



Skin cancer knowledge, attitudes, beliefs, and prevention practices among medical students: A systematic search and literature review [☆]

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ABSTRACT

Background: As future physicians, medical students will play an important role in the prevention of skin cancers by becoming directly involved in skin cancer prevention education and counseling patients about the hazards of ultraviolet light.

Objective: We assessed the skin cancer-related knowledge, attitudes, beliefs, and prevention practices reported in previous studies of medical students.

Methods: The search for relevant articles was performed in four electronic databases: PubMed (Medline), Cumulative Index to Nursing and Allied Health, ERIC, and PsycINFO. Studies were included if they met the following criteria: 1) targeted medical students; 2) assessed sun avoidance, sun protection, skin self-examination, and/or indoor tanning behaviors; 3) were published in peer-reviewed journals; and 4) complete data were available for extraction.

Results: A total of 21 studies are included in this review. Important findings include moderate-to-high levels of skin cancer knowledge and low levels of both sunscreen and ultraviolet light knowledge. The attitudes and knowledge of medical students reflect a low level of concern with regard to the perceived importance of skin cancer compared with other forms of cancer despite a high level of concern for the importance of skin cancer prevention. Furthermore, this review demonstrated that medical students fail to protect themselves routinely from the sun and have a high interest in tanning bed use.

Conclusion: This review demonstrates the need to educate medical students about skin cancer and skin cancer preventive behaviors. New strategies and educational campaigns should be developed to communicate better information on skin cancer morbidity, mortality, and prevention to medical students. This will pay dividends by improving the practice of these future physicians in all specialties.

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Introduction

The incidence of skin cancer is very high in many countries. It represents the most commonly diagnosed cancer in the United States, with 5.4 million nonmelanoma skin cancer cases treated annually

(Rogers et al., 2015). Melanoma, one of the most serious forms of skin cancer, has the ability to metastasize and become life-threatening (Isvy et al., 2012). In 2017, it was estimated that 87,110 new cases of melanoma will be diagnosed in the United States and 9730 individuals are expected to die from this disease (American Cancer Society [ACS], 2017a).

In Australia, skin cancer accounts for 75% of all cancers. Furthermore, Australia has the world's highest age-standardized rate of

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melanoma, more than 12 times the average world rate in 2008 (Doran et al., 2016; Trakatelli et al., 2016). Throughout Europe, approximately 100,000 new cases of melanoma are diagnosed annually with 22,200 melanoma deaths per year (Cancer Research UK, 2014).

Solar and artificial ultraviolet (UV) exposure is the most significant preventable cause of skin cancer (Greinert and Boniol, 2011). Adequate methods of primary prevention help reduce the development of new skin cancer cases. The American Skin Cancer Society (2017) recommends the following primary strategies to prevent excess UV radiation exposure: 1) seek shade when out in the sun, especially in the middle of the day when UV radiation is strongest (between 10:00 a.m. and 4:00 p.m.); 2) wear protective clothing outside (i.e., long-sleeved shirts and long pants or long skirts); 3) use wide-brimmed hats; 4) use sunscreen with a sun protection factor of 30 or higher; and 5) avoid the use of tanning beds. Recommended secondary skin cancer prevention methods include the promotion of early detection, regular skin self-examinations (SSE), and professional skin examinations (Mahon, 2003). The combination of these approaches has been shown to decrease the burden and reduce the incidence, morbidity, and mortality of skin cancer (Greinert and Boniol, 2011).

A number of cancer organizations have developed social media, broadcast, and local educational programming to raise skin cancer awareness and promote preventative measures (ACS, 2017b; Cancer Council Australia, 2016; Cancer Research UK, 2014; Skin Cancer Foundation, 2017). However, physicians and other health care professionals serve as key sources of health information for millions of individuals (Liu et al., 2001). As future physicians, medical students will play an important direct role in the prevention of skin cancer by becoming involved in skin cancer prevention educational activities and counseling patients about the hazards of UV light (Isvy et al., 2013). Their skin cancer knowledge, attitudes, beliefs, and prevention practices are therefore important in decreasing the future burden of skin cancer. For this reason, we reviewed and assessed the skin cancer-related knowledge, attitudes, beliefs, and prevention practices previously reported among medical students.

To the best of our knowledge, no review of this kind has been previously conducted. The resulting data will hopefully be beneficial in establishing the current knowledge base in these areas, identifying knowledge gaps, and informing the design and implementation of future skin cancer prevention interventions that target medical students.

Methods

Eligibility criteria

Studies were included based on the following criteria: 1) study participants were students who were working on their doctorate in medicine; 2) the studies were included in the PubMed (Medline), Cumulative Index to Nursing and Allied Health (CINAHL), ERIC, and PsycINFO databases; 3) the studies measured at least one of the following variables: Sun avoidance, sun protection, SSE, and/or indoor tanning behaviors; 4) all study designs were considered; 5) both English and non-English studies were considered; 6) there was no restriction on the date of publication; 7) the studies were published in peer-reviewed journals to the best of the reviewers' knowledge; and 8) the studies contained complete data for extraction.

Studies were excluded on the basis of the following criteria: 1) duplicate studies; 2) incomplete or ongoing studies; 3) literature reviews; 4) conference abstracts; 5) studies that focused clinical features or treatment of skin cancer; 5) studies that did not sample students who were pursuing a doctorate in medicine; and 6) studies that were not included in the PubMed (Medline), CINAHL, ERIC, and PsycINFO databases.

Literature search strategy

The search for relevant articles was performed in four electronic databases: PubMed (Medline), CINAHL, ERIC, and PsycINFO. To avoid missing any important studies, we conducted additional searches using Google Scholar. Two independent reviewers performed the literature search, and the search was not limited by a time frame. Combinations of the following keywords were used: "sun protection", "skin Cancer", "suntan use", "melanoma", "skin self-examination", "skin cancer screening", "indoor tanning", "knowledge", "awareness", "attitudes", "beliefs", "perceptions", "practice", "behaviors", "prevention", "safety", "screening", and "medical students".

The studies were reviewed to eliminate any duplicates and ensure that the inclusion criteria were met. Titles, abstracts, and full texts were reviewed to determine the inclusion and exclusion criteria. The reference lists of the primary literature were reviewed and checked to obtain any additional related studies. Finally, researchers performed a screening of all included literature studies to ensure that all work met the predefined eligibility criteria. Any questions with regard to the eligibility criteria were resolved between the two reviewers.

Two independent reviewers read through the full articles and extracted the data needed from the articles. All medical students included in the sample size were confirmed to be students who were working on their doctorate in medicine. The extracted data were crosschecked by both reviewers, and any discrepancies were discussed until a consensus was reached.

Results

A total of 231 citations were identified through electronic search engines. After eliminating duplicates, a total of 167 articles remained and underwent a screening process based on titles and abstracts, resulting in the elimination of 119 articles. The remaining 48 articles were analyzed meticulously to determine inclusion criteria eligibility. An additional three articles were identified after a thorough examination of reference lists. In the present review, 21 articles met the eligibility criteria and were included (Fig. 1). The results are reported in Table 1, which was organized chronologically by publication date.

Study characteristics

A total of 21 studies from 1998 through 2017 were reviewed. Studies were conducted in the United States (n = 4), Australia (n = 2), Brazil (n = 2), Peru (n = 2), Albania (n = 1), Canada (n = 1), England (n = 1), France (n = 1), Hungary (n = 1), Malaysia (n = 1), Pakistan (n = 1), Poland (n = 1), Romania (n = 1), Sweden (n = 1), and Turkey (n = 1). All studies employed quantitative, survey-based data collection methods, except for one that used qualitative, focus-group interviews (Nanyes et al., 2012). Sample sizes ranged from 50 to 1445 medical students. Among the studies that provided medical students' sex, nine studies reported a higher proportion of female medical students (Awadh et al., 2016; Bilushi et al., 2012; Guile and Nicholson, 2004; Isvy et al., 2012; Jerkegren et al., 1998; Purim and Wroblevski, 2014; Rodriguez-Gambetta et al., 2016; Scott et al., 2017; Zuba et al., 2016). Furthermore, the mean age range of medical students in the nine studies that reported these data was 20.3 to 25.01 years (Bilushi et al., 2012; Gillani et al., 2001; Jerkegren et al., 1998; Patel et al., 2010; Purim and Wroblevski, 2014; Romani et al., 2005; Shahnam et al., 2015; Sweni et al., 2010; Zuba et al., 2016).

Skin cancer-related knowledge, attitudes, and beliefs

Skin cancer knowledge among medical students varied from a moderate to a high level across the literature (Forsea et al., 2012;

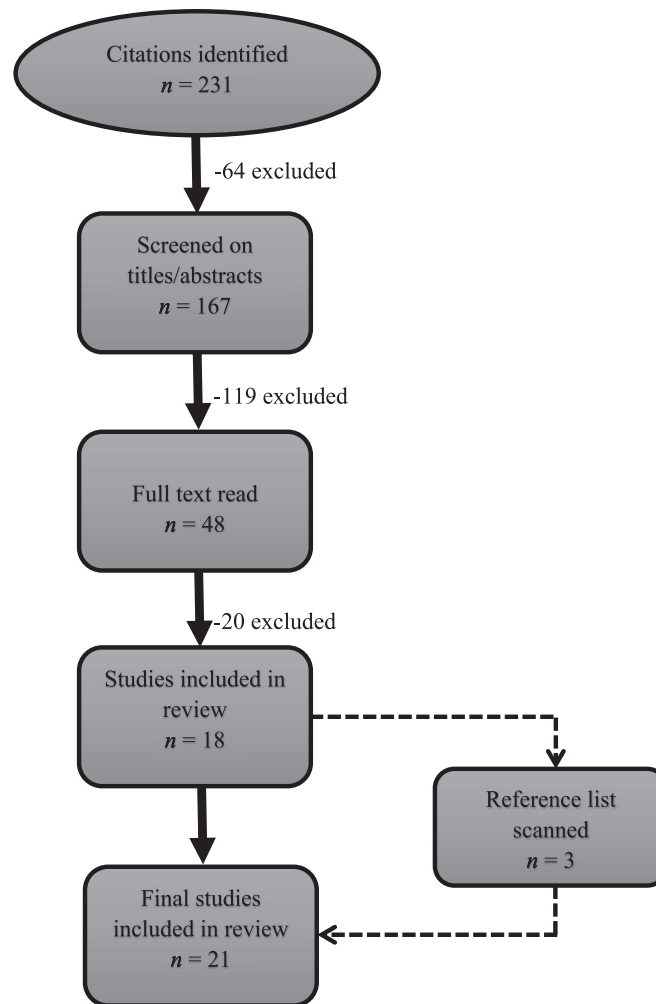


Fig. 1. Flow diagram of literature review

Gillani et al., 2001; Gooderham and Guenther, 1999; Guile and Nicholson, 2004; Jerkegren et al., 1998; Patel et al., 2010; Romani et al., 2005). Senior medical students consistently demonstrated higher knowledge scores in comparison with first-year medical students (Jerkegren et al., 1998; Purim and Wroblewski, 2014). For example, when compared with second-year medical students, fourth-year medical students were more likely to know that basal cell carcinoma was not the most dangerous type of skin cancer (Hymowitz et al., 2006).

In contrast, however, sunscreen and UV light knowledge survey questionnaire results indicated deficiencies in student knowledge. For instance, 72.4% of students erroneously considered particulate air pollution to be a factor that affects UV index (Isvy et al., 2012; Ozuguz et al., 2014). Most students understood the major causes of skin cancer but lacked knowledge about the appropriate use of sunscreen (Rodriguez-Gambetta et al., 2016). For example, only 23.1% of medical students knew that sunscreens should still be applied on cloudy days (Awadh et al., 2016; Rodriguez-Gambetta et al., 2016). Focus-group interviews of medical students conducted by Nanyes et al. (2012) further revealed that most medical students did not know the meaning of the sun protection factor numbers and were confused about the proper application of sunscreen.

Despite gaps in skin cancer knowledge, studies showed that more than 90% of medical students were aware that sun protection, sun

awareness education, and sunscreen use is important for one's health (Forsea et al., 2012; Gooderham and Guenther, 1999; Patel et al., 2010; Rodriguez-Gambetta et al., 2016). However, 78% of medical students cosmetically valued naturally tanned skin, and 58% enjoyed sunlight and did not want to restrict their exposure (Hymowitz et al., 2006). When these attitudes were compared between men and women, 12.2% of female medical students compared with 4.6% of male students valued looking tanned (Rodriguez-Gambetta et al., 2016). The focus-group interview data collection demonstrated that the most common reason that medical students ignored skin cancer was because it was not perceived to be as life-threatening as other cancers, such as lung and breast cancer (Nanyes et al., 2012).

