Health Care Financing Administration	**Cases:** diagnosis of advanced prostate cancer from SEER registry, identified from Jul 1997 to Feb 2000, age 40-79, English speaking, non-Hispanic White, (African American initially included but ultimately excluded from analysis); cases with prior prostate cancer, or those living outside designated area were excluded **Controls:** age, race and residence matched persons from random digit dialing or Health Care Financing Administration rosters with same exclusion criteria	Cases / Controls n: 450 / 455 Age (median): 64 / 65 Sex (% men): 100 / 100 Skin phenotype: NR Ethnicity: 100% non-Hispanic White	

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Study reference USPSTF quality	Measurement of exposure (or intervention if applicable)	Confounders considered (if observational study)	Followup	Measurement of adverse outcomes	Comments
Cancer risk					
John 2005[105] Fair	in-person interviews, administered structured questionnaires, plus exam with measurement of skin pigmentation with portable reflectometer, DNA sample (blood or mouthwash) in addition solar radiation level by state of residence assessed from National Weather Service Stations	adjusted for age, family history of prostate cancer	response rate: 72% cases, 63% controls	(Table 2) risk of advanced prostate cancer with sun exposure lifetime outdoor activities (h/wk), # cases, # controls, age-adj OR, [95%CI], mutivar-adj OR [95%CI] <2.7: 85, 91, 1.0 [n/a], 1.0 [n/a] 2.7-5.6 99, 91, 1.16 [0.77, 1.75], 1.15 [0.76, 1.73] 5.7-10.4 92, 91, 1.08 [0.72, 1.64], 1.09 [0.72, 1.65] 10.5-19.8 94, 91, 1.11 [0.73, 1.67], 1.10 [0.73, 1.67] 19.9+ 80, 91, 0.94 [0.62, 1.44], 0.95 [0.62, 1.45] p-value (trend) 0.8 lifetime outdoor jobs (h/wk), # cases, # controls, age-adj OR, [95%CI], mutivar-adj OR [95%CI] 0 123, 120, 1.0 [n/a], 1.0 [n/a] <1.4 84, 84, 0.99 [0.67, 1.47], 0.96 [0.65, 1.43] 1.4-5.6 100, 83, 1.19 [0.81, 1.75], 1.20 [0.81, 1.77] 5.7-14.7 81, 84, 0.94 [0.63, 1.40], 0.95 [0.64, 1.41] 14.8+ 62, 84, 0.73 [0.48, 1.10], 0.73 [0.48, 1.11] p-value (trend) 0.3 facultative pigmentation, # cases, # controls, age-adj OR, [95%CI], mutivar-adj OR [95%CI] light 100, 90, 1.0 [n/a], 1.0 [n/a] 2 107, 90, 1.08 [0.73,1.61], 1.08 [0.73,1.62] 3 86, 91, 0.85 [0.56,1.28], 0.83 [0.55,1.26] 4 86, 91, 0.85 [0.56,1.28], 0.83 [0.55,1.26] dark 68, 90, 0.68 [0.44,1.03], 0.66 [0.43,1.01] p-value (trend) 0.03 sun exposure index ((facultative pigmentation-constitutive pigmentation)/constitutive pigmentation) # cases, # controls, age-adj OR, [95%CI], mutivar-adj OR [95%CI] low 106, 89, 1.0 [n/a], 1.0 [n/a] 2 93, 90, 0.85 [0.57,1.28], 0.87 [0.58,1.30] 3 89, 92, 0.81 [0.54,1.21], 0.80 [0.53,1.20] 4 103, 91, 0.94 [0.63,1.40], 0.95 [0.64,1.42] high 56, 90, 0.52 [0.33, 0.80], 0.51 [0.33,0.80] p-value (trend) 0.02 multivar adj for age, family history of prostate cancer, +/- month of pigmentation measurements	

Study reference USPSTF quality	Study objective	Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Intervention description (if trial)
Cancer risk					
Hartge 2006[106] Fair	To determine whether measures of UV exposure is associated with an increased risk of Non-Hodgkin Lymphoma	Case-control Multi-state, US General population from SEER cancer registry and random digit dialing and Centers for Medicare and Medicare population rosters	**Cases:** Diagnosis of first primary NHL from SEER registry, identified from July 1998 to June 2000, age 20-74, assumed English speaking; cases with HIV were excluded **Controls:** Age, sex, race and study area matched persons from random digit dialing or Centers for Medicare and Medicaid Services population roster	Cases Controls n: 551 462 Age (%<55): 41 27 Sex (% men): 53 52 Skin phenotype: dark 30 20 medium 306 252 light 215 189 Ethnicity: % White 90 91 % African Amer NR (assumed 0, not c/w descrip in methods) % Hispanic 5 5 % Asian 4 3	

Appendix C Table 3. Evidence Table for Adverse Effects of Sun-Protective Behaviors

Study reference USPSTF quality	Measurement of exposure (or intervention if applicable)	Confounders considered (if observational study)	Followup	Measurement of adverse outcomes	Comments
Cancer risk					
Hartge 2006[106] Fair	in-person interviews, plus mailed questionnaire, to determine demographic, diet, and sun exposure history in addition measurements of solar radiation obtained from Robertson-Berger (RB) meters located in many states	adjusted for age, sex, center, ethnicity, education, alcohol consumption, weekly exercise, residential UV radiation, dietary vitamin D	response rate: 59% cases, 44% controls	(Table 3) risk of NHL with various measures of sun exposure hours mid-day sun last 10 years, # cases, #controls, multivar-adj OR [95%CI] <7 216, 159, 1.0 [n/a] <14 145, 126, 0.85 [0.62, 1.18] <28 131, 123, 0.75 [0.54, 1.05] 28+ 59, 51, 0.73 [0.46, 1.15] p-value (trend) 0.07 hours mid-day sun during teens years, # cases, #controls, multivar-adj OR [95%CI] <7 62, 46, 1.0 [n/a] <14 89, 68, 0.97 [0.59, 1.61] <28 185, 155, 0.81 [0.52, 1.27] 28+ 211, 187, 0.75 [0.48, 1.18] p-value (trend) 0.12 hours mid-day sun during twenties, # cases, #controls, multivar-adj OR [95%CI] <7 143, 107, 1.0 [n/a] <14 143, 124, 0.86 [0.60, 1.22] <28 156, 132, 0.83 [0.58, 1.18] 28+ 105, 94, 0.75 [0.50, 1.11] p-value (trend) 0.15 hours mid-day sun during thirties, # cases, #controls, multivar-adj OR [95%CI] <7 183, 137, 1.0 [n/a] <14 135, 135, 0.75 [0.54, 1.04] <28 145, 112, 0.95 [0.68, 1.33] 28+ 68, 66, 0.78 [0.50, 1.19] p-value (trend) 0.44 use of sunlamp or sunbed, # cases, #controls, multivar-adj OR [95%CI] never 401, 338, 1.0 [n/a] <5x 32, 33, 0.78 [0.46, 1.32] 5-9x 32, 25, 0.90 [0.52, 1.58] 10+x 84, 66, 0.90 [0.61, 1.30] p-value (trend) 0.49 history of blistering sunburns, # cases, #controls, multivar-adj OR [95%CI] never 224, 177, 1.0 [n/a] 1x 117, 103, 0.87 [0.62, 1.23] 2-4x 114, 84, 1.02 [0.72, 1.46] 5+x 92, 96, 0.68 [0.47, 0.97] p-value (trend) 0.10	

Study reference USPSTF quality	Study objective	Study design Location Population	Participant inclusion/exclusion criteria	Baseline demographics	Intervention description (if trial)
Cancer risk					
John 2007[107] Good	To determine whether measures of sun exposure is associated with an increased risk of breast cancer	Case-control California General population from SEER cancer registry and RDD	**Cases:** diagnosis of primary invasive breast cancer from SEER registry, identified from 1995 to 1999, age 35-79, English or Spanish speaking, Hispanic, non-Hispanic White, African American **Controls:** age, race matched persons from RDD	Cases Controls n: 1786 2127 Age (%50-64): 40 39 Sex (% men): 0 0 Skin phenotype: NR <u>Ethnicity</u> % White 33.4 30.4 % African Amer 30.4 28.1 % Hispanic 36.2 41.5	

Appendix C Table 3. Evidence Table for Adverse Effects of Sun-Protective Behaviors

