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Behavioral Counseling for Skin Cancer Prevention
Evidence Report and Systematic Review for the US Preventive Services Task Force

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IMPORTANCE Exposure to UV radiation, especially in childhood, increases skin cancer risk.

OBJECTIVE To systematically review the evidence on the benefits and harms of behavioral counseling for skin cancer prevention to inform the US Preventive Services Task Force (USPSTF).

DATA SOURCES Cochrane Central Register of Controlled Trials, MEDLINE, and PubMed were searched for studies published from January 2009 to March 31, 2016, for skin cancer prevention and from August 2005 to March 31, 2016, for skin self-examination. Surveillance in targeted publications was conducted through February 14, 2018. Studies included in previous USPSTF reports were reevaluated for inclusion.

STUDY SELECTION Fair- and good-quality studies of primary care–relevant behavioral interventions focused on improving skin cancer outcomes, intermediate outcomes, or skin cancer prevention and self-examination behaviors.

DATA EXTRACTION AND SYNTHESIS Two investigators independently reviewed abstracts and full-text articles and extracted data into evidence tables. Results were qualitatively summarized but not pooled because of heterogeneity of measures.

MAIN OUTCOMES AND MEASURES Skin cancer, sunburn, precursor skin lesions, sun protection behaviors, and any harms from interventions.

RESULTS Twenty-one trials in 27 publications were included (N = 20 561). No studies assessed skin cancer outcomes in pediatric populations; 1 adult trial (n = 1356) promoting skin self-examination found no significant difference in participants diagnosed with melanoma in the intervention group vs the control group at 12-month follow-up (0 vs 1 diagnosis). There was no consistent improvement in prevention of sunburn for children (3 trials [n = 2508]) or adults (6 trials [n = 3959]). There were small to moderate increases in sun protection behavior in pediatric populations (6 trials [n = 4252]) and adults (12 trials [n = 13 099]) and small increases in skin self-examination in adults (11 trials [n = 7771]; odds ratios, 1.16-2.6). One of 3 trials of indoor tanning found an intervention effect; an appearance-focused intervention (n = 430) resulted in a smaller increase in mean indoor tanning sessions at 6 months in the intervention group vs the control group. Harms were rarely reported: 1 trial of skin self-examination (n = 1356) found an increase in skin procedures in the intervention group vs the control group at 6 months (8.0% vs 3.6%, $P < .001$) but not between 6 and 12 months (3.9% vs 3.3%, $P = .50$), and 1 trial (n = 217) found no between-group difference in skin cancer worry (28.9% vs 18.4%, $P = .16$).

CONCLUSIONS AND RELEVANCE Behavioral interventions can increase sun protection behavior, but there is no consistent evidence that interventions are associated with a reduction in the frequency of sunburn in children or adults and minimal evidence on skin cancer outcomes. Intervention can increase skin self-examination in adults but may lead to increased skin procedures without detecting additional atypical nevi or skin cancers.

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Editorial page 1101

Related article page 1134 and **JAMA Patient Page** page 1176

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Skin cancer is the most commonly diagnosed cancer in the United States. It is an abnormal growth of cells that begins in the outermost (epidermal) layer of the skin and is broadly classified as melanoma and nonmelanoma skin cancer. The incidence of melanoma, the most severe form of skin cancer, has been increasing, but overall melanoma mortality rates have not increased significantly.[1-3] Although 2% of all skin cancers are melanoma, it is estimated to cause more than 80% of skin cancer deaths.[4,5] UV radiation causes most skin cancers through damage to DNA[6] and represents the major environmental risk factor for all types of skin cancer.[7,8] Five-year survival for melanoma is 98.4% for local-stage disease to 17.9% for distant-stage disease.[9,10] Thus, behavioral counseling promoting behaviors for reducing UV exposure, and skin self-examination to identify and report suspicious lesions, could prevent skin cancer.

This review was conducted to inform the US Preventive Services Task Force (USPSTF) in its update of the 2012 recommendation on behavioral counseling for skin cancer prevention[11,12] (B recommendation for ages 10-24 years; I statement [insufficient evidence] for adults older than 24 years) and its 2009 I statement on skin self-examination for skin cancer detection.[13,14]

Methods

Scope of Review

This review addressed 5 key questions (KQs) (**Figure 1**). Methodological details (including study selection, a list of excluded studies, and description of data analyses), as well as more detailed results for each study (including detailed descriptions of all interventions), are publicly available in the full evidence report[16] at https://www.uspreventiveservicestaskforce.org/Page/Document/UpdateSummaryFinal/skin-cancer-counseling1.

This review differs in structure compared with the previous USPSTF review on skin cancer counseling, published in 2011.[11] The previous review focused on primary prevention of skin cancer through behavioral intervention and did not include skin self-examination, a method of secondary prevention. Skin self-examination was included in the 2009 USPSTF evidence review on skin cancer screening[14] but was not included in the 2016 update,[17] which focused solely on clinician skin examination.

Data Sources and Searches

All articles included in the previous USPSTF evidence report on behavioral counseling for skin cancer prevention[11] and in the USPSTF skin cancer screening evidence report published in 2009[14] were evaluated for inclusion (the 2009 update included literature published between 1999 and 2005). For articles published since the previous reviews, a research librarian created 2 search strategies: 1 for counseling and 1 for skin self-examination. For counseling on sun protection behaviors, the search encompassed articles published from January 1, 2009, to February 1, 2017. For skin self-examination, the search encompassed articles published from August 1, 2005, to February 1, 2017.

To locate relevant studies for all key questions (KQs), the following databases were searched: Cochrane Central Register of Controlled Trials, MEDLINE, and PubMed, publisher-supplied (eMethods in the Supplement). The database searches were supplemented by reviewing reference lists from recent and relevant systematic reviews. The search strategy was peer-reviewed by a second research librarian.

Since February 2017, ongoing surveillance was conducted through article alerts and targeted searches of a subset of core clinical journals identified by the USPSTF[15] to identify major studies published in the interim that may affect the conclusions or understanding of the evidence and therefore the related USPSTF recommendation. The last surveillance was conducted on February 14, 2018, and identified no new studies that met inclusion criteria.

Study Selection

Two reviewers independently reviewed 2311 titles and 372 articles (**Figure 2**) to assess specified inclusion criteria (eTable 1 in the Supplement). Discrepancies were resolved through consensus and consultation with a third investigator. Excluded articles were those that did not meet inclusion criteria or that were rated as poor quality.

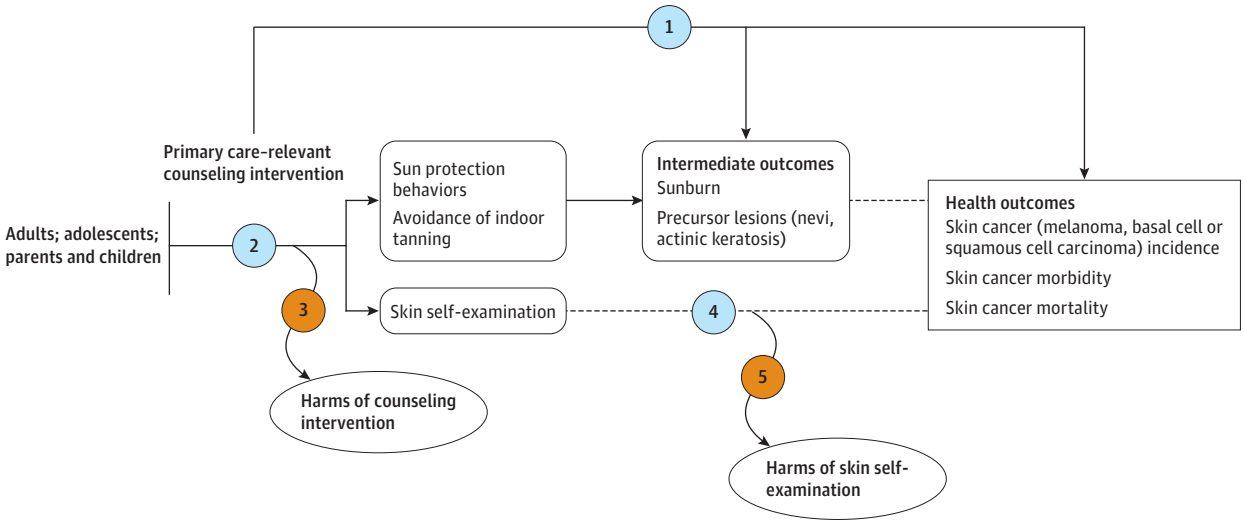
For all KQs, the population of interest was people of any age without skin cancer, including parents or caregivers of children who would be the focus of a counseling intervention. To be as inclusive as possible of interventions with potential relevance to an average-risk, primary care population, studies in which 75% or more of the population had no skin cancer history were eligible, but studies in which 25% or more of the population had a prior history of skin cancer or were otherwise under surveillance for skin cancer were excluded.

Included settings were those with an established link to primary care and those in countries categorized as "very high" on the United Nations Human Development Index.[18] Studies conducted in countries rated very high on the Human Development Index are more likely to be applicable to US settings. Primary care–relevant counseling interventions were defined as those delivered in primary care settings, judged to be feasible for implementation in primary care, or available for referral from primary care.[19] Studies set in the community with no link to primary care, at a worksite, within childcare or recreational settings, and mass media campaigns were excluded. Included interventions were those aimed at improving sun protection behaviors or teaching skin self-examination in a primary care or primary care–linked setting. Multicomponent interventions (such as a community-level intervention including media campaigns, screening days, and primary care counseling) in which the effect of primary care–relevant counseling could not be assessed were excluded. Included comparison groups were usual care, assessment-only controls, attention-control groups using an equivalent-intensity intervention on a different health topic, or comparison groups using minimal intervention; studies comparing equivalent-intensity skin cancer counseling interventions were excluded.

For questions on behavioral counseling (KQ1, KQ2, KQ3), only randomized or nonrandomized controlled intervention studies were eligible for inclusion. For skin self-examination questions (KQ4, KQ5), trials and prospective cohort studies were eligible.

For KQ1, intermediate outcomes were defined as sunburn, nevi, and actinic keratosis, and health outcomes included melanoma, basal cell carcinoma, or squamous cell carcinoma incidence, morbidity, or mortality. Behavioral outcomes for KQ2 could be parent- or self-reported outcomes that related to sun protection behaviors (eg, composite scores, use of protective clothing, sun avoidance, use of sunscreen), skin self-examination, or indoor tanning use. For KQ3, any harms of behavioral counseling interventions or skin self-examination were eligible for inclusion.

Figure 1. Analytic Framework and Key Questions



Key questions

1 Does counseling patients in skin cancer prevention improve

a. Intermediate outcomes (sunburn or precursor lesions)?

b. Skin cancer outcomes (melanoma, squamous cell, or basal cell carcinoma incidence, morbidity, or mortality)?

2 Do primary care-relevant counseling interventions improve skin cancer prevention behaviors (eg, reduced sun exposure, sunscreen use, use of protective clothing, avoidance of indoor tanning, and skin self-examination)?

3 What are the harms of counseling interventions for skin cancer prevention (eg, increased time in the sun, reduced physical activity, vitamin D deficiency, and anxiety)?

4 What is the association between skin self-examination and skin cancer outcomes (melanoma, squamous cell, or basal cell carcinoma incidence, morbidity, or mortality)?

5 What are the harms of skin self-examination?

Evidence reviews for the US Preventive Services Task Force (USPSTF) use an analytic framework to visually display the key questions that the review will address to allow the USPSTF to evaluate the effectiveness and safety of a preventive service. The questions are depicted by linkages that relate interventions and outcomes. A dashed line indicates a relationship between an intermediate outcome and a health outcome that is presumed to describe the natural progression of the disease. Further details are available in the USPSTF procedure manual.[15]

Data Extraction and Quality Assessment

At least 2 reviewers critically appraised all articles that met inclusion criteria based on the USPSTF design-specific quality criteria (eTable 2 in the Supplement). Each study was rated as good, fair, or poor quality. A good-quality study met all quality criteria. A fair-quality study failed to meet at least 1 criterion but had no known issue that would invalidate its results. Studies were rated as poor quality if they had major risk of bias; poor-quality studies were excluded from this review. Disagreements about critical appraisal were resolved by consensus and, if needed, consultation with a third independent reviewer.

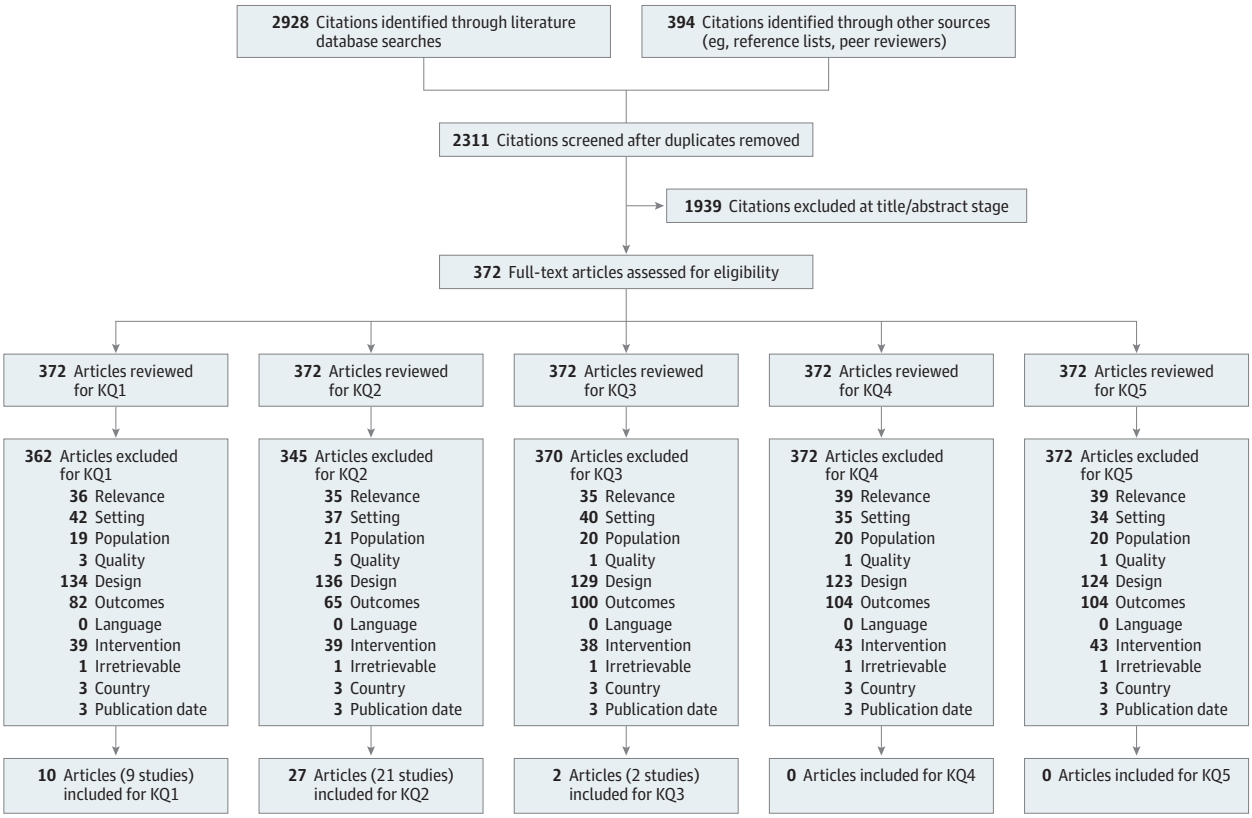
One reviewer completed primary data abstraction; a second reviewer checked all data for accuracy and completeness.