Skin cancer prevention practices

With regard to skin cancer protective behaviors, Shahnam et al. (2015) revealed that 80% of medical students used fewer than three methods of sun protection concurrently. Approximately 70% of medical students avoided the sun as a measure of prevention (Forsea et al., 2012). Sun avoidance practices, however, differed by sex, with more female medical students than male medical students displaying sun avoidance behavior (Isvy et al., 2012; Patel et al., 2010).

Table 1
Summary of included studies

| First author; year; country | Data collection procedure, sample size, and demographics | Knowledge, attitudes, and beliefs | Skin cancer prevention practices |
|--------------------------------------|--|--|---|
| Jerkegren et al., 1998; Sweden | Questionnaire, n = 154 (medical students: 55.8% first semester, 44.2% 10 th semester), 57.8% female, mean age = 22.6 years (first semester), 28 years (10 th semester) | Melanoma, risk factors, and sun protection knowledge mean score (0–25): • first-semester medical students = 18.1 (moderate) • 10 th -semester medical students = 21.4 (high) | • Sun-related behavior mean score (85–400): first-semester medical students = 253; 10 th -semester medical students = 252 • Sunbed use mean score (70–300): first-semester medical students = 121; 10 th -semester medical students = 118 • High sun exposure: first-semester medical students = 21%; 10 th -semester medical students = 20% |
| Gooderham and Guenther, 1999; Canada | Questionnaire, n = 79 (first-year medical students), 59.5% male, 53.2% Caucasian, 88.6% age 20–25 years | Knowledge: mean score = 10 (SD = 2.3) of a maximum score of 16 (moderate). Students answered correctly as follows: • 38% how many moles does the average person have • 32.9% what is the lifetime risk for Canadians of developing skin cancer, • 19.0% the most common skin cancer • 94.9% you are adequately protected from UV rays with thin cloud cover • 92.4% tanning salons offer a safe alternative to sun-tanning outdoors • 76.0% people with many moles are at an increased risk of developing melanoma • 74.7% squamous cell carcinoma is the least serious type of skin cancer • 25.3% darker clothing offers greater protection against the sun tan lighter clothing • 26.6% wet clothing offers less protection against the sun than dry clothing • 74.7% when you are swimming in a pool, the part under water is protected from the sun because water reflects most if not all harmful UV rays • 88.6% the use of self-tanning creams or lotions to color the skin is an effective method to prevent sunburn • 50.6% the ozone layer filters most of the UV-B rays but little or none of the UV-A rays • 87.3% a suntan offers adequate protection to prevent sunburn • 84.8% chemical sunscreens give optimal protection as soon as they contact the skin • 88.1% what does SPF stand for • 9.2% what are the ABCDs of melanoma detection. 54.6% felt that a tanned appearance is healthy and 94.6% felt that sun awareness teaching is important to prevent skin cancer. | • In the past summer, I scheduled outdoor activities: 19.2% (around noon); 25.6% (early in morning/late in afternoon); 55.2% (did not give any thought to time of day) • Sun protection when outdoors: 16.7% (never/rarely); 42.3% (sometimes); 4.1% (usually/always) • Regular use of sun protection: 50.0% female; 34.8% male • SPF use on the body: 24.4% (SPF <15); 52.6% (SPF 15–29); 23.1% (SPF ≥15) • SPF use on the face: 19.2% (SPF <15); 5.5% (SPF 15–29); 17.2% (SPF ≥15) • This past summer, clothing use when outside: 69.2% (shirts and T-shirt); 3.9% (shorts and long-sleeved shirt); 24.4% (long pants and T-shirt); 2.6% (long pants and long-sleeved shirt) • In this past year, use of hats: 28.2% (did not use); 51.3% (occasionally wear baseball cap); 3.9% (occasionally wear Tilley style with wide brim); 16.7% (routinely wear baseball cap); 0% (routinely wear Tilley style with wide brim) • Tanning salon use: 79.5% (did not use); 15.4% (1–2 times); 1.3% (before vacations); 2.6% (periodically); 1.3% (routinely) |
| Gillani et al., 2001; Pakistan | Questionnaire, n = 71 (second-year preclinical medical students), 66% male, mean age = 20.3 years, median age = 20 years (range, 18–25 years) | Skin cancer knowledge mean score: 77% (SD = 11.5, range, 45–96%) (moderate). Students were aware as follows: • 46%, that skin cancer is the most common of all cancers globally • 55%, of individuals at increased risk of developing MM • 87%, of the body site where MM could occur • 44%, that the appearance of a new mole is associated with increased risk of developing MM • 87%, that the change in appearance of a mole is associated with increased risk of developing MM • 87%, of inherited risk • 85% of the fatality associated with MM • 99%, of skin complexion risk • 96%, of sun exposure risk | • Use sunscreen: 64.8% (never); 11.3% (always); 13.9% (sometimes) • Use sunblock year-round: 77.5% (never); 7.0% (always); 15.5% (sometimes) • Wear protective clothing on the beach: 43.7% (never); 4.2% (always); 52.1% (sometimes) • Wear cap in the sun: 52.1% (never); 4.2% (always); 43.7% (sometimes) • Wear sunglasses: 64.8% (never); 5.6% (always); 29.6% (sometimes) |
| Guile and Nicholson, 2004; England | Questionnaire, n = 154 (fourth- and fifth-year medical students), 64% female, 97% age 18–30 years | Mean knowledge score: 13.39 of a maximum score of 18 (moderate) | Mean behavior score: 22.32 Mean exposure score: 8.55 of a maximum score of 28 Mean protection score: 7.97 of a maximum score of 15 • Use sunscreen: 46% (usually); 15% (sometimes); 21% (rarely); 18% (never) • Sunbathe with intention of tanning: 33% (never); 15% (rarely); 28% (occasionally); 21% (quite often); 3% (very often) |

Table 1 (continued)

| First author; year; country | Data collection procedure, sample size, and demographics | Knowledge, attitudes, and beliefs | Skin cancer prevention practices |
|-----------------------------|---|--|--|
| Romani et al., 2005; Peru | Questionnaire, n = 190 (final-year medical students), 58.4% male, mean age = 25.01 (SD = 1.79) years (range, 22–33 years) | <p>Knowledge: mean score = 11.5 (SD = 3.3) with a minimum of 2 and maximum of 19 of a total score of 20 (moderate).</p> <p>Students' level of knowledge:</p> <ul style="list-style-type: none"> • 18.4% high level • 56.3% intermediate level • 25.3% low level • 8.4% knew four semiological diagnostic criteria melanoma (ABCD) • 59.3% knew most common skin cancer • 71.8% knew most dangerous skin cancer • 38.8% believed that it is healthy to be tanned • 36.7% felt better when they are tanned • 29% had favorable attitude toward sun protection measures <p>For "what attitude they would take if they were exposed to the sun," students answered:</p> <ul style="list-style-type: none"> • 58.2% always use sunscreen • 46.9% wear sunglasses sometimes • 48.9% sometimes use umbrella • 59.3% use clothes to cover up skin | <ul style="list-style-type: none"> • 43.2% used sunscreen in the last 6 months, of whom 54.3% use sunscreen sometimes and 6.2% always • 126 students answered the question "what part of your body uses sunscreen": 64.3% used "throughout the exposed areas" • Among those who use sunscreen, 55.5% use SPF >30 • Among 31.6%, protection is applied 15–30 min before exposure • Of the students who go to the beach regularly: 27.4% are exposed to the sun between 2–4 hr, 17.8% >4 hr • Only 17.4% students had adequate practice • Female students are 60% less likely to have inadequate practice sun protection than male students |
| Hymowitz et al., 2006; USA | Questionnaire, n = 238 (second- and fourth-year medical students), 62% male | <ul style="list-style-type: none"> • Fourth-year students compared with second-year students were more likely to know that basal cell carcinoma was not the most dangerous type of skin cancer (88% vs. 56%) and that melanoma most often occurs on the back in men (70% vs. 42%) and on the legs in women (44% vs. 16%) • 78% of students valued tanned skin, 58% enjoyed the sun and did not want to limit their exposure, 44% tried to get a tan while out in the sun | <ul style="list-style-type: none"> • 59% use sunscreen sporadically (more commonly reported by male than female students; 65% vs. 51%; OR: 1.78; 95% CI, 1.04–3.05) • 43% had never performed a skin self-examination (second-year students were less likely than fourth-year students to perform skin self-examination; 52% vs. 30%) |
| Doshi et al., 2007; USA | Questionnaire, n = 67 (third-year medical students: Pre-intervention n = 50; control n = 17) | <p>Attitude toward effects that make people look most attractive (pre-intervention vs. control):</p> <ul style="list-style-type: none"> • very dark, bronze suntan (2% vs. 0%) • light brown suntan (46% vs. 47.09%) • a little color from the sun (16% vs. 23.53%) • staying your natural skin color (16% vs. 29.41%) <p>Sufficiently protected from the sun if only apply sunscreen for protection (pre-intervention vs. control):</p> <ul style="list-style-type: none"> • strongly agree (2% vs. 0%) • agree (48% vs. 41.18%) • neutral (6% vs. 11.76%) • disagree (36% vs. 41.18%) • strongly disagree (8% vs. 5.88%) <p>Spend more time in the sun when applying sunscreen for protection (pre-intervention vs. control):</p> <ul style="list-style-type: none"> • strongly agree (24% vs. 0%) • agree (56% vs. 76.47%) • neutral (6% vs. 5.88%) • disagree: (14% vs. 17.65%) • strongly disagree: (0% vs. 0%) <p>Find it difficult to protect yourself from the sun (pre-intervention vs. control):</p> <ul style="list-style-type: none"> • strongly agree: (30% vs. 5.88%) • agree: (34% vs. 29.41%) • neutral: (6% vs. 5.88%) • disagree: (26% vs. 52.94%) • strongly disagree (4% vs. 5.88%) | – |
| Patel et al., 2010; USA | Questionnaire, n = 270 (medical students: 49.4% first-year, 50.6% second-year), 56.7% male, 54.3% non-Hispanic white, mean age = 23.5 (SD = 2.8) years (range, 20–40 years) | <p>Sun protection and skin cancer knowledge: mean score = 90 (SD = 13.2), men 87.7% (SD = 14.8), women 93.1% (SD = 9.8; high)</p> <ul style="list-style-type: none"> • I think sun protection is important: men 92.5%, women 100.0% ($p < .001$) • I like looking tan: men 66%, women 76.3% • I forget to use sun protection methods: men 58.0%, women 57% • sunscreen is too expensive: men 24.7%, women 20.8% • darker-skinned individuals do not need sun protection: men 25.3%, women 8% ($p < 0.001$) • I do not have enough time to apply sunscreen: men 16.6%, women 16.8% | <p>Sun avoidance: men 3.25 (SD = 0.95), women 3.52 (SD = 0.83)</p> <p>Sun protection behaviors (1 = very unlikely; 5 = very likely):</p> <ul style="list-style-type: none"> • Use sunscreen: men 2.94 (SD = 0.84), women 3.51 (SD = 0.79) • Other measures (wear sunglasses, wear hats, conduct skin self-examination, avoid tanning salons and booths): men 2.91 (SD = 0.68), women 3.09 (SD = 0.63) |

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Table 1 (continued)

| First author; year; country | Data collection procedure, sample size, and demographics | Knowledge, attitudes, and beliefs | Skin cancer prevention practices |
|-------------------------------|--|--|---|
| | | <ul style="list-style-type: none"> • sun protection is important while driving: men 34.5%, women 56.5% ($p < .001$) • sun protection is important for sun exposure <1 hr: men 50%, women 75.9% ($p < .001$) • I think I am at risk for skin cancer: men 44.9%, women 55.8% • sun exposure is the most important risk factor in causing skin cancer: men 70.8%, women 85.8% ($p = .002$) • geography is the most important risk factor in causing skin cancer: men 34%, women 57.1% ($p = .003$) • family history is the most important risk factor in causing skin cancer: men 55.8%, women 65.5% | |
| Sweni et al., 2010; Hungary | Questionnaire, n = 228 (second-year medical students and beyond), mean age = 24 (SD = 4.9, range 17–25 years) | – | <ul style="list-style-type: none"> • Use sunscreen: 70% • Use special clothing (full-length sleeves, caps) for protection: 66% |
| Bilushi et al., 2012; Albania | Questionnaire, n = 150 (medical students), 78% female, mean age = 20.05 (SD = 0.93) years (median = 20 years, mode = 20 years) | – | <ul style="list-style-type: none"> • 32% protect against sun on daily activity, 59.3% sometimes, 8.7% do not • 34% protect against sun on the beach, 56.7% occasionally protect, 9.3% do not protect • 84.7% use protection means against the sun (e.g., umbrella, sunscreen, hat) on the beach, 13.3% occasionally, 2% do not • 53.3% carefully inspect their skin for spots or sunburns |
| Forsea et al., 2012; Romania | Questionnaire, n = 150 (final-year medical students) | <p>Knowledge related to skin cancer: mean score = 22.4–24.8 of a maximum score of 29 (moderate to high)</p> <ul style="list-style-type: none"> • 66% believed tanned people are more attractive • 8% tanned people have better health • 3% worth burning to get a good tan • 55% I look better with a tan • 95% it is important for my health to use sunscreen | <p>Sun protection in summer:</p> <ul style="list-style-type: none"> • 35.6% (sunscreen on exposed areas) • 50% (sunglasses) • 10.6% (wide-brim hat) • 15.15% (long sleeves) • 70.45% (avoid exposure 10:00 a.m.–5:00 p.m.) <p>Use sunscreen:</p> <ul style="list-style-type: none"> • 8.8% (never) • 25% (sometimes) • 86.36% (on the beach) • 12.12% (on cloudy days) • 49.24% (summer) • 16.16% (winter) <p>Use sunscreen on vacation:</p> <ul style="list-style-type: none"> • 73.5% (several times/day) • 10.6% (one time/day) • 5.3% (only first few days) • 2.3% (sometimes) • 6.1% (never) <p>SPF used in sunscreens:</p> <ul style="list-style-type: none"> • 4.5% (SPF 2–6) • 19.7% (SPF 6–15) • 34.8% (SPF 15–25) • 31.8% (>25) <p>Interested in tanning: 69%</p> <p>Use UV tanning beds: 6.8%</p> |
| Isvy A; 2012; France | Questionnaire, n = 570 (fifth- or sixth-year medical students or first-year residents), 69.6% female | <ul style="list-style-type: none"> • 41.4% correctly identified peak UV risk 12:00 p.m.–4:00 p.m. • 73–95.8% responded months with the highest UV index were June, July, and August <p>Students erroneously considered as having impact on the UV index:</p> <ul style="list-style-type: none"> • wind (16.8%) • particulate air pollution (72.4%) • high temperature (29.6%) • high relative humidity (43.9%) <p>Environmental factors considered to not affect or to have lowering effect on UV index:</p> <ul style="list-style-type: none"> • clouds (29.8%) • elevated ozone layer (21.8%) <p>Medical students knew:</p> <ul style="list-style-type: none"> • >90% that sunburns in childhood induce problems in adulthood, sun causes photoaging, tanning can occur while swimming and during cloudy weather, and tanning-bed use is a risk factor for skin cancer • 22.5% that sunscreen use allowed longer sun exposure | <ul style="list-style-type: none"> • Avoid peak hours: 53.8% men, 61.5% women • Seek shade: 64.2% men, 58.9% women • Use sunscreen: 59% of men, 82.4% of women • Clothes with long sleeves: 6.9% men, 11.6% women • Cap or hat: 30.1% men, 31.2% women • Sunglasses: 66.5% of men, 78.3% of women • Skin self-examination ≥ 1/year: 53.8% men, 64.0% women <p>Tanning bed use:</p> <ul style="list-style-type: none"> • 9.2% men and 15.4% women have ever used a tanning bed • 3.5% men and 5.8% women have used tanning bed 1 or 2 times • 2.3% men and 5.8% women have used tanning bed 3–5 times • 3.5% men and 3.8% women have used tanning beds more than 5 times |

Table 1 (continued)

| First author; year; country | Data collection procedure, sample size, and demographics | Knowledge, attitudes, and beliefs | Skin cancer prevention practices |
|------------------------------------|--|---|---|
| Nanyes et al., 2012; USA | Focus-group interviews, n = 80 (medical students) | <ul style="list-style-type: none"> • 67.7% thought tanning beds were forbidden for children • 16.1% thought photosensitive tablets allowed for shortening of the in-cabin exposure time • 10.2% thought that tanning beds are recommended for dark-skinned persons to prevent vitamin D deficiency • Students understand the causes of skin cancers but were confused about SPF and the proper use of sunscreen • Most students did not know the meaning of SPF numbers, what SPF sunscreen is most appropriate to use, how often to reapply sunscreen, whether sunscreen was immediately effective or required time to activate • Most common reasons for ignoring skin cancer was because it was not as scary as other cancers (i.e., lung and breast) • Other reasons for ignoring skin cancer: confusion about sunscreen, lack of understanding of risk of skin cancer, lack of realization that it could happen to them, lack of awareness of skin cancer, unwillingness to deal with the issue, and belief that prevention efforts might not pay off | Most students used a tanning bed or tanned in the sun to improve appearance |
| Ozuguz et al., 2014; Turkey | Questionnaire, n = 120 (medical students: 65% first-year, 35% sixth-year), 53.33% male | <ul style="list-style-type: none"> • 70% of students reported some knowledge of sunscreen usage • 5% of students reported that sunscreen usage is not important. <p>Overall, the questionnaire revealed that both first- and sixth-year students' knowledge of sunscreen, UV light, and skin cancer is deficient.</p> | <ul style="list-style-type: none"> • 52.5% used sunscreen only while at the beach • 17.5 % used sunscreen throughout the summer • 3.3% used sunscreen all the time (throughout year) • 50% of first-year students and 31% of sixth-year students used clothing, hat, and sunglasses |
| Shahnam et al., 2015; Australia | Questionnaire, n = 255 (science students, including medical students), mean age (medical students) = 22.7 (SD = 1.02) years | – | <p>Medical students' data:</p> <ul style="list-style-type: none"> • 80% used less than three sun-protection methods concurrently • 53% seek shade • 24% use sunscreen • 21% wear protective clothing • 3% wear a hat • 38% wear sunglasses • Sun exposure: 31.5% (between 10:00 a.m. and 4:00 p.m.) • Use sunscreen: Not attended dermatology discipline: 50% (summer) and 9.1% (daily); attended dermatology discipline: 49.1% (summer) and 8.1% (daily) • Use sunscreen: Only in summer (76.4% of men; 29.4% of women), daily (9.8% of men, 7.3% of women), during exercise (9.2% of men, 58.3% of women; $p < .001$) • SPF used in sunscreens: Not attended dermatology discipline (4.5% [<15], 23.4% [15–25], 65.8% [>30]), attended dermatology discipline (8.7% [<15], 25.1% [15–25], 65% [>30]) • Cap, visor or hat: Not attended dermatology discipline (5.4%), attended dermatology discipline (9.1%) • Sunglasses: Not attended dermatology discipline (48.6%), attended dermatology discipline (55%) • SSE: Not attended dermatology discipline (20.9%), attended dermatology discipline (61.1%) • Perform or have already performed tanning: 4.3% |
| Purim and Wroblewski, 2014; Brazil | Questionnaire, n = 398 (72.1% have had attended discipline of dermatology, medical students: 20.1% first and second years, 59% third and fourth years, and 20.9% fifth and sixth years), 54.9% female, 87.4% White (color/race), mean age = 22.9 (SD = 3.1) years (range, 18–42 years) | <p>Not attended dermatology discipline: 30.6% knew ABCD rule and how to identify suspicious lesions</p> <p>Attended dermatology discipline: 69.6% knew ABCD rule and how to identify suspicious lesions</p> | <ul style="list-style-type: none"> • Use sunscreen: Only in summer (76.4% of men; 29.4% of women), daily (9.8% of men, 7.3% of women), during exercise (9.2% of men, 58.3% of women; $p < .001$) • SPF used in sunscreens: Not attended dermatology discipline (4.5% [<15], 23.4% [15–25], 65.8% [>30]), attended dermatology discipline (8.7% [<15], 25.1% [15–25], 65% [>30]) • Cap, visor or hat: Not attended dermatology discipline (5.4%), attended dermatology discipline (9.1%) • Sunglasses: Not attended dermatology discipline (48.6%), attended dermatology discipline (55%) • SSE: Not attended dermatology discipline (20.9%), attended dermatology discipline (61.1%) • Perform or have already performed tanning: 4.3% |
| Awadh et al., 2016; Malaysia | Questionnaire, n = 101 (final-year medical students), 63.4% female | <ul style="list-style-type: none"> • 27.7–78.2% knew that sunscreen is effective in preventing sunburn, skin aging, skin cancer, enhancing a tan, and reversing aging signs • 31.7–92.1% knew sunscreen should be applied during sunny day, cloudy day, attending indoor activities, at night, and while swimming in the pool, beach, waterfall • 7.9–67.3% knew when and how often to apply sunscreen on sunny days/outdoors, amount of sunscreen to cover entire body, what SPF stands | <ul style="list-style-type: none"> • Skin protection from sunlight: 25.7% no protection at all; 23.8% wearing hat/cap/umbrella; 16.8% moisturizer/lotion/powder • 36.6% use sunscreen; 20.8% use sunscreen occasionally; 10.9% once a day; 5.9% every morning and evening; 1.0% every 4 hr; 0% every 2 hr • Use sunscreen: 25.7% at the beach; 14.9% while exercising; 4.0% while shopping; 4.0% when attending lectures; 3.0% with other activities |

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Table 1 (continued)

| First author; year; country | Data collection procedure, sample size, and demographics | Knowledge, attitudes, and beliefs | Skin cancer prevention practices |
|---------------------------------------|--|---|---|
| | | <p>for, that sunscreen provides better protection when protection order is higher, and the risk of UV-A/B radiation</p> <ul style="list-style-type: none"> • 7.9–34.7% had their sunscreen use influenced by friends, family, health care professionals, and others • 53.5% encouraged the use of sunscreen to others • 9.9% encouraged the use of sunscreen for babies <6 months old • 40.6–79.2% agree that sunscreen is necessary to avoid the harmful effects of sun exposure, protect the skin from UV light, a must-have skin product, and part of a daily skincare routine • 17.9–25.8% agree that sunscreen application makes students happy and confident • 31.7% and 54.5% agree skin would have enough protection if one SPF-containing product is used and protecting clothing is enough to give secure protection from light, respectively • >90% knew that solar radiation is the major cause of skin cancer, darker skin also needs sunscreen, use of sunscreen prevents skin cancer • 72.9% knew a sunscreen of SPF 15 is not better than one of SPF 30 • 23.1% knew of the necessity of using sunscreen on a cloudy day • 72.9% knew that using sunscreen does not eliminate sun exposure risk • 87.0% agreed it is worth using sunscreen to avoid future health problems • 18.2% agreed that tanned people are more attractive • 6.7% agreed that tanned people are more healthy • 12.2% of female students agreed it is worth getting a sunburn to look tan compared with 4.6% male students | <ul style="list-style-type: none"> • Use sunscreen: 23.8% immediately before exposure to sun; 13.9% 30 min before exposure • 24.8% apply sunscreen only to exposed body parts; 14.9% on the face only; 2.0% on hands only, 0% on the entire body • 32.7% choose sunscreen based on SPF value, 5.9% price, 5.0% brand, 3.0% types of skin • Reasons for no sunscreen use: 29.7% unnecessary, 18.8% oily, 16.8% costly • 27.7% of students have people around them who use sunscreen |
| Rodriguez-Gambetta et al., 2016; Peru | Questionnaire, n = 299 (first-year medical students), 63.2% female, 53.5% age <18 years | <ul style="list-style-type: none"> • >90% knew that solar radiation is the major cause of skin cancer, darker skin also needs sunscreen, use of sunscreen prevents skin cancer • 72.9% knew a sunscreen of SPF 15 is not better than one of SPF 30 • 23.1% knew of the necessity of using sunscreen on a cloudy day • 72.9% knew that using sunscreen does not eliminate sun exposure risk • 87.0% agreed it is worth using sunscreen to avoid future health problems • 18.2% agreed that tanned people are more attractive • 6.7% agreed that tanned people are more healthy • 12.2% of female students agreed it is worth getting a sunburn to look tan compared with 4.6% male students | <p>During the summer:</p> <ul style="list-style-type: none"> • 66.9% walk in shadows • 28.8% do not go out in hours of higher radiation • 12.4% use an umbrella • 8.0% use long sleeves • 17.7% use hats/caps • 43.4% of female and 29.1% of male students use sunscreen • 34.9% of female and 21.8% of male students use long pants • 32.3% of female and 22.7% of male students use sunglasses with UV filters |
| Zuba et al., 2016; Poland | Questionnaire, n = 116 (medical students: 12% first year, 21.5% second year, 32.7% third year, 3.4% fourth year, 5.2% fifth year, 24.1% sixth year), 66.4% female, mean age = 22.3 (SD = 2.4) years (range, 19–28 years) | <ul style="list-style-type: none"> • 47.41% knew the definition of skin phototype • 63.71% gave correct definition of skin phototype • 85.71% knew that skin phototype restricts tanning times • 8.62% thought that tanning beds should be used no more than 15 min a year • 99.14% thought that sunglasses should be used during tanning in tanning beds • 64.04% defined sun protection factor properly • 47.41% knew what tanning means <p>Photosensitizing and phototoxic drugs:</p> <ul style="list-style-type: none"> • 33.33% tetracyclines • 0.00% ketoprofen • 3.60% psoralens • 9.01% retinoids • 9.91% contraceptive drugs <p>What adverse effects of sunbathing do you know:</p> <ul style="list-style-type: none"> • 27.93% skin aging • 28.83% sunburns • 76.58% skin cancers <p>What contraindications for sunbathing do you know:</p> <ul style="list-style-type: none"> • 29.73% pregnancy • 23.42% skin cancer • 7.21% use of photosensitizing drugs | <p>Indoor tanning approximately 15 (once per month/year)</p> |
| Nunes et al., 2017; Brazil | Questionnaire, n = 50 (medical students), 66% male, 74% age 21–25 year | <ul style="list-style-type: none"> • 40% knew that SPF indicates protection against UV-B • 10% knew that PPD indicates protection against UV-A • 6% consider sunscreen reapplication unimportant • Reasons for not using sunscreen: 34% (oiliness), 10% (price), 4% (smell), 30% (more than two reasons) | <ul style="list-style-type: none"> • Habit to expose to the sun without protection: 14% • No use of physical means to protect from sun: 26% • Up to 1 hr of daily sun exposure: 56% • Solar exposure at critical times (10–15 hr): 44% • Up to 2 hr of sun exposure from 2:00 p.m.–6:00 p.m.: 64% • Up to 2 hr of sun exposure on the weekend: 64% • Use sunscreen: 40% always on the face; 88% on the face (SPF ≥ 30); 20% always on the body; 82% on the body (SPF ≥ 30); 68% half hr before |

Table 1 (continued)

| First author; year; country | Data collection procedure, sample size, and demographics | Knowledge, attitudes, and beliefs | Skin cancer prevention practices |
|-------------------------------|---|--|---|
| Scott et al., 2017; Australia | Questionnaire, n = 1445 (medical students), 65% female, 92% age 18–30 years | <ul style="list-style-type: none"> • Intentionally tanning with knowledge that it may increase the risk of skin cancer: 28% • Common barriers to applying sunscreen or reapplying sunscreen: 78% forgetfulness, 44% greasiness | <p>exposure; 34% after swimming, perspiring, practicing physical activity; 38% only during the summer; 12% no sunscreen when practicing outdoor physical activity</p> <ul style="list-style-type: none"> • Do not tan frequently: 88% • Sun exposure (≥ 1 hr outdoor per day on weekends during summer months): 90% • Always or often use sunscreen during outdoor activities during the summer months: 70% • Recommend sunscreen amount used: 29% • Reapplying sunscreen: 20% (every 2 hr); 48% (every 4 hr); 14% (every 6 hr); 17% (never reapply sunscreen) • Reapplying sunscreen after swimming: 44% • Intentional tanning: 28% |

ABCD, asymmetry, border irregularity, color, and diameter; CI, confidence interval; MM, multiple myeloma; OR, odds ratio; PPD, persistent pigment darkening; SD, standard deviation; SPF, sun protection factor; SSE, self-skin examination; UV, ultraviolet

Recent use of sunscreen protection was reported among approximately 43% of medical students (Romani et al., 2005). Sunscreen use among medical students differed based on circumstances, with more students using sunscreen during vacations or beach activities (Forsea et al., 2012; Ozuguz et al., 2014). Sex played an important role in determining sunscreen use. Three studies demonstrated that female medical students were more likely to use sunscreen in comparison with their male counterparts (Isvy et al., 2012; Patel et al., 2010; Rodriguez-Gambetta et al., 2016). Additionally, Hymowitz et al. (2006) reported a more sporadic use of sunscreen among male students than female students.

Protective clothing was not popular among medical students. One study (Gooderham and Guenther, 1999) revealed that only 2.6% of medical students reported wearing long pants and long-sleeved shirts when outside, and another study (Gillani et al., 2001) indicated that 43.7% of medical students reported never wearing protective clothing on the beach. Moreover, 52.1% of students reported never wearing a hat or cap (Gillani et al., 2001). During a 1-year time span, approximately 28% of medical students indicated not using a hat or cap (Gooderham and Guenther, 1999).

The use of sunglasses among medical students ranged from approximately 49% to 55% (Ozuguz et al., 2014; Purim and Wroblewski, 2014; Shahnam et al., 2015). Similar to sunscreen use, a difference in the use of sunglasses was observed by sex, with female medical students wearing sunglasses more often than male students (Isvy et al., 2012; Rodriguez-Gambetta et al., 2016).

The focus-group interviews of medical students elucidated their use of both tanning beds and outdoor tanning (Nanyes et al., 2012). Although 69% of medical students reported an interest in tanning, only 6.8% of students used tanning beds (Forsea et al., 2012). Female medical students (3.8–15.4%) reported a higher number of tanning bed use than their male counterparts (2.3–9.2%; Isvy et al., 2012).

Among the studies that assessed SSE (Hymowitz et al., 2006; Isvy et al., 2012; Patel et al., 2010; Purim and Wroblewski, 2014), one study reported that 43% of medical students had never perform an SSE (Hymowitz et al., 2006). Another more recent study showed higher levels of SSE per year among women compared with men (64% vs. 54%, respectively; Isvy et al., 2012).

Discussion

The goal of this review was to examine the knowledge, attitudes, beliefs, and prevention practices of medical students from various

countries. As future physicians, medical students play a vital role in the primary prevention of skin cancer. Their level of skin cancer knowledge, attitudes, beliefs, and prevention practices will help shape future patient care and strategic decisions aimed at lowering the burden of skin cancer. This literature review of previous studies highlights important findings, including moderate-to-high levels of skin cancer knowledge and low levels of both sunscreen and UV light knowledge.

The attitudes and knowledge of medical students examined in this review reflect a low level of concern regarding the perceived importance of skin cancer compared with other forms of cancer, despite a high level of concern for the importance of skin cancer prevention. Furthermore, the use of sun protection is uncommon among medical students, and their interest in tanning bed use is high.

Research has shown a link between both melanoma and nonmelanoma skin cancers and sun exposure or UV radiation and that skin cancer may be preventable through the use of effective sun protection (Green et al., 1999). Medical students should, therefore, be encouraged to protect themselves effectively from UV damage and to provide their patients with the tools to practice preventive behaviors aimed at reducing skin cancer (Woloschuk et al., 2000). Unfortunately, due to the lack of knowledge regarding sunscreen use and UV protective behavior reported among the medical student samples, medical students may not have sufficient knowledge to promote the message of effective sun protection to future patients. Educational interventions and a focus on health promotion and disease prevention in the medical school curriculum is necessary to increase medical students' knowledge regarding skin cancer preventive behaviors.

Although the medical students in the reviewed studies indicated a high level of importance for skin cancer prevention, they also demonstrated a high value of tanned skin (Forsea et al., 2012; Gooderham and Guenther, 1999; Hymowitz et al., 2006; Patel et al., 2010; Rodriguez-Gambetta et al., 2016). This demonstrates the significance of appearance to these students and their resultant attitude toward tanning (Watson et al., 2013). Appearance-focused motivation is highly prevalent among the general population, especially among young women. The U.S. Preventative Task Force recommends behavioral counseling that incorporates appearance-focused messages to reduce the risk of developing skin cancer (Moyer, 2012). Thus, it may be prudent to develop and implement behavioral counseling for medical students focused on appearance. Such a program may assist in modifying medical students' personal attitudes toward tanning and may subsequently influence their future patient counseling.

Several studies reported differences by sex with regard to sun protective behavior. Female medical students reported a greater intention to use sun protective behavior, greater skin cancer knowledge, and more appreciation for sun protection than their male counterparts (Isvy et al., 2012; Ozuguz et al., 2012; Purim and Wroblewski, 2012; Rodriguez-Gambetta et al., 2016; Shahnam et al., 2015). A majority of male medical students (76.4%) were found to be unlikely to use sunscreen outside of the summer months, and 43% never used sunscreen (Purim and Wroblewski, 2012). Male medical students were also more likely to believe that having dark or tanned skin provides protection from skin cancer and less likely to utilize protective clothing (Isvy et al., 2012; Patel et al., 2010). These findings are concerning because although the number of female physicians is steadily increasing, the majority of physicians practicing in the United States (66%) and other countries are male (The Henry J. Kaiser Family Foundation, 2017).

Female medical students were found to be more likely to use sunscreen and wear protective clothing such as long sleeves and sunglasses (Isvy et al., 2012; Shahnam et al., 2015). However, female medical students were also more likely to value a tanned appearance, to have used a tanning bed, and to believe that a tanned appearance is worth risking a sunburn (Isvy et al., 2012; Rodriguez-Gambetta et al., 2016). The data suggest that both sexes are affected by a lack of knowledge, and even though female medical students were found to be more informed overall, they were also more negatively affected by perceptions of beauty. Attention should be placed on differences by sex in knowledge and behavior to decrease the disparity between male and female medical students to provide effective skin cancer prevention.

Although few studies assessed SSE, the majority of medical students in the reviewed studies were found to be less likely to perform an overall SSE. A previous study of college-aged students showed that common reasons for not performing an SSE were lack of education on how to perform an SSE, not remembering to do it, being unaware that one should do it, and a low perceived risk of skin cancer (Jensen and Moriarty, 2008). Female students were found to be more likely than male students to perform an SSE (49% vs. 17%), as were Caucasian students compared with students of other racial and ethnic groups (Arnold and DeJong, 2005).

Of particular concern is the finding that, among students who did perform an SSE, only 17.5% performed a thorough examination, leaving large areas (especially the upper back) unchecked. Skin cancer prevention counseling provided by a physician or nurse was found to be a key determinant of performing a thorough SSE, and individuals who visited a dermatologist were more likely to perform an SSE than those who did not (Arnold and DeJong, 2005). However, another study found that among those who noticed a change in a mole, 54% were either not planning to see a physician or were delaying their visit due to either low perceived threat or the cost of seeking medical attention. (Douglass et al., 1998). Future interventions should focus on eliminating these barriers and exploring strategies to enhance SSE performance among medical students. Additionally, medical schools may need to include a short transitional course to the curriculum on skin cancer protective behaviors during clinical training. Transitional courses have been successful in helping medical students develop needed clinical competencies (Chumley et al., 2005).

Limitations

This literature review should be considered within the context of several acknowledged limitations. First, the medical students in the reviewed studies were heterogeneous with respect to country of origin, and study samples were from several countries, including Albania, Australia, Brazil, Canada, England, France Hungary,

Malaysia, Pakistan, Peru, Poland, Romania, Sweden, Turkey, and the United States. The variation in country of origin limits the ability for generalizability and emphasizes the need for future research.

Second, the review was limited to four databases (PubMed [Medline], CINAHL, ERIC, and PsycINFO) and a comprehensive list of search terms. Although the authors attempted to screen all studies that met the inclusion criteria for the review, some studies may have been excluded unintentionally due to the use of the selected delimitations. However, the authors did not exclude studies on the basis of publication date or language in an effort to perform an exhaustive review based on the inclusion criteria.

Finally, although the reviewed studies provide important information with regard to medical students' perceptions of skin cancer, the findings do not indicate current skin cancer prevention practices among physicians or report longitudinal findings. Thus, the research team cannot determine causation between medical students' knowledge and perceptions in the reviewed studies and their interactions and counseling behavior with future patients.

Conclusion

The findings from this review indicate a need to educate medical students regarding susceptibility to skin cancer and skin cancer preventive behaviors. New strategies and educational campaigns should be developed to better communicate information regarding skin cancer morbidity, mortality, and prevention to medical students to improve the practice of future physicians in all specialties. Given the incidence rates of skin cancer, we believe it is necessary that more emphasis be placed on skin cancer within the medical school curriculum, both at the preclinical and clinical levels. To maximize primary prevention efforts for skin cancer, all medical students should be engaged, not just those anticipating a career in dermatology.

In addition, research suggests that differences by sex exist with regard to attitudes and practices related to sun-safe behaviors. Men and women appear to differ in how they respond to sun-safe practices. These differences should be underscored to diminish the biases identified in this review. Additional studies focusing on the effectiveness of specific educational techniques in preparing medical students will be important to have the best impact on this highly preventable disease. Doing so will strengthen the attitudes and practices of future physicians who can affect the morbidity and mortality rates associated with nonmelanoma skin cancer.

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