Study reference USPSTF quality	Measurement of exposure (or intervention if applicable)	Confounders considered (if observational study)	Followup	Measurement of adverse outcomes	Comments
Cancer risk					
John 2007[107] Good	in-person interviews, administered structured questionnaires, plus exam with measurement of skin pigmentation with portable reflectometer, DNA sample (blood or mouthwash)	adjusted for age, race/ethnicity, education, family history of breast cancer, personal history of benign breast disease, age at menarche, number of full-term pregnancies, breastfeeding, menopausal status, hormone therapy use, BMI, height, lifetime physical activity, alcohol consumption; and stratified by constitutive skin pigmentation	response rate: 87% cases, 84% controls	(Table 3) risk of advanced breast cancer with sun exposure lifetime outdoor activities (h/wk by quartile), # cases, # controls, mutivar-adj OR [95%CI] light pigmentation / medium pigmentation / dark pigmentation low 37, 153, 1.0 [n/a] / 43,180, 1.0 [n/a] / 49,174, 1.0 [n/a] 2 41, 167, 0.97 [0.58,1.62] / 47,154, 1.17 [0.72, 1.91] / 52,180, 1.01 [0.65, 1.59] 3 59, 188, 1.29 [0.80,2.09] / 55,169, 1.23 [0.76, 1.97] / 61,165, 1.31 [0.84, 2.03] high 37, 180, 0.86 [0.51,1.45] / 36,175, 0.77 [0.46, 1.29] / 50,153, 1.14 [0.72, 1.81] p-value (trend) 0.90 / 0.82 / 0.36 facultative pigmentation, # cases, # controls, mutivar-adj OR [95%CI] light pigmentation / medium pigmentation / dark pigmentation light 55, 171, 1.0 [n/a] / 48,171, 1.0 [n/a] / 53,169, 1.0 [n/a] 2 48, 183, 0.73 [0.45,1.17] / 54,161, 1.22 [0.76, 1.98] / 48,169, 0.89 [0.52, 1.55] 3 35, 167, 0.56 [0.33,0.94] / 38,180, 0.86 [0.51, 1.46] / 56,169, 1.00 [0.56, 1.81] dark 37, 173, 0.54 [0.32,0.94] / 41,171, 1.07 [0.62, 1.85] / 57,174, 1.00 [0.55, 1.81] p-value (trend) 0.02 / 0.88 / 0.81 sun exposure index ((facultative pigmentation-constitutive pigmentation)/constitutive pigmentation) light pigmentation / medium pigmentation / dark pigmentation low 56, 174, 1.0 [n/a] / 47,172, 1.0 [n/a] / 50,171, 1.0 [n/a] 2 47, 174, 0.78 [0.49,1.26] / 55,173, 1.29 [0.80, 2.08] / 52,170, 1.15 [0.73, 1.82] 3 37, 171, 0.62 [0.37,1.04] / 35,167, 0.90 [0.53, 1.55] / 59,168, 1.39 [0.89, 2.17] high 35, 175, 0.53 [0.31, 0.91] / 44,171, 1.26 [0.74, 2.15] / 53,172, 1.28 [0.81, 2.05] p-value (trend) 0.01 / 0.68 / 0.20	
John 2007[107] Good				(Table 3) risk of localized breast cancer with sun exposure lifetime outdoor activities (h/wk by quartile), # cases, # controls, mutivar-adj OR [95%CI] light pigmentation / medium pigmentation / dark pigmentation low 85, 153, 1.0 [n/a] / 97,180, 1.0 [n/a] / 101,174, 1.0 [n/a] 2 91, 167, 0.95 [0.65,1.40] / 70,154, 0.79 [0.53, 1.17] / 89,180, 0.80 [0.56, 1.15] 3 103, 188, 0.89 [0.61,1.29] / 129,169, 1.35 [0.94, 1.93] / 96,165, 0.94 [0.66, 1.35] high 107, 180, 1.05 [0.72,1.54] / 92,175, 1.02 [0.70, 1.50] / 64,153, 0.70 [0.47, 1.04] p-value (trend) 0.85 / 0.20 / 0.18 facultative pigmentation, # cases, # controls, mutivar-adj OR [95%CI] light pigmentation / medium pigmentation / dark pigmentation light 95, 171, 1.0 [n/a] / 101,171, 1.0 [n/a] / 73,169, 1.0 [n/a] 2 109, 183, 1.18 [0.82,1.71] / 118,161, 1.34 [0.93, 1.94] / 87,169, 1.22 [0.76, 1.97] 3 97, 167, 1.10 [0.75,1.61] / 90,180, 1.04 [0.70, 1.54] / 88,169, 1.20 [0.71, 2.01] dark 89, 173, 1.11 [0.74,1.67] / 81,177, 1.12 [0.73, 1.71] / 102,174, 1.40 [0.83, 2.33] p-value (trend) 0.72 / 0.80 / 0.24 sun exposure index ((facultative pigmentation-constitutive pigmentation)/constitutive pigmentation) light pigmentation / medium pigmentation / dark pigmentation low 104, 174, 1.0 [n/a] / 108,172, 1.0 [n/a] / 75,171, 1.0 [n/a] 2 103, 174, 1.09 [0.76,1.58] / 107,173, 1.12 [0.78, 1.62] / 99,170, 1.43 [0.97, 2.10] 3 87, 171, 0.96 [0.65,1.41] / 90,167, 1.01 [0.68, 1.49] / 87,168, 1.30 [0.88, 1.93] high 96, 175, 1.10 [0.74,1.63] / 84,171, 1.06 [0.71, 1.60] / 89,172, 1.11 [0.74, 1.67] p-value (trend) 0.81 / 0.86 / 0.74 multivar adj for age, race/ethnicity, education, family history of breast cancer, personal history of breast disease, age at menarche, number full-term pregnancies, breastfeeding, BMI, height, physical activity, alcohol consumption	

OHD=hydroxyvitamin D; RCT=randomized controlled trial; IG=intervention group; CG=control group; SPF=sun protection factor; N/A=not applicable; PTH=parathyroid hormone; FSH=follicle stimulating hormone; UV=ultraviolet; nmol=nanomole; L=liter; BMI=body mass index; CCT=clinical controlled trial; km=kilometer; CI=confidence interval; NR=not reported; NHANES=National Health and Nutrition Examination Survey; multivar=multivariate; adj=adjusted; RR=relative risk; IU=international unit; HMO=health maintenance organization; NSAID=nonsteroidal anti-inflammatory drug; SES=socioeconomic status; HIV=human immunodeficiency virus; x=times; NHL=nonHodgkins lymphoma

Appendix C Table 4. Studies Excluded From the Review for Key Question 5

Reference	Reason for Exclusion
Adami J, Gridley G, Nyren O, et al. Sunlight and non-Hodgkin's lymphoma: a population-based cohort study in Sweden. *Int J Cancer.* 1999;80:641-645.	No relevant outcomes
Armstrong BK, Kricker A. Sun exposure and non-Hodgkin lymphoma. *Cancer Epidemiol Biomarkers Prev.* 2007;16:396-400.	Study design
Autier P, Boniol M, Dore JF. Sunscreen use and increased duration of intentional sun exposure: still a burning issue. *Int J Cancer.* 2007;121(1):1-5.	Study quality
Autier P, Dore JF, Cattaruzza MS, et al. Sunscreen use, wearing clothes, and number of nevi in 6- to 7-year-old European children. European Organization for Research and Treatment of Cancer Melanoma Cooperative Group. *J Natl Cancer Inst.* 1998;90:1873-1880.	Study design
Autier P, Dore JF, Lejeune F, et al. Cutaneous malignant melanoma and exposure to sunlamps or sunbeds: an EORTC multicenter case-control study in Belgium, France and Germany. EORTC Melanoma Cooperative Group. *Int J Cancer.* 1994;58:809-813.	Study design
Autier P, Dore JF, Schifflers E, et al. Melanoma and use of sunscreens: an EORTC case-control study in Germany, Belgium and France. EORTC Melanoma Cooperative Group. *Int J Cancer.* 1995;61:749-755.	Study design
Bodiwala D, Luscombe CJ, French ME, et al. Associations between prostate cancer susceptibility and parameters of exposure to ultraviolet radiation. *Cancer Lett.* 2003;200:141-148.	Study quality
Boniol M, Autier P, Dore JF. Photoprotection. *Lancet.* 2007;370:1481-1482.	Study design
Boscoe FP, Schymura MJ. Solar ultraviolet-B exposure and cancer incidence and mortality in the United States, 1993-2002. *BMC Cancer.* 2006;6:264.	Study design
De Vries E, Soerjomataram I, Houterman S, et al. Decreased risk of prostate cancer after skin cancer diagnosis: a protective role of ultraviolet radiation? *Am J Epidemiol.* 2007;165:966-972.	No relevant outcomes
Dixon A. Arc welding and the risk of cancer. *Aust Fam Physician.* 2007;36:255-256.	No relevant outcomes
English DR, Milne E, Simpson JA. Sun protection and the development of melanocytic nevi in children. *Cancer Epidemiol Biomarkers Prev.* 2005;14:2873-2876.	No relevant outcomes
Farrerons J, Barnadas M, Lopez-Navidad A, et al. Sunscreen and risk of osteoporosis in the elderly: a two-year follow-up. *Dermatology.* 2001;202(1):27-30.	Study quality
Farrerons J, Barnadas M, Rodriguez J, et al. Clinically prescribed sunscreen (sun protection factor 15) does not decrease serum vitamin D concentration sufficiently either to induce changes in parathyroid function or in metabolic markers. *Br J Dermatol*.1998;139 (3):422-427.	Study quality
Freedman DM, Dosemeci M, McGlynn K. Sunlight and mortality from breast, ovarian, colon, prostate, and non-melanoma skin cancer: a composite death certificate based case-control study. *Occup Environ Med.* 2002;59:257-262.	No relevant outcomes
Geller AC, Colditz G, Oliveria S, et al. Use of sunscreen, sunburning rates, and tanning bed use among more than 10,000 US children and adolescents. *Pediatrics.* 2002;109:1009-1014.	No relevant outcomes
Grant WB. A meta-analysis of second cancers after a diagnosis of nonmelanoma skin cancer: additional evidence that solar ultraviolet-B irradiance reduces the risk of internal cancers. *J Steroid Biochem Mol Biol.* 2007;103:668-674.	Study design
Gruber SB, Armstrong B. Cutaneous and ocular melanoma. In: Schottenfeld D, Fraumeni JF, eds. *Cancer Epidimiology and Prevention.* 2006:1196-229.	Study design
Heckmann M, Zogelmeier F, Konz B. Frequency of facial basal cell carcinoma does not correlate with site-specific UV exposure. *Arch Dermatol.* 2002;138:1494-1497.	Study design
Holick MF, Chen TC, Lu Z, Sauter E. Vitamin D and skin physiology: a D-lightful story. *J Bone Mineral Res.* 2007;22(Suppl 2):28-33.	Study quality
Holick MF. Sunlight "D"ilemma: risk of skin cancer or bone disease and muscle weakness. *Lancet.* 2001;357:4-6.	Study design
John EM, Dreon DM, Koo J, et al. Residential sunlight exposure is associated with a decreased risk of prostate cancer. *J Steroid Biochem Mol Biol.* 2004;89-90:549-552.	No relevant outcomes

Appendix C Table 4. Studies Excluded From the Review for Key Question 5

Reference	Reason for Exclusion
Lawler S, Sugiyama T, Owen N. Sun exposure concern, sun protection behaviors and physical activity among Australian adults. *Cancer Causes Control.* 2007;18:1009-1014.	Study quality
Lim JL, Stern RS. High levels of ultraviolet B exposure increase the risk of non-melanoma skin cancer in psoralen and ultraviolet A-treated patients. *J Invest Dermatol.* 2005;124:505-513.	Population
Lucas RM, Repacholi MH, McMichael AJ. Is the current public health message on UV exposure correct? *Bull World Health Organ.* 2006;84:485-491.	Study design
Matsuoka LY, Wortsman J, Hanifan N, Holick MF. Chronic sunscreen use decreases circulating concentrations of 25-hydroxyvitamin D. A preliminary study. *Arch.Dermatol.* 1988;124(12):1802-1804.	Study quality
Moan J, Porojnicu AC, Robsahm TE, et al. Solar radiation, vitamin D and survival rate of colon cancer in Norway. *J Photochem Photobiol B.* 2005;78:189-193.	Study relevance
Ness AR, Frankel SJ, Gunnell DJ, Smith GD. Are we really dying for a tan? *BMJ.* 1999;319:114-116.	Study design
Porojnicu AC, Robsahm TE, Ree AH, Moan J. Season of diagnosis is a prognostic factor in Hodgkin's lymphoma: a possible role of sun-induced vitamin D. *Br J Cancer.* 2005;93:571-574.	Study relevance
Reichrath J. Protecting against adverse effects of sun protection. *J Am Acad Dermatol.* 2003;49:1204-1206.	Study design
Reichrath J. Sunlight, skin cancer and vitamin D: What are the conclusions of recent findings that protection against solar ultraviolet (UV) radiation causes 25-hydroxyvitamin D deficiency in solid organ-transplant recipients, xeroderma pigmentosum, and other risk groups? *J Steroid Biochem Mol Biol.* 2007;103:664-667.	Study design
Robsahm TE, Tretli S, Dahlback A, et al. Vitamin D3 from sunlight may improve the prognosis of breast-, colon- and prostate cancer (Norway). *Cancer Causes Control.* 2004;15:149-158.	No relevant outcomes
Samanek AJ, Croager EJ, Gies P, et al. Estimates of beneficial and harmful sun exposure times during the year for major Australian population centres. *Med J Aust.* 2006;184:338-341.	Study design
Sayre RM, Dowdy JC. Darkness at noon: sunscreens and vitamin D3. *Photochem Photobiol.* 2007;83:459-463.	Study design
The Cancer Council Australia. Risks and benefits of sun exposure: position statement. 2005.	Study design
Thompson SC, Jolley D, Marks R. Reduction of solar keratoses by regular sunscreen use. *N Engl J Med.* 1993;329:1147-1151.	No relevant outcomes
Thieden E, Philipsen PA, Sandby-Moller J, Wulf HC. Sunscreen use related to UV exposure, age, sex, and occupation based on personal dosimeter readings and sun-exposure behavior diaries. *Arch Dermatol.* 2005;141(8):967-973.	Study quality
van der Rhee HJ, De Vries E, Coebergh JW. Does sunlight prevent cancer? A systematic review. *Eur J Cancer.* 2006;42:2222-2232.	Reported only intermediate outcomes
Weinstock MA. Do sunscreens increase or decrease melanoma risk: an epidemiologic evaluation. *J Invest Dermatol Sym Proc.* 1999;4:97-100.	Study design
Westerdahl J, Olsson H, Masback A, et al. Use of sunbeds or sunlamps and malignant melanoma in southern Sweden. *Am J Epidemiol.* 1994;140(8):691-699.	No relevant outcomes
Westerdahl J, Olsson H, Masback A, Ingvar C, Jonsson N. Is the use of sunscreens a risk factor for malignant melanoma? *Melanoma Res.* 1995;5(1):59-65.	No relevant outcomes
Wiecker TS, Luther H, Buettner P, et al. Moderate sun exposure and nevus counts in parents are associated with development of melanocytic nevi in childhood: a risk factor study in 1,812 kindergarten children. *Cancer.* 2003;97:628-638.	No relevant outcomes
Xu LY, Koo J. Predictive value of phenotypic variables for skin cancer: risk assessment beyond skin typing. *Int J Dermatol.* 2006;45:1275-1283.	Study relevance
Youl P, Aitken J, Hayward N, et al. Melanoma in adolescents: a case-control study of risk factors in Queensland, Australia. *Int J Cancer.* 2002;98:92-98.	No relevant outcomes
Zlotkin S. Vitamin D concentrations in Asian children living in England. Limited vitamin D intake and use of sunscreens may lead to rickets. *BMJ.* 1999;318:1417.	Study design

Appendix D. Ongoing Trials

P rincipal investigators	Location	Population	Approximate size	Investigations	Outcomes	Status as of 2008
KQ1: Is there direct evidence that counseling patients in sun protective behaviors reduces intermediate outcomes or skin cancer (melanoma, SCC, or BCC)?						
None						
KQ2: Does primary care feasible counseling change sun protective behaviors?						
Ellen R. Gritz, PhD[1]	Houston, Texas	Melanoma patients with children ages ≤12 years	570	Describe the sun exposure and sun protection practices of patients and their children	Protective practices and sun exposure	Currently recruiting, expected completion April 2009
Ellen R. Gritz, PhD[2]	Houston, Texas	Melanoma patients and their families	170	Collect information on the ultraviolet radiation (UVR-E) reduction and early detection practices of melanoma patients and their family members		Expected primary completion November 2008
Richard G. Roetzheim, MD, MSPH[3]	Florida	Children ages 8-11 years	2000	Effectiveness of a school-based intervention to increase hat use	Use of hats in and outside of school	Continuing through 2008-2009 school year, completion date unknown
KQ3: Do primary care feasible counseling interventions have adverse effects?						
None						
KQ4: Are sun protective behaviors associated with incidence of or morbidity and mortality from skin cancer?						
Julia Newton Bishop, MD[4]	United Kingdom	Families with melanoma	3,700	Determine what lifestyle factors and which genes govern relapse from melanoma Compare sun exposure and genes that cause melanoma in patients with melanoma vs healthy participants Assess how unusual moles relate to sun exposure and genes that cause melanoma	Melanoma	Currently recruiting, expected completion December 2020
KQ5: Are sun protective behaviors associated with adverse effects?						
None						

References

1. Available at: ClinicalTrials.gov: http://www.clinicaltrials.gov/ct2. Accessed on November 28, 2008.
2. Available at: ClinicalTrials.gov: http://www.clinicaltrials.gov/ct2. Accessed on November 28, 2008.
3. Available at: Sun Protection for Florida's Children: http://www.safeplay.org. Accessed on November 28, 2008.
4. Available at: ClinicalTrials.gov: http://www.clinicaltrials.gov/ct2. Accessed on November 28, 2008.

Appendix E. Glossary and Abbreviations

Behavioral counseling: Any intervention that includes some provision of education, skills training, and support providing guidance to clients/patients on how to change sun-protective behavior, delivered alone or in combination with other interventions intended to promote sun-protective behavior.

Confidence interval (CI): 95 percent confidence interval.

Melanoma: Cutaneous melanoma includes four major subtypes: superficial spreading, nodular, lentigo maligna, and acral lentiginous. For the purposes of this review, acral melanoma, as well as mucosal melanoma, ocular melanoma, and pre-pubertal melanoma ("childhood melanoma"), are excluded.

Nevus, nevi (plural): Benign pigmented spot on the skin, such as a mole, that is a cluster of melanocytes and supportive tissue. In contrast, d*ysplastic nevi,* or atypical moles, are melanocytic lesions that can be precursors to melanoma. Dysplastic nevi are distinguished by histology; however, they may also have certain clinical characteristics (e.g., increased diameter, lack of pigment uniformity).

Not reported (NR)

Odds ratio (OR)

Primary care relevant: Behavioral counseling interventions conducted in primary care, judged to be feasible to conduct in primary care, or can be referred from primary care.

Randomized controlled trial (RCT)

Relative risk (RR), also risk ratio

Skin phenotype: Skin (as well as hair and eye) color and skin type (i.e., ability to tan or burn that is genetically determined). A common measure of skin type is the Fitzpatrick Skin Type Scale.

Sun exposure: Intermittent, chronic, or total exposure to ultraviolet light. Intermittent patterns of exposure are most often related to recreational activities, versus chronic or continuous patterns of exposure, which are related to occupational exposure. For the purposes of this review, studies that included only crude measures of sun exposure (e.g., place of residence or type of occupation) were excluded.

Indoor tanning: Home or commercial ultraviolet light for the purposes of sun tanning; in the early 1980s UVA was added (before, it was primarily UVB). For the purposes of this review, medical uses of sunlamps or sunbeds, primarily UVA, are excluded.

Sunburn: Inflammation of the skin in response to ultraviolet light, manifested by painful erythema with or without blistering.

Sunscreen or sunblock: Lotion with sun protection factor (SPF) 15 or higher that is used to protect against ultraviolet light, both UVA and UVB. Protection against UVA was added in 1989. SPF was introduced in 1978 and is reported when available. For the purposes of this review, sun tan lotions or oils were excluded.

Vitamin D: Fat-soluble prohormone, the two major forms of which are vitamin D2 (ergocalciferol) and vitamin D3 (cholecalciferol). Vitamin D3 is produced in the skin when it is exposed to sunlight (UVB); vitamin D3 can be made in the skin at least two times per week after only 10 to 15 minutes of sun exposure to the face, arms, hands, or back without sunscreen. Vitamin D3 is hydroxylated in the liver and stored as 25-hydroxyvitamin D3 (calcidiol); calcidiol is again hydroxylated in the kidney to the main biologically active hormone 1,25-dihydroxyvitamin D3 (calcitriol). Vitamin 25-hydroxyvitamin D3 (25-OHD) is the commonly accepted serum marker for vitamin D status.

Appendix E. Glossary and Abbreviations

VDR gene: Vitamin D receptor gene. The effects of 1,25-dihydroxyvitamin D3 are mediated by this gene, which is expressed in breast and many other types of tissue. The expression and/or function of the VDR protein may be influenced by polymorphisms in the gene.