Data Synthesis and Analysis

Summary tables were created for each KQ. Tables included details on study design and quality, setting and population (eg, country, inclusion criteria, age, sex, race/ethnicity), intervention details, length of follow-up, measure descriptions, and outcomes. Standardized summary-of-evidence tables were used to summarize the overall strength of evidence for each KQ. These tables included the number and design of included studies, summary of results, reporting bias, summary of study quality, limitations of the body of evidence, and applicability of the findings.

Results for child and adolescent populations and adult populations are reported separately and are summarized in tables and as a narrative synthesis. Measures of significance are author-reported; for this review, results were considered statistically significant at $P < .05$. The individual items and scales measuring sun protection behaviors were variable across trials and make interpretation of absolute differences difficult. To assist with interpretation and demonstrate the range of effects across studies, standardized mean differences (Cohen *d*) in change were plotted for trials that provided sufficient data (**Figure 3**, **Figure 4**, **Figure 5**). Pooled estimates were not provided, given the small number of contributing studies and variability in measures.

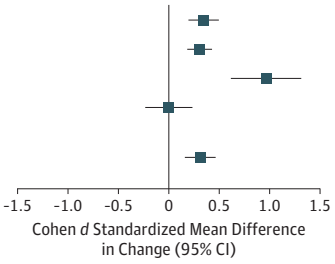
Figure 2. Literature Search Flow Diagram



All eligible full-text articles were reviewed for all key questions (KQs). Reasons for exclusion: Relevance: Study was not relevant to behavioral counseling for skin cancer prevention. Setting: Study was not conducted in, recruited from, or feasible for primary care. Population: Study was not conducted in an included population. Quality: Study was poor quality. Design: Study did not use an included design. Outcomes: Study did not have relevant outcomes or had incomplete outcomes. Language: Publication was not in English. Intervention: Intervention was out of scope. Irretrievable: Publication was not available or accessible. Country: Study was not conducted in a country relevant to US practice (those categorized as "Very High" on the United Nations Human Development Index).[18] Publication date: Primary results published prior to included date range.

Figure 3. Cohen *d* Standardized Mean Difference in Change From Baseline of Sun Protection Composite Scores in Children (KQ2)

Source	Population	Planned Duration of Follow-up, wk	No.		Standardized Mean Difference in Change From Baseline (95% CI)
			Intervention	Control	
Crane et al,[25] 2012	Children (aged 6 y)	156	344	333	0.35 (0.19 to 0.50)
Glanz et al,[26] 2013	Children (aged 4-10 y) at risk	16	517	530	0.31 (0.18 to 0.43)
Glasser et al,[22] 2010	Children (aged 3-10 y)	13	71	70	0.96 (0.61 to 1.31)
Gritz et al,[23] 2013	Children (aged ≤12 y) of melanoma survivors	17	138	143	0.00 (-0.23 to 0.23)
Norman et al,[24] 2007	Adolescents (aged 11-15 y)	104	315	341	0.31 (0.16 to 0.47)

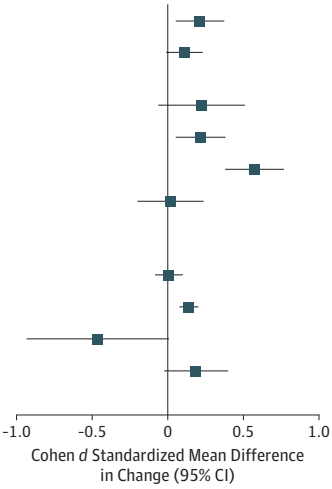


Five of 6 trials are included in this forest plot. Studies differ in terms of study population, length of follow-up, and composite scores. Crane et al[20] was not included in the plot because people were recruited at birth and therefore had no baseline data. "At risk" defined as "high" or "moderate" skin cancer risk as assessed by the brief skin cancer risk assessment tool (BRAT).

The strength of evidence was graded for each KQ according to guidance for Evidence-based Practice Centers from the Agency for Healthcare Research and Quality.[21] For each key question, the evidence was graded according to consistency (similarity of effect direction and size), precision (degree of certainty around an estimate), reporting bias (potential for bias related to publication, selective outcome reporting, or selective analysis reporting), and study quality (ie, study limitations).

Figure 4. Cohen *d* Standardized Mean Difference in Change From Baseline of Sun Protection Composite Scores in Adults (KQ2)

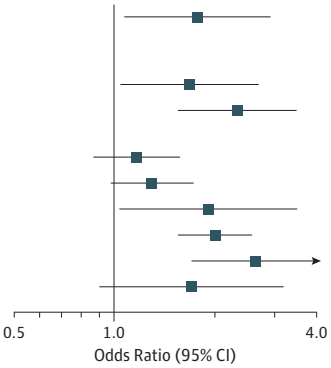
Source	Population	Planned Duration of Follow-up, wk	No.		Standardized Mean Difference in Change From Baseline (95% CI)
			Intervention	Control	
Glanz et al,[42] 2010	Adults at risk	17	307	289	0.21 (0.05 to 0.37)
Glanz et al,[26] 2013	Parents of children aged 4-10 y	16	517	530	0.11 (-0.01 to 0.23)
Glanz et al,[39] 2015	Adults at risk	13	83	109	0.22 (-0.06 to 0.51)
Glazebrook et al,[45] 2006	Adults at risk[a]	26	258	325	0.22 (0.05 to 0.38)
Heckman et al,[46] 2016	Young adults at risk	12	195	229	0.57 (0.38 to 0.77)
Manne et al,[38] 2010	Adult (aged ≥20 y) first-degree relatives of melanoma patients	52	161	161	0.02 (-0.20 to 0.24)
Prochaska et al,[40] 2005	Adults	104	864	920	0.01 (-0.09 to 0.10)
Prochaska et al,[41] 2005	Adults	104	1822	2012	0.14 (0.08 to 0.20)
Vuong et al,[47] 2014	Adults	56	37	34	-0.46 (-0.94 to 0.01)
Youl et al,[32] 2015	Adults	52	178	166	0.19 (-0.03 to 0.40)



Ten of 12 trials reporting sun protection composite scores are included in this forest plot. Studies differ in terms of study population, length of follow-up, and composite scores. Two studies were excluded from the plot because of differences in outcomes reported. "At risk" defined as "high" or "moderate" skin cancer risk as assessed by the brief skin cancer risk assessment tool (BRAT).

Figure 5. Odds of Conducting Skin Self-examination in Adults (KQ2)

Source	Population	Planned Duration of Follow-up, wk	Skin Self-examination	Self-reported Skin Examination, No./Total No. (%)		Odds Ratio (95% CI)
				Intervention	Control	
Geller et al,[31] 2006	Adult siblings of melanoma patients	52	Total	132/149 (88.5)	138/165 (83.5)	1.76 (1.06-2.92)
Glazebrook et al,[45] 2006	Adults at risk[a]	26	Any	209/259 (80.7)	243/328 (74.1)	1.67 (1.04-2.69)
Heckman et al,[46] 2016	Young adults at risk[b]	12	Total	87/195 (44.6)	59/229 (25.8)	2.32 (1.54-3.49)
Janda et al,[43] 2011	Men aged ≥50 y	56	Partial	298/420 (71.0)	279/411 (67.8)	1.16 (0.86-1.56)
			Total	153/420 (36.4)	126/411 (30.7)	1.29 (0.97-1.72)
Rat et al,[30] 2014	Adults at risk[c]	22	Any	51/97 (52.6)	28/76 (36.8)	1.90 (1.03-3.51)
Weinstock et al,[29] 2007	Adults	52	Total	254/530 (55.0)	154/487 (35.0)	1.99 (1.54-2.57)
Youl et al,[32] 2015	Adults	52	Any	103/163 (63.2)	65/165 (39.2)	2.64 (1.69-4.13)
			Total	28/163 (17.2)	18/165 (10.9)	1.69 (0.90-3.19)



Seven of 11 studies are included in this forest plot. Studies differ in terms of study population, length of follow-up, and type of skin self-examination (total, any, partial). Four studies were excluded from the plot because of differences in outcomes reported.

[a] Patients invited to participate if they had 1 or more risk factors for melanoma (red hair, multiple moles, history of sunburn as a child, freckling, family history of melanoma, fair sun-sensitive skin).

[b] Defined as "high" or "moderate" skin cancer risk as assessed by the brief skin cancer risk assessment tool (BRAT).

[c] All patients classified as "high" risk according to the Self-Assessment Melanoma Risk Score (SAMscore).

Results

In total, 2311 abstracts and 372 full-text articles were reviewed for all KQs (Figure 2). Of these, 21 unique trials reported in 27 articles were included: 6 reported results in pediatric populations (n = 4252)[20,22-26] (**Table 1**), and 16 reported on adult populations (n = 16 309) (**Table 2**).[26,29-32,34,37-43,45-47] Three of the adult trials were conducted exclusively in young adults (aged 17-25 years or university students [n = 1528]).[34,37,46]

Nineteen trials were rated as fair quality[20,22-25,29-31,34,37-43,45-47] and 2 as good quality.[26,32] For trials rated as fair quality, limitations included a lack of reporting on handling of missing data and incomplete reporting of blinding methods, randomization, allocation concealment, or follow-up rates. Follow-up rates ranged from 70.8% to 80.5% in pediatric studies and from 63.6% to 95.8% in adult trials.

Table 1. Characteristics of All Included Pediatric Randomized Clinical Trials[a]

Source[a]	Population	No. Randomized	Planned Duration of Follow-up, mo	Female, No. (%)	Age, Mean (SD) or No. (%) in Category	Skin Cancer Risk Factors, No (%)	Intervention Component (No. of Sessions or Mailings)	Outcomes Reported	
								KQ1	KQ2
Crane et al,[25] 2012	Children (6 y)	867[b]	36	360 (52.5)	6 y: 686 (100)[b]	White: 686 (100)[b] Fair white skin: 355 (51.8) Blond/red hair: 496 (72.3) Blue eyes: 334 (48.7) Painful burn/no tan: 83 (12.1)	Tailored mailings (14): Newsletters for parents and children promoting child sun protection	Sunburn; nevi	Sun protection; sunscreen
Gritz et al,[23] 2013	Children (≤12 y) of melanoma survivors	340	4	167 (49.1)	7.3 (3.9) y	White: 334 (98.2) Sun sensitivity: 2.29 (0.69)[c] Family history of skin cancer: 340 (100)	In-person parent education (1); materials (children's video, print materials); sun protection aids (shirt, hat, sunscreen)	Sunburn	Sun protection; sunscreen
Kaiser Kids Sun Care Crane et al,[20] 2006	Children (0-6 mo)	728	36	362 (49.7)	0-6 mo: 728 (100)	White: 449 (81.9) Fair white skin: 318 (43.7) Blond/red hair: 148 (20.3) Blue/gray eyes: 545 (74.9)	PCP counseling (4); print materials for parents promoting child sun protection (4); sunscreen samples; hat		Sun protection; sunscreen
Project SCAPE (family) Glanz et al,[26] 2013[d]	Children (4-10 y) at increased skin cancer risk	1301	4	637 (49.0)	7.1 (1.1) y	White: 853 (65.6) High skin cancer risk: 498 (38.3)[e] Moderate skin cancer risk: 803 (61.7)[e]	Tailored mailings (3) for parents promoting children's and parents' sun protection	Sunburn	Sun protection; sunscreen; skin self-examination
Sun Sense Glasser et al,[22] 2010	Children (3-10 y)	197	3	95 (48.2)	3-4 y: 66 (33.5) 5-7 y: 67 (34.0) 8-10 y: 60 (30.5)	White: 88 (44.7)	Standard mailings (3) promoting sun protection; print materials, DVD; children's activities		Sun protection; sunscreen
SunSmart Norman et al,[24] 2007 Rosenberg et al,[27] 2007 Patrick et al,[28] 2006	Adolescents (11-15 y)	819	24	438 (53.5)	12.7 (1.3) y	White: 478 (58.4) High skin sensitivity: 206 (25.2)[f] Moderate skin sensitivity: 360 (44.0)[f]	PCP counseling using tailored risk information (1); telephone counseling (4); mailed materials promoting sun protection; sunscreen samples		Sun protection; sunscreen

Abbreviations: KQ, key question; PCP, primary care physician; SCAPE, Skin Cancer Awareness, Prevention and Education.

[a] All included pediatric RCTs were conducted in the United States; all were fair quality except for Project SCAPE (family), which was good quality.

[b] Crane et al[25] randomized 867 participants but only reported results for white non-Hispanic participants at baseline (n = 686) and at final follow-up (n = 677). The authors report that results for white non-Hispanic participants were similar to results for all participants.

[c] Mean (SD). Sun sensitivity index computed from questions on eye color, hair color, and skin; scores range from 1 (high sensitivity) to 4 (low sensitivity).

[d] The Project SCAPE family trial by Glanz et al[26] reported outcomes for both children and adults; this table reports baseline characteristics for children only.

[e] As assessed by the brief skin cancer risk assessment tool (BRAT), which includes questions about family history, number of large moles, freckles, and sun sensitivity (skin color, natural hair color, ease of tanning, burning).

[f] Skin sensitivity determined by previously validated instrument with scores ranging 1 to 10 based on skin reaction to sun, untanned skin color, and hair color.

Table 2. Characteristics of All Included Adult Randomized Clinical Trials[a]

Source	Population	No. Randomized	Planned Duration of Follow-up, mo	Women, No. (%)	Age, Mean (SD), years or Category, No (%)	Skin Cancer Risk Factors, No. (%)	Intervention Component (No. of Sessions or Mailings)	Outcomes Assessed		
								KQ1	KQ2	KQ3
Check It Out Weinstock et al,[29] 2007 (United States)	Adults (≥18 y)	1356	12	791 (58.3)	53.2 (14.8)	High skin cancer risk: 325 (24.0)[b] Moderate skin cancer risk: 488 (36.0)[b]	Study team counseling (2); materials promoting skin self-examination (print, video); skin self-examination aids; tailored letter (1)	Nevi	Skin self-examination	Harms
COPARIME Rat et al,[30] 2014 (France)	Adults (age range NR) at increased melanoma risk	217[c]	5	131 (76.0)	43.2 (16.1)	High skin cancer risk: 173 (100)[d]	PCP counseling using tailored feedback (1)	Sunburn	Sun protection; indoor tanning; skin self-examination	Harms
Geller et al,[31] 2006 (United States)	Adult (≥18 y) siblings of melanoma patients	494	12	264 (53.4)	18-50: 288 (58.3) ≥51: 206 (41.7)	White: 494 (100) Fair skin: 419 (84.8) Family history of skin cancer: 494 (100)	Health educator telephone counseling (4); mailed print materials (3) promoting sun protection and skin self-examination		Sunscreen; skin self-examination	
Healthy Text Youl et al,[32] 2015 Baker et al,[33] 2016 (Australia)	Adults (18-42 y)	546	12	368 (67.4)	31.9 (6.2)	Fair or very fair skin: 359 (65.8) Red hair: 22 (4.0) Blue/gray eyes: 202 (37.0) Tends to burn not tan: 142 (26.0) Never tans: 82 (15.0)	Intervention 1: Tailored text messages promoting sun protection (21) Intervention 2: Tailored text messages promoting skin self-examination (21)	Sunburn	Sun protection; skin self-examination	
Hillhouse et al,[34] 2008 Hillhouse et al,[35] 2010 Abar et al,[36] 2010 (United States)	University students aged 17-21 y who use indoor tanning	430	6	430 (100)	18.6 (0.8)	Always burns, never tans: 31 (7.4)[e] Usually burns, then tans: 97 (23.5)[e]	Standard print materials (1) promoting appearance-based alternatives to indoor tanning		Indoor tanning	
Mahler et al,[37] 2007 (United States)	Adult (18-44 y) university students	133	12	107 (80.5)	20.1 (3.4)	White: 60 (45.0) Family history of skin cancer: 36 (27.1)	Facial photographs of participant with simulated sun damage (1); appearance-focused video promoting sun protection (1)		Sun protection	
Manne et al,[38] 2010 (United States)	Adult (≥20 y) FDRs of melanoma patients	443	12	279 (63.0)	47.6 (13.2)	White: 435 (98.2) Family history of skin cancer: 443 (100)	Tailored mailings (3) promoting sun protection and skin self-examination; phone counseling (1)		Sun protection; skin self-examination	
PennSCAPE Glanz et al,[39] 2015 (United States)	Adults (18-91 y) with increased skin cancer risk	206[f]	3	141 (73.4)	55.2 (15.2)	White: 192 (100) High skin cancer risk: 117 (60.9)[b] Moderate skin cancer risk: 75 (39.1)[b] NMSC personal history: 30 (15.6) Family history of skin cancer: 83 (43.2)	Tailored mailings (3) on risk reduction, skin self-examination, clinical skin examination, and sunscreen	Sunburn	Sun protection; sunscreen; skin self-examination	
Prochaska et al,[40] 2004 (United States)	Adults (age range NR)	2460	24	1845 (75.0)	42.5 (5.5)	White: 2263 (92.0)	Tailored mailings (3) promoting sun protection		Sun protection; sunscreen	
Prochaska et al,[41] 2005 (United States)	Adults (age range NR)	5407	24	3779 (69.9)	44.7 (12.7)	White: 5229 (96.7)	Tailored mailings (3) promoting sun protection		Sun protection; sunscreen	

(continued)

Table 2. Characteristics of All Included Adult Randomized Clinical Trials[a] (continued)

Source	Population	No. Randomized	Planned Duration of Follow-up, mo	Women, No. (%)	Age, Mean (SD), years or Category, No (%)	Skin Cancer Risk Factors, No. (%)	Intervention Component (No. of Sessions or Mailings)	Outcomes Assessed		
								KQ1	KQ2	KQ3
Project SCAPE (adult) Glanz et al,[42] 2010 (United States)	Adults (20-65 y) with increased skin cancer risk	724	4	561 (77.5)	41.7 (11.0)	White: 581 (80.2) High skin cancer risk: 265 (36.6)[b] Moderate skin cancer risk: 459 (63.4)[b]	Tailored mailings (3) promoting sun protection and skin self-examination; skin self-examination aids	Sunburn	Sun protection; sunscreen; skin self-examination	
Project SCAPE (family)[g] Glanz et al,[26] 2013 (United States)	Parents of children aged 4-10 y	1301	4	>1170 (>90.0)[h]	NR	White: 887 (68.2)	Tailored mailings (3) for parents promoting children's and parents' sun protection	Sunburn	Sun protection; sunscreen; skin self-examination	
Skin Awareness Study Janda et al,[43] 2011 Walton et al,[44] 2014 (Australia)	Adult (50-90 y) men	930	13	0	50-60: 392 (42.2) 61-70: 331 (35.6) 71-90: 206 (22.2)	Fair/very fair skin: 579 (62.3) Red/fair/blond hair: 251 (27.0) Blue/gray eyes: 433 (46.6) High skin sensitivity: 57 (6.1)[i]	Standard mailing (1) promoting skin self-examination (video, skin self-examination aids; print materials); reminder postcards		Skin self-examination	
Skinsafe Glazebrook et al,[45] 2006 (United Kingdom)	Adults (age range NR) with ≥1 melanoma risk factor	589	6	473 (80.3)	38.3 (14.8)	NR[j]	Interactive online program (1) with tailored feedback promoting sun protection and skin self-examination		Sun protection	
UV4.me Heckman et al,[46] 2016 (United States)	Young adults (18-25 y) with increased skin cancer risk	965	3	637 (66.1)	21.8 (2.2)	White: 825 (85.7) Fair skin: 833 (86.3) High or moderate skin cancer risk: 965 (100)[b] Family history of skin cancer: 339 (35.2)	Intervention 1: Tailored interactive web program (12 modules) Intervention 2: Public website	Sunburn	Sun protection; sunscreen; indoor tanning; skin self-examination	
Vuong et al,[47] 2014 (Australia)	Adults (≥18 y)	108[k]	13	59 (59.0)	<50: 59 (59.0) ≥50: 41 (41.0)	High skin cancer risk: 76 (76.0)[b] Moderate skin cancer risk: 18 (18.0)[b]	PCP counseling using tailored feedback; print materials (1)		Sun protection	

Abbreviations: COPARIME, Cohorte de patients à risque de mélanome; FDR, first-degree relative; KQ, key question; NMSC, nonmelanoma skin cancer; NR, not reported; PCP, primary care physician; SCAPE, Skin Cancer Awareness, Prevention and Education.

[a] All included adult studies were randomized clinical trials or cluster RCTs, with the exception of Vuong et al,[47] which was a nonrandomized controlled intervention study of patients attending either an intervention clinic or a control clinic. All were fair quality except for Healthy Text and Project SCAPE (family), which were good quality.

[b] As assessed by the brief skin cancer risk assessment tool (BRAT), which includes questions about family history, number of large moles, freckles, and sun sensitivity (skin color, natural hair color, ease of tanning, burning).

[c] The COPARIME study (Rat et al[30]) randomized 217 participants but reported baseline characteristics for 173 participants only.

[d] Assessed via the Self-Assessment Melanoma Risk Score (SAMscore). Domains of SAMscore are skin type, freckles, moles, severe blistering sunburn in childhood, lived more than 1 year in high-sunshine country; personal history.

[e] Study reports Fitzpatrick skin types: type I (always burns, never tans): 7.4%; type II (usually burns, then tans): 23.5%; type III (may burn, tans well): 40.8%; type IV (rarely burns, tans well): 25.8%; type V (very rarely burns, tans well, brown skin): 2.4%.

[f] The PennSCAPE trial (Glanz et al[39]) randomized 206 participants but reported baseline characteristics for 192 participants only.

[g] The Project SCAPE family trial by Glanz et al[26] reported outcomes for both children and adults; this table reports baseline characteristics for adults only.

[h] The Project SCAPE family trial[26] reports that "Over 90% of responding parents were mothers" (exact N and % not reported).

[i] Defined as never tanning, only burning or freckling.

[j] In intervention practices, patients invited to participate in intervention group if they had 1 or more characteristics identified by research as a risk factor for melanoma (red hair; multiple moles; history of sunburn as a child; freckling; family history of melanoma; fair, sun-sensitive skin). Control group participants selected to match skin and demographic profile of intervention group participants.

[k] Vuong et al[47] randomized 108 participants but reported baseline characteristics for 100 participants only.

Less common were issues with selection of control group, lack of reporting measures of intervention fidelity or adherence, and either baseline values or raw data not being reported. Most adherence estimates were higher than 70%; no measures suggested poor fidelity or adherence.

All trials used heterogeneous measures of self-report or parent-report to assess behavioral outcomes, sunburn, and skin self-examination. Measures of skin self-examination ranged from self-report of any or partial examination, to mole-checking, to total body examination with numbers of body parts examined. Most trials addressed seasonality by choosing sunny climates as intervention sites, planning interventions to peak in spring, timing follow-up assessments in late summer or fall, or querying a specific time frame during assessment (eg, most recent sun exposure).

Children and Adolescents

Six trials were conducted among child or adolescent populations (n = 4252).[20,22-26] Of the 6 pediatric studies, 5 reported results in children aged 0 to 12 years[20,22,23,25,26] and 1 reported results in adolescents aged 11 to 15 years.[24] Study populations were predominantly white or fair-skinned. Four trials were published since the previous USPSTF review.[22,23,25,26] Most interventions focused on parents; some also provided child-appropriate materials, and adolescents were counseled directly in 1 trial.[24] All intervention messages focused on increasing sun protection behaviors (eg, using sunscreen, avoiding mid-day sun, wearing protective clothing). None of the interventions among pediatric populations focused on the use of indoor tanning or performing skin self-examination. Three of the 6 trials included direct, face-to-face counseling plus print support, telephone support, or both.[20,22,24] Of the remaining 3 trials, 2 included tailored mailings,[25,26] and 1 included standard mailings of print materials, a DVD, and children's activities.[23]

Adults

Of the 16 adult studies, 3 reported results in young adults (aged 17-25 years or university students [n = 1528]),[34,37,46] 1 included parents of children aged 4 to 10 years as part of a family-focused intervention (n = 1301),[26] and 1 included only men older than 50 years (n = 930).[43] The remaining 11 adult trials reported results in adults of a broad age range (ages 18 and older [n = 12 550]).[29-32,38-42,45,47] Study populations were predominantly white or fair-skinned. Ten trials conducted with adult populations were published since the previous USPSTF review.[26,29,30,32,38,39,42,43,46,47]

Seven of the 16 adult trials were either conducted in or recruited from primary care.[29,30,39,41,42,45,47] Four of these were conducted directly in primary care settings,[29,30,45,47] and 3 recruited participants from a primary care setting but conducted their interventions by mail.[39,41,42] The remaining interventions were judged to be referable from or feasible for primary care. The majority of the interventions included comprehensive skin cancer prevention messages, such as general skin cancer education and strategies for reducing sun exposure (sun protection or sun avoidance behaviors), and 5 interventions also included messages promoting or teaching skin self-examinations.[31,38,39,45,46] Three interventions focused exclusively on promoting skin self-examinations.[29,32,43]

Seven interventions were mail-based,[26,34,39-43] and 5 included direct counseling provided either by primary care physicians[30,47] or by health educators in person[29] or via telephone.[31,38] Others used text messages,[32] online programs,[45,46] or appearance-based images.[37] Fourteen of 16 trials included tailored feedback specific to the participant's level of risk, barriers to change, or both[26,29-32,37-42,45-47]; the other 2 included relatively focused populations (young adult female indoor tanners[34] and men older than 50 years[43]) that allowed for specific intervention messaging.

Effects of Interventions on Health Outcomes

Key Question 1. Does counseling patients in skin cancer prevention improve (a) intermediate outcomes (sunburn or precursor lesions) or (b) skin cancer outcomes (melanoma, squamous cell, or basal cell carcinoma incidence, morbidity, or mortality)?

Children and Adolescents

None of the 6 trials among children and adolescents reported skin cancer outcomes (KQ1). Three trials of standard or tailored mailings for parents promoting sun protection for children aged 3 to 10 years generally found no intervention effect for parent-reported sunburn outcomes (eTable 3 in the Supplement).[23,25,26] A trial of tailored mailings for parents of 6-year-olds (n = 867) found a small intervention effect on nonsevere sunburn (effect size, −0.25 [95% CI, −0.47 to −0.04]; *P* = .02) but no effect on severe, blistering sunburn at 3-year follow-up.[25] This same trial found no difference between the mean number of small or large nevi between intervention and control group children at 3-year follow-up.

Adults

Only 7 of the 16 adult trials reported intermediate or skin cancer outcomes (eTable 4 in the Supplement). One of 6 trials found an intervention effect for sunburn outcomes. In that trial of online education for young adults (n = 965; 86% with fair skin), the proportion of participants reporting red or painful sunburn in the past month decreased more markedly from baseline to 3 months in the tailored interactive web program group compared with 2 other groups (54.5% to 26.3% in the tailored interactive web program group; 51.5% to 38.2% in the public website group; 56.3% to 41.2% in the assessment-only control group; *P* = .01 for comparison of intervention vs assessment only, between-group difference not reported).[46] One trial (n = 1356) of counseling and promotional materials to encourage skin self-examination assessed skin cancer outcomes at 12 months and found no difference in numbers of cancers and atypical nevi detected in intervention and control groups.[29]

Effects of Interventions on Behavioral Outcomes

Key Question 2. Do primary care–relevant counseling interventions improve skin cancer prevention behaviors (eg, reduced sun exposure, sunscreen use, use of protective clothing, avoidance of indoor tanning, and skin self-examination)?

Children and Adolescents

All 6 trials among children and adolescents reported the effect of interventions on composite sun protection behaviors; 5 of the 6 trials found that interventions involving physician counseling, tailored mailings, or an educational presentation had a statistically significant benefit on parent-reported composite sun protection scores compared with controls at 3-month to 3-year follow-up (eTable 5 in the Supplement).[20,22,24-26] Standardized mean differences (Cohen *d*) in effect sizes ranged from 0 to 0.96 (Figure 3), with the 3 larger trials

Table 3. Summary of Evidence, by Key Question: Children and Adolescent Trials[a]

No. of Studies, No. of Observations	Summary of Findings by Outcome	Consistency and Precision	Reporting Bias	Study Quality[b]	Body of Evidence Limitations	EPC Assessment of Strength of Evidence	Applicability
KQ1: Intermediate and Health Outcomes							
3 RCTs n = 2508 (All 3 trials identified in update, all in populations aged 3-10 y)	One trial among children aged 6 y (n = 867) found a small intervention effect for nonsevere sunburn but not for severe sunburn or number of nevi at 3-y follow-up. Two other trials among children (mean age, 7 for both) found no between-group differences in sunburn frequency at 4-mo follow-up. No studies reported skin cancer outcomes.	Skin cancer or nevi: NA Sunburn: Inconsistent, imprecise	Suspected[c]	1 Good 2 Fair	Few studies overall; none among children <3 y or adolescents. Sunburn assessed by parent self-report; limited reporting of absolute values.	Skin cancer or nevi: Insufficient Sunburn: Low	Likely applicable to US primary care for predominantly fair-skinned populations, although feasibility may vary.
KQ2: Behavioral Outcomes							
6 RCTs n = 4252 (4 trials identified in update, all in populations aged 3-10 y)	Five of 6 trials found an intervention effect for parent-reported sun protection composite scores across all age groups at 3-mo to 3-y follow-up. Standardized effect sizes ranged from 0 to 0.96 (0.16 to 0.50 in larger trials). Effects on individual sun-protection behaviors, including sunscreen use, were generally consistent within each trial. No trials reported indoor tanning use.	Sun protection: Reasonably consistent, imprecise Indoor tanning: NA Skin self-examination: NA	Suspected[c]	1 Good 5 Fair	Limited reporting of absolute values; clinical interpretation of composite scores difficult to assess; self-reported data; heterogeneous measures and time frames. Only 1 study each of children <3 y and adolescents.	Low	Likely applicable to US primary care for predominantly fair-skinned populations, although feasibility may vary
KQ3: Harms of Intervention							
No studies	NA	NA	NA	NA	NA	Insufficient	NA
KQ4: Association Between Skin Self-examination and Outcomes							
No studies	NA	NA	NA	NA	NA	Insufficient	NA
KQ5: Harms of Skin Self-examination							
No studies	NA	NA	NA	NA	NA	Insufficient	NA

Abbreviations: EPC, Evidence-based Practice Center; KQ, key question; NA, not applicable; RCT, randomized clinical trial.

[a] One study (Glanz et al[26]) reported outcomes for both children and adults.

[b] Quality assessed using criteria from the US Preventive Services Task Force methods.[15]

[c] One trial (n = 867) only reported results for white non-Hispanic participants (n = 677).

(of physician counseling or tailored mailings) suggesting small to moderate effects ranging from 0.16 to 0.50 (mean around 0.32).[24-26] Effects on sunscreen use and other individual sun protection behaviors were generally consistent within each trial, and there were no apparent trends in the effectiveness of the interventions according to intervention or population characteristics.

Adults

In 12 trials reporting sun protection behaviors among adults,[26,30,32,37-42,45-47] evidence was mixed (eTable 6 in the Supplement). One young adult trial involving a tailored interactive web program[46] and 5 adult trials involving tailored material (through mailings, text messages, or an interactive web program) found increases in sun protection composite measures compared with control groups.[26,32,41,42,45] Standardized effect sizes ranged from −0.46 (favoring the control group) to 0.57 (favoring the intervention group) and between 0.10 and 0.20 for most studies (Figure 4). Sunscreen use was the most commonly reported individual behavior. Only 1 of 3 trials[30,34,46] found a significant change in self-reported indoor tanning behavior: a trial of an appearance-focused intervention among young adult female indoor tanners found an attenuated increase in mean number of indoor tanning sessions from baseline to 6 months in the intervention group (mean, 4.67-6.80 sessions in previous 3 months) compared with a larger increase (mean, 4.48-10.90 sessions) in the control group ($P < .001$).[34] No consistent patterns of intervention effectiveness by age or by intervention component were identified, although trials of longer duration or more contacts with participants tended to find intervention effects. Evidence for skin self-examination was more consistent. Of the 11 trials assessing skin self-examination,[26,29-32,38,39,42,43,45,46] 9 trials[26,29-32,42,43,45,46] (of tailored educational content, counseling, or standard mailings) found significant increases in self-reported skin self-examination compared with control conditions. Odds ratios for skin self-examination in intervention groups compared with control groups ranged from 1.16 to 2.64, with absolute differences in rates of skin self-examination ranging from 3.2% to 24.0% in favor of the intervention groups (Figure 5).

Harms of Interventions

Key Question 3. What are the harms of counseling interventions for skin cancer prevention (eg, increased time in the sun, reduced physical activity, vitamin D deficiency, and anxiety)?

No harms were assessed in pediatric trials. Two adult trials reported harms. One trial of counseling and promotional materials to encourage skin self-examination (n = 1356) found that more intervention group participants reported a skin procedure compared with the attention-control group between 0 and 6 months (8.0% vs 3.6%; mean difference, 4.4 [95% CI, 1.9 to 6.9]; $P < .001$).[29] However, between 6 and 12 months, proportions were similar between groups (3.9% vs 3.3%; mean difference, 0.6 [95% CI, −1.4 to 2.6]; $P = .50$.

In 1 study of a single primary care physician counseling session with risk assessment and feedback compared with no intervention (n = 217), a slightly higher proportion of adults in the intervention group vs control group reported worrying about developing melanoma, but this difference was not statistically significant (28.9% vs 18.4%; between-group difference not reported; $P = .16$).[30]

Association Between Skin Self-examination and Skin Cancer Outcomes

Key Question 4. What is the association between skin self-examination and skin cancer outcomes (melanoma, squamous cell, or basal cell carcinoma incidence, morbidity, or mortality)?

No studies met inclusion criteria.

Harms of Skin Self-examination

Key Question 5. What are the harms of skin self-examination?

No studies met inclusion criteria.

Discussion

This systematic review[16] was conducted to support the USPSTF in updating its 2012 recommendation on behavioral counseling for skin cancer prevention[11,12] and its 2009 I statement on skin self-examination for skin cancer detection.[13,14] Four new trials in pediatric populations[22,23,25,26] and 10 new trials in adult populations[26,29,30,32,38,39,42,43,46,47] met inclusion criteria, as did 2 pediatric trials[20,24] and 6 adult trials[31,34,37,40,41,45] included in the previous reviews. The body of evidence on the effect of behavioral interventions has increased substantially since the previous review and generally reaffirms its findings, adding new evidence on the effect of interventions on sunburn, skin cancer prevention behaviors, and skin self-examination. Most of the evidence available covered the behavioral outcomes of sun protection behaviors and skin self-examination; evidence was much more limited for indoor tanning and for health outcomes. Measures were heterogeneous enough to preclude pooling of results. **Table 3** and **Table 4** summarize findings for this evidence review.

All studies for KQ1 (sunburn, precursor lesions, or skin cancer) represent new evidence since the previous review. Across 9 fair- to good-quality pediatric and adult trials,[23,25,26,29,30,32,39,42,46] the body of evidence suggests no consistent association between interventions and sunburn frequency in adults or children. Baseline rates of sunburn were low in some but not all populations (for example, in 4- to 10-year-olds and their parents), so a floor effect may be possible. The body of evidence for nevi or cancer outcomes is limited to 2 fair-quality studies,[25,29] neither of which suggest that intervention affects nevi count or skin cancer over 12 months to 3 years of follow-up. No studies of sun protection–focused interventions among adults assessed skin cancer outcomes.

Small to moderate effects of behavioral interventions on increased sun protection behaviors were observed in studies of all age groups, though overall, adult trial results were more mixed and fewer studies demonstrated an intervention effect. The clinical significance of these incremental increases in behaviors is unclear. Few consistent patterns according to age or population risk factors were found. Intervention effects were not demonstrated for indoor tanning outcomes in adults in 2[30,46] of 3[30,34,46] studies.

Skin self-examination interventions focused on adults.[26,29-32,38,39,42,43,45,46] Relative to control conditions, interventions can increase rates of skin self-examination in young adults and adults. No trial exceeded 12 months, and repeated measures were reported in only 2 trials with mixed results.[29,43]

Potential harms of interventions—which can include vitamin D deficiency, reduced physical activity, paradoxically increased sun

Table 4. Summary of Evidence, by Key Question: Adult and Young Adult Trials[a]

No. of Studies, No. of Observations	Summary of Findings by Outcome	Consistency and Precision	Reporting Bias	Study Quality[b]	Body of Evidence Limitations	EPC Assessment of Strength of Evidence	Applicability
KQ1: Intermediate and Health Outcomes							
7 RCTs n = 5315 (All 7 trials identified in update)	Of 6 trials, 1 (n = 965; 86% white; young adults, mean age, 22 y) reported an intervention effect for self-reported sunburns at 3-mo follow-up. All other trials were conducted among adults with broader age ranges, and none found an intervention effect. One trial of skin self-examination promotion (n = 1356) reported minimal cases of melanoma, NMSC, and atypical nevi, and no between-group differences at 12-mo follow-up.	Skin cancer or nevi: NA Sunburn: Inconsistent, imprecise	Not detected	Overall: 2 good, 5 fair Cancer or nevi: 1 fair Sunburn: 2 good, 4 fair	Skin cancer or nevi: Single study with 12-mo follow-up, outcome assessment methods not clear. Sunburn: Baseline rates low in some studies; heterogeneous self-reported measures.	Skin cancer or nevi: Insufficient Sunburn: Low	Sunburn findings are likely applicable. Cancer and nevi findings possibly applicable in skin self-examination-focused intervention populations; unclear for interventions focused on sun protection behavior or indoor tanning.
KQ2: Behavioral Outcomes							
16 (15 RCTs, 1 nonrandomized controlled intervention study) n = 16 309 (10 trials identified in update)	Most trials found greater improvements in self-reported sun protection composite scores in intervention vs control participants at 3-mo to 2-y follow-up; 6 of 12 reported statistically significant between-group differences. Sunscreen use (4 trials) and intentional outdoor exposure (3 trials) were the most frequently reported improved behaviors. Of 3 indoor tanning trials, a study of female indoor tanners (n = 430; mean age, 19), found relatively smaller increases in indoor tanning sessions in the past 3 mo in the intervention vs control conditions at 6-mo follow-up. Nine of 11 trials showed an intervention effect for total, partial, or any skin self-examination. Of the 3 trials conducted in young adults (n = 1528), 2 reported intervention effects.	Sun protection: Reasonably consistent, imprecise Indoor tanning: Inconsistent, imprecise Skin self-examination: Reasonably consistent, imprecise	Not detected	Overall: 2 good, 14 fair Sun protection: 2 good, 11 fair Indoor tanning: 3 fair Skin self-examination: 2 good, 9 fair	Same limitations as listed in KQ2 (children and adolescents)	Sun protection: Low Indoor tanning: Low Skin self-examination: Moderate	Likely applicable to US primary care for predominantly fair-skinned populations; feasibility may vary.
KQ3: Harms of Intervention							
2 RCTs n = 1573 (both trials identified in update, both in adult populations)	Skin procedures were more common in the intervention group in 1 trial of skin self-examination promotion (n = 1356) at 6-mo, but not 12-mo, follow-up. Cancer worry did not differ between groups in 1 trial of counseling and risk assessment (n = 217). Neither trial involved young adults.	NA	Not detected	2 Fair	Few studies; outcome measurement not well described.	Insufficient	May be applicable
KQ4: Association Between Skin Self-examination and Outcomes							
No studies	NA	NA	NA	NA	NA	Insufficient	NA
KQ5: Harms of Skin Self-examination							
No studies	NA	NA	NA	NA	NA	Insufficient	NA

Abbreviations: EPC, Evidence-based Practice Center; KQ, key question; NA, not applicable; NMSC, nonmelanoma skin cancer; RCT, randomized clinical trial.

[a] One study (Glanz et al[26]) reported outcomes for both children and adults.

[b] Quality assessed using criteria from the US Preventive Services Task Force methods.[15]

exposure through false reassurance, cancer worry, or overtreatment after skin self-examination—were rarely assessed. Based on a single fair-quality trial, skin procedures may increase in the first 6 months after a skin self-examination–focused intervention, without a corresponding increase in cancer detection.[29] Given the paucity of evidence for favorable association between skin self-examination and melanoma mortality or between skin self-examination and cancer detection (discussed in KQ1), increased use of biopsy resulting from skin self-examination remains a potential harm. Skin cancer worry did not differ between groups at follow-up in 1 adult study.[30]

There were few patterns suggesting that specific intervention components, settings, or delivery inform intervention effectiveness. Higher-intensity interventions, those that reinforced messages over time, or those with multiple intervention components were most likely to find an intervention effect. The 2 pediatric studies involving physician counseling also included other components such as print materials and sunscreen samples and found improvements in sun protection behaviors relative to controls, but the 2 adult studies involving physician counseling—both single-session interventions—found no intervention effect. Family-focused and electronically delivered interventions, perhaps combined with in-person counseling, may represent promising approaches for future interventions.

In the case of sparse data from trials on the direct link between interventions and health outcomes, assessment of observational evidence for associations between the behaviors that might result from interventions and health outcomes may help contextualize the findings. In its 2012 recommendation, the USPSTF found convincing evidence linking UV radiation exposure during childhood to a moderately increased risk for melanoma later in life (range of odds ratios, 1.8-4.4); and for adults, adequate evidence linking UV radiation exposure from outdoor recreational activities to an increase in melanoma risk (range of odds ratios, 1.3-5.0) based on case-control and cohort studies of fair to good quality.[11,48]

Recent observational studies generally confirm this evidence, suggesting even stronger evidence for the risks of indoor tanning use[49-60] and mixed evidence on the association between melanoma development and ambient sun exposure, typically assessed based on geographic location.[61-65] Follow-up data from a randomized trial suggest a protective effect for sunscreen use and risk of invasive, but not in situ, melanoma development in adults.[66] One large population-based study, also confirming the findings of the previous evidence review, found increased risk of both melanoma incidence and death attributable to melanoma with increasing quartile of UV exposure.[61,65] Reduced physical activity and vitamin D deficiency, potential harms of sun protection behavior, have not been detected in observational studies. Increased sunscreen use was associated with increased sunburns in cross-sectional studies,[67,68] suggesting a potential false-reassurance pathway, but no included trials found evidence for this potential harm.

Reductions in UV exposure could prospectively reduce skin cancer risk. However, the best evidence would likely come from trials such as those included in this review, and no data beyond 3 years were available.

The 2009 USPSTF review on skin cancer screening found no new evidence for the effectiveness of either skin examination by a physician or skin self-examination in reducing the morbidity or mortality of skin cancer, but the review discussed 1 fair-quality case-control study.[13,14] A 20-year follow-up study of this same population published in 2016 found no beneficial association between skin self-examination and death attributable to melanoma. However, a more expansive measure of skin awareness did appear to be a significant independent predictor of melanoma death.

In general, study populations were likely applicable to white or fair-skinned US primary health care populations. All intervention components are theoretically implementable or referable from primary care, although the ability of individual clinicians and practices to initiate intervention components likely varies widely.

The body of evidence was limited by short follow-up times (up to 3 years for children, up to 2 years for adults, 3-6 months in most studies), so it is possible that time frames were not sufficient to allow for detection of nevi or cancer events. In addition, trials of behavioral interventions used self-reported outcomes, which are subject to bias. The clinical relevance of incremental changes in composite measures of sun protection behaviors is difficult to assess. There were no new studies among children aged 0 to 3 or adolescents, and few studies among young adults. Skin cancer outcomes were reported only in a single study focused on skin self-examination.

Limitations

Limitations of the review approach include its focus on interventions conducted in or referable from primary care, its exclusion of multilevel interventions in which the effect of a primary care component could not be assessed, and its exclusion of populations of current survivors of skin cancer. Interventions were excluded if they took place in worksites, schools, or other community settings, since those are reviewed by the Community Preventive Services Task Force.[69,70] Thus it is unknown how these results can be interpreted relative to interventions in other contexts.

Conclusions

Behavioral interventions can increase sun protection behavior, but there is no consistent evidence that interventions are associated with a reduction in the frequency of sunburn in children or adults and minimal evidence on skin cancer outcomes. Intervention can increase skin self-examination in adults but may lead to increased skin procedures without detecting additional atypical nevi or skin cancers.

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Concept and design: Henrikson, Morrison, Blasi, Nguyen, Patnode.
Acquisition, analysis, or interpretation of data: All authors.
Drafting of the manuscript: Henrikson, Morrison, Blasi, Nguyen, Shibuya.
Critical revision of the manuscript for important intellectual content: Henrikson, Morrison, Blasi, Nguyen, Patnode.
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