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The experience of outdoor physical activity for skin cancer survivors: understanding the importance of the built and natural environments

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Abstract

Purpose Cancer patients are encouraged to do more physical activity (PA). Exercising in outdoor settings, however, may expose people to UV radiation, which is the main risk factor of melanoma. This study aimed to understand how melanoma diagnoses affect people's perception of the outdoor environment for PA.

Method In-depth interviews were conducted among 19 individuals (20–85 years) with a history of melanoma at a skin cancer clinic in the Denver metropolitan area. Transcribed interviews were coded for emergent themes. The coding framework included topics related to PA behavior, sun protection, and perceptions of outdoor environment.

Results Respondents reported no change in their level of outdoor activity after the melanoma diagnosis; they tried to reduce the risk of sun exposure by using sunscreen and sun-protective clothing. They also reported seeking shade, trees, and groundcover along urban corridors, in order to avoid sun exposure, reflective surfaces, and heat while being active outdoors.

Conclusion Given the public health significance of UV exposure and extreme heat, further investments should be made to craft streetscape design guidelines and implement sun-proof spaces across public facilities, including parks, schools, and sport fields in order to ameliorate environmental risks for skin cancer survivors, to prevent future cancers among those that are vulnerable to the hazards of excessive UV exposure and extreme heat, and to promote outdoor PA.

Implications for Cancer Survivors Skin cancer survivors and other vulnerable population subgroups will benefit from discussions around neighborhood-based design interventions that promote PA while accounting for sun safety.

Keywords skin cancer · Physical activity · street environment · shade

Introduction

According to the American Cancer Society, only 5–10% of all cancers are caused by high-risk genes and are therefore hereditary [1]. For the other 90–95%, a healthy lifestyle, including healthy diet, smoking cessation, and exercise, can reduce the risk of occurrence and recurrence of cancer [2, 3].

A growing body of literature provides indisputable evidence about the positive role of exercise in preventing cancer reoccurrence, as well as alleviating the adverse effects of cancer and its treatment [4, 5]. Many organizations, including the American Cancer Society, have provided exercise guidelines for people with cancer. Similar to general exercise recommendations for adults [6], these guidelines encourage people to engage in at least 150 min of moderate-intensity physical activity (PA) or 75 min of vigorous-intensity PA each week. They recommend a range of exercise, such as walking, jogging, bicycling, and different sports that are mainly conducted outdoors [7]. Getting exercise in outdoor settings, however, may expose cancer patients to other environmental hazards that compromise their health. Although beneficial in helping the skin produce vitamin D, the ubiquitous UV exposure can be among the environmental hazards that can negatively impact skin, eyes, and the immune system [8].

Being exposed to UV radiation is particularly worrisome for people with a history of skin cancer. Data show that one in every five people in the USA develops at least one type of skin cancer during his/her life [9]. Skin cancer survivors are voluntarily or involuntarily exposed to UV, as they cannot restrict their entire lives to indoor settings. What distinguishes people with a history of skin cancer from the general population is the higher risk of future skin cancers or other malignancies due to

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excessive sun exposure [10–12], their subjective perception of this risk, and necessary preventive measures needed to minimize this risk [13, 14].

Sun exposure and skin cancer

Chronic and intermittent sun exposure are the main risk factors of all three major types of skin cancer: basal cell carcinoma (BCC), squamous cell carcinoma (SCC),[1] and melanoma [15, 16]. Sun exposure also may increase the possibility of developing new melanomas in people with a history of melanoma and keratinocyte (basal and squamous cell) carcinomas. Patients with melanoma are at 1.2 to 8.2% higher risk of developing another melanoma [10–12]. Evidence of the link between additional sun exposure and reoccurrence of melanoma is, however, inconsistent. Kricker suggests that sun protection can reduce the risk of future melanomas for people with a history of the disease [17]. Berwick et al. (2005) suggest a link between higher levels of sun exposure before diagnosis and decreased mortality from melanoma. The authors speculate that the beneficial relationship between sun exposure and survival from melanoma could be mediated by vitamin D [18]. In spite of the complex relationship between these behaviors and morbidity and mortality from melanoma, clinical recommendations for melanoma patients stress sun protection (applying sunscreen, wearing protective clothing, and seeking shade outdoor), as well as frequent follow-up visits, and skin self-examination [19].

Risk perception and preventive behavior among skin cancer patients

Cancer survivors are not consistent in adopting positive health behaviors or taking preventive measures after their diagnosis [20, 21]. According to the Protection Motivation Theory, the adoption of protective behaviors depends on an individual's appraisal of the threat and their perceived coping capability. The threat appraisal depends on the perception of the severity of the threat and the vulnerability of the individual. The coping appraisal ties to the individual's belief in the effectiveness of the adaptive measure (i.e., response efficacy), perceived capability of performing the adaptive behavior (i.e., self-efficacy), and the perceived cost of the preventive measure [22]. The acceptance or denial of the disease also predicts the adoption of health behaviors. Denial is a psychological escapism from the overwhelming distress of the disease. Patients in denial refuse to acknowledge the truth about their illness and may object to adopting preventive measures [23].

The fear of developing future cancers and the impact of the disease on social interactions and body image may motivate skin cancer patients to take primary preventive measures, such as sun protection, smoking cessation, diet improvement, and other behavioral changes [13]. Studies suggest that among melanoma patients, time since diagnosis, tumor stage, and comorbidity are predictors of negative Impact of Cancer (IOC)[2] scores. In that increased time from diagnosis was associated with lower-level negative IOC scores. Patients may be less influenced by melanoma with increased time from diagnosis. In contrast, patients at advanced melanoma stages or with more comorbidity were shown to be more negatively influenced by their cancer. Women with melanoma seem to adjust their sun safety behavior more than men [24]. Keratinocyte carcinoma patients, however, seem to either fail to change their sun-protective behaviors [25] or selectively modify only their sun exposure habits but do not significantly improve other health behaviors [13]. Rhee (2008) suggests that sun-protective measures among this group are driven by their perceived increased risk of future keratinocyte carcinoma and not melanoma, as they do not perceive risk for developing future melanoma.

The impacts of being diagnosed with melanoma and keratinocyte carcinoma over survivors' lives have been extensively studied using health-related quality of life (HRQOL) measures [13, 24]. HRQOL is a multidimensional construct that captures the subjective perceptions of different aspects of the patient's symptoms and functional status. These measures provide one indication of how cancer diagnoses impact patients' lifestyle behaviors and general outlook. HRQOL questionnaires, however, do not fully examine how a diagnosis of skin cancer changes a patient's lifestyle, including PA behaviors, as a result of UV avoidance [26]. There is limited research on whether and how skin cancer, melanoma in particular, affects people's levels of PA or their perception of the outdoor environment as a facilitator for or barrier to PA. Studies suggest that melanoma survivors spend less time outdoors and change the timing and pattern of their outdoor activities to avoid excessive UV exposure [14, 19, 27]. Consequently, limiting time outdoors can also lead to unintended consequences by negatively affecting survivors' levels of PA and social interactions. Outdoor activity is seen as beneficial for physical, psychological, and social health [28] and may have therapeutic and restorative benefits specifically for cancer patients. Thus, there is a need to identify ways to maintain outdoor activity while also preventing dangerous levels of UV exposure to at-risk populations.

Perception of urban outdoor settings for PA, safety, comfort, and aesthetics

For the past two decades, urban planners/designers, landscape architects, and public health practitioners have tried to

[1] BCC and SCC are also known as keratinocyte carcinomas.

[2] The IOC is an instrument that measures the well-being of cancer survivors in long term and their adaptation to change [59].

promote PA through neighborhood-based interventions [29, 30]. Neighborhood public spaces offer opportunities for outdoor PA across all age groups, social statuses, and health levels. The current layout of streets, however, may not completely accommodate the concerns and needs of this range of users. The use of neighborhood streets for PA depends on people's perception of the desirability of that area [31, 32]. Three aspects of the environment—comfort, safety, and pleasurability (aesthetics)—can affect this perceived desirability [31, 33]. "Safety" includes concerns about crime, traffic, and other environmental hazards. "Comfort" includes physical factors, such as shade, trees, and sidewalks that can provide a supportive environment for walking [31]. "Sensory pleasure" denotes the pleasure that passersby experience walking on a street due to various stimuli, such as colors, shapes, sound, smell, and light [31]. For melanoma survivors, the risk of excessive sun exposure may affect their perception of the desirability of outdoor settings and limit their choice of outdoor areas for PA.

The question of how a diagnosis of skin cancer, melanoma in particular, affects PA is specifically relevant to Colorado. The UV index indicates the risk of overexposure to UV radiation from the sun on a scale from 0 (none) to 11 and more (extremely high) [34]. Located in a high-altitude region, the average UV index rises over nine in Colorado [35]. In the summer, Denver residents are exposed to 25% more UV than at the sea level; it increases to 50% more at 10,000 ft altitude [36]. The issue is particularly salient in this part of the United States where 68.3% of people are fair skinned, making them more susceptible to the adverse impacts of UV radiation than other groups [37, 38]. Melanoma is the 6th most commonly diagnosed cancer in Colorado [39]. The annual rate of new melanoma diagnoses among Whites in Colorado was the 15th highest (2011–2015) in the USA, and the mortality rate caused by melanoma in this time period was the 8th highest in the USA [39]. Moreover, Colorado has been experiencing a decline in urban tree cover due to development, climate change, and infestation with emerald ash borers (EAB) [40]. The impact of tree canopy loss has been examined in relation to Urban Heat Island effect or carbon sequestration. How tree canopy may impact sun safety practices and perceptions in relation to PA, especially for skin cancer survivors, has not been previously studied.

The present qualitative study seeks to understand whether outdoor PA is worrisome for people who have had a diagnosis of skin cancer in Colorado. It examines how skin cancer affects people's perception of the outdoor environment for PA and whether and how they adjust their lifestyles to diminish the risk of reoccurrence of the disease.

Methods

Overview

We conducted in-depth interviews using a semi-structured interview guide with 19 people who had a history of melanoma. These interviews collected qualitative information about the impacts of melanoma on survivors' sun safety behavior and their perceptions of the built environment for PA. Interviews were conducted at a skin cancer treatment center in the Denver metropolitan area.

Sample

The study sample included 19 people, aged 20 to 85, who were diagnosed with primary cutaneous melanoma. Participants were recruited while they were visiting the clinic for follow-up health checks. The main oncologist and director of the clinic helped recruit people who met our inclusion criteria, were interested in participating in our study, and were available for 20–35 min after their checkup to answer interview questions.

Data collection procedure

Qualitative interview

We used a semi-structured interview guide, including five questions, that was informed by literature on skin cancer risk perception, sun protection [13, 19, 24], and walkability [31, 41]. The content areas were defined based on their relevance to melanoma survivors and the gap in the literature regarding skin cancer survivors' PA behavior and their perception of the outdoor environment for PA. We asked participants about their perceptions of the causes of their disease and the impact of melanoma on their sun protection and PA behavior. The interview was preceded by eight questions about interviewee's gender, age, ethnicity, level of education, marital status, health status, city of residence, and hours of PA per week. The interview guide is available upon request.

Visual landscape assessment

Participants were also shown 26 pictures of different streetscapes in Denver and asked to pick their most and least favorite places for walking and explain why they selected those streets. The 26 photographs were shown to interviewees in the same order. These photographs were from a set of street pictures that were taken across Denver's neighborhoods in June 2017. The 26 pictures were initially selected to present a range of environmental characteristics. In preparation for this study, we recruited five judges (outside our interviewees) to rate these photographs on the 10 environmental

characteristics that can affect the desirability of the street for walking: trees, shade, the level of maintenance, architecture, sidewalk quality, the mix of vegetation in landscape, the openness of view, and the level of natural surveillance [42]. These characteristics were determined based on a literature review. We applied the convenience sampling method and recruited judges at a public library and from an employment site. Judges did not have any expertise about the subject.

Interview procedure

Interviews with skin cancer survivors were completed in May 2018. They took between 20 and 35 min and were conducted face to face in a private room at the skin cancer treatment center. All interviews were conducted by one researcher. Thematic saturation began to occur after the 10th interview as no more patterns or themes were emerging thereafter. We interviewed 19 patients to make a balance between the number of male and female interviewees and recruit people from a range of age groups.

Data analysis and data synthesis

The researcher conducted interviews, audio-recorded responses to the questions and street photograph assessment, and transcribed recordings. The results of interviews and visual landscape assessment were used together in the analysis. The analysis included several phases. First, the researcher read verbatim transcripts, highlighted the sections that were relevant to the research question, wrote memos about the themes, and inductively generated preliminary coding categories. Then, a team including the researcher and a faculty member discussed observed themes and developed a coding framework. In the next iteration, the researcher re-read and coded the transcripts. Supporting quotes were highlighted for more illustration, but for confidentiality reasons not attributed to individuals.

To identify the environmental features that affected participants' perception of the street environment for PA, we calculated the number of times that each photograph was identified as most desirable and those rated as least favorite environments for PA. The three most favorable and least favorable environments for PA were selected. We identified dominant environmental characteristics and the features of the street environment that were desirable for each picture based on the scores assigned by judges and based on the respondents' answers. In the last step, findings were also analyzed to show differences in ratings by gender, educational attainment, age group, and time from diagnosis.

Results

Participant characteristics

We interviewed 11 men and 8 women. Table 1 presents the characteristics of interviewees. All participants identified themselves as White. Fifteen participants were over 45 years old. Educational attainment was high among our sample as 11/15 had a college degree or higher level of education. Most participants reported very good or excellent health. Six

Table 1 Characteristics of interviewees ($n = 19$)

Demographic and socio-economic characteristics	Number (%)
Gender	
Male	11 (58)
Female	8 (42)
Ethnicity	
White	19 (100)
Other	0
Education	
< College degree	8 (42)
College degree	6 (31)
Graduate degree	5 (26)
Marital status	
Married	17 (89.5)
Single, divorced	2 (10.5)
Age, year	
20–24	1 (5)
25–44	3 (16)
45–64	8 (42)
65–85	7 (37)
Employment	
Employed	12 (63)
Retired	6 (32)
Unemployed/student	1 (5)
Place of residence	
Large urban	9 (47)
Small town or mountain community	8 (42)
Rural	2 (11)
Perceived health	
Poor to fair	0 (0)
Good	3 (16)
Very good	13 (68)
Excellent	3 (16)
Hours of PA (95% CI) sd	(8.5, 21.6)
Time from diagnosis	
< 5 years	8 (42)
5 to 10 years	2 (11)
> 10 years	9 (47)

participants were born and raised in CO. Others were mainly from the West or Mid-West and moved to Colorado more than 20 years ago. Nine/nineteen participants lived in larger urban areas or affiliated suburbs, 8/19 lived in smaller cities in the mountain communities, and 2/19 lived in other rural areas. Five interviewees, mainly men, had been diagnosed with keratinocyte carcinoma prior to their melanoma. Three of the participants experienced a second primary melanoma.

Interview results and identified themes

We synthesized the outcome of our analysis into five overarching themes that delineated interviewees' sun protection, PA behavior, and evaluation of outdoor environments for PA. Table 2 provides a summary of representative quotes for each of the themes described in the next section. For each quote, we assigned a participant ID to illustrate how the sample of participants contributed to each thematic area.

Knowledge about melanoma and its causes

Interviewees reported having limited knowledge of melanoma and its risk factors before their diagnosis; their perception of the risk factors usually came from their oncologist. Most respondents associated their melanoma with excessive sun exposure and episodes of sunburn in childhood and adolescence. These sunburns were usually linked to water sports, sun tanning, or inadequate cover while doing outdoor activities. (Some of the interviewees had been lifeguards or had swimming pools at home.) Many, especially women, blamed sun tanning habits in their adolescence and youth for their melanoma. Being over 45, most patients grew up in a time when sunscreen use or other preventive measures were not widely adopted and tanned skin was considered a sign of health. In one instance, a respondent reported being encouraged by her family to get tan in order to not look pale. Only two respondents stressed genetic factors and two related their melanoma to other accidents and injuries, such as burning with a candle.

In many cases, the melanoma symptom went unnoticed for a long time and was accidentally discovered by the patient's family doctor or dermatologist. Some patients did not have knowledge about melanoma symptoms prior to their diagnosis. In some cases, the patient did not notice melanoma in the first place because the symptom did not match the "ABCDEs of Melanoma" guide [43, 44]. For instance, it appeared as a wart, lump, or a lesion.

The shift in sun safety attitudes

All patients reported that melanoma had an immediate impact on their perception of UV risk and the application of safety measures. Some patients mentioned that their prior diagnosis with keratinocyte carcinomas caused them to slightly improve their sun habits; however, their diagnosis with melanoma was a wake-up call that significantly affected their safety behavior. Those who had been conscious about their sun safety before diagnosis seemed to try pushing their sun safety to the next level by searching for new products or working on the systematic causes of their cancer, for example, switching to alternative healthy diets after their diagnosis. This trend was more pronounced in women and patients with a higher level of education.

Melanoma and PA behavior

Interviewees frequently suggested that a diagnosis with melanoma had very minor impacts on their activity behavior and the time they spent outdoors. Most interviewees believed that it was important for them not to allow melanoma to take over their lives. They showed awareness and anxiety about the risk of sun exposure but tried to keep enjoying their outdoor life by applying conventional and more advanced sun protection methods, such as sun-proof apparel.

We found four patterns regarding the impact of melanoma on activity behavior. First, people who were active before their diagnosis and stayed active. This group ($n = 13$) included long-time athletes, those who enjoyed outdoor activities, and those whose job or family duties required them to stay active after the diagnosis. Some interviewees mentioned that they could not avoid outdoor activities because of their job or life situations. Examples of these groups were two interviewees who owned a farm and parents who had to participate in outdoor activities because of their teenage children. This group relied on sunscreen and clothing to protect themselves while being outside. Within this group, three participants (mainly older males) believed that a change of PA behavior would not guarantee the prevention of future melanomas as the disease was caused by sunburns in childhood, referring to their oncologists' notes. These people did not constrain outdoor times but tried to apply sunscreen or hats selectively. Participants in this group reported a range of outdoor activities, including water sports in urban areas or outside the cities.

The second pattern was a group of two people who were not very active before their diagnosis and did not change their level of PA after the diagnosis. These interviewees stated that they did not enjoy outdoor activities and being diagnosed did not affect their lifestyle in this regard. The third pattern constituted three people who reported a decrease in their level of PA after the diagnosis. This change, however, happened as a result of other health conditions (other surgeries for instance) than skin cancer, changes in their life situations, or aging. Finally, the fourth, which included only one woman among all the interviewees, described switching her work from outdoors to indoors to prevent more sun exposure. All 19 participants reported that they no longer bathed in the sun.

Table 2 Summary of interview themes (I = Interviewee)

Identified themes and categories	Representative quotes
Knowledge about melanoma and its causes	
Educational materials on melanoma are not comprehensive.	"It [melanoma] just wasn't as well-known. I mean, there is a lot of information around breast cancer, but not around skin cancer as much." (I11)
Social norms about tanned skin	
Sun tanning was considered a social norm about beauty.	"It was a trend to put baby oil on your skin and lay in the sun. I worked on my tan as a child and teenager." (I11) "This was the day when tan was a sign of a healthy skin." (I13)
The shift in sun safety attitudes	
Melanoma had a big impact on the patient's perception of the UV risk.	"I have a little bit of phobia of the sun now." (I11)
Melanoma was a wake-up call even for patients who had experienced NMSC.	"I did protect my skin to the point [when I was diagnosed with NMSC]. But, It was the melanoma diagnosis that really made me wake up." (I1)
Reliance on protective clothing	
Some people preferred protective clothing to sunscreen.	"I'd rather wear clothing than put a lot of sunscreen on myself." (I9) "I do it [applying sunscreen] a little bit less because it is not comfortable to always be coated in all those chemicals." (I4)
Melanoma and PA behavior	
People tried to diminish the risk of sun exposure outside through stricter sun safety measures	"It [melanoma] did not change that [PA behavior]. It changed how I went about doing these outdoor activities, wearing a hat, wearing long sleeves. Now they have sun-protective clothing that has sunscreen in it." (I1)
It was important for interviewees not to let melanoma take over their lives.	"And the fact that I know I've had cancer does not dictate that I should do or should not do any of those things. I still do pretty much what I want to do and if I do not want to do it I do not do it." (I4)
Some people curtailed their PA because of other reasons and not melanoma.	"I had some other surgeries in the last couple of years that probably affected it [PA] more." (I11) "I'm slowing down just because of age. And just do not have the energy to go out and do it you know." (I12)
Trees, shade, sidewalk, and maintenance	
For many, their preference for shade started after their diagnosis.	"It [preference for shade] started after my diagnosis for sure, when shade became more important…. I think now I seek out the shade." (I9)
Most patients seek shade outside in spite of applying other sun safety practices.	"I do pick the shady side of the street. Even though I have a hat on and long sleeves and my ankle-length pants and whatever, I still will cross the street if it's shady on that side where the sun is." (I1) "I like trees and shade and grass." (I4)
Many preferred shade to avoid both sun exposure and heat.	"Like I do not like to be in the sun and it is always in the back of my mind. So, I think there is probably an element of that. But I also just know that I do not really enjoy being in biting down hot sun anyway." (I11)
People do not seek out shade in cooler weathers.	"It is nice to be shaded. Especially in summer time and in the wintertime, you kind of like to have the sun." (I8) "I think it [preference for shade] all would depend on how hot it was. Probably in Denver, I would always prefer the shade. But up where I live when it's really cool, then a lot of times, then I would prefer the sun." (I19)
Some preferred detached sidewalks because of more shade.	"Well, yeah, it's just easier. You know I mean when you walk in the sidewalk, you usually you have a little bit more shade." (I16)
The reflection from the landscape makes it uncomfortable for some people.	"I appreciate xeriscaping. I think it is necessary in places where there is not a lot of water like say Arizona, …I think the stone [in the landscape] to me is reflective and it is hot." (I9)

Fig. 1 Three environments that were favored for walking

Shade, trees, sidewalk, and maintenance

Figure 1 shows the three environments that were most favored for walking. Figure 2 illustrates the three environments that were not favored for walking.

Referring to the environmental scores assigned by judges to the different photos (Appendix A), the first set of photos was ranked higher in terms of shade, trees, and sidewalk quality. The type of sidewalk and percentage of vegetation were the second most important criteria that distinguish the two sets of street environments.

Interviewees discussed shade and trees as the most important features of the streetscape that affected the desirability of the street for walking. Almost all interviewees were concerned about shade on sidewalks. A few interviewees, mainly women, stated that their preference for shade had a direct link to their skin cancer and they would seek shade across all seasons. This group was concerned about not only direct sun exposure but also sun reflection from stones and concrete, and accordingly, they advocated for more groundcover or grass. Many participants reported that their preference for shade was to avoid high temperature and stated that they would prefer sunny areas in winter. These participants also mentioned that their concern about sun exposure was in the back of their minds, but for that they relied on sunscreen and protective clothing while being outdoors. People in many instances referred to a shady landscape as fresh and "cool" and to a sunny one as a "hot" landscape.

Participants also showed attention to the quality and type of sidewalk when selecting a street for walking. People, especially older interviewees, were concerned about the quality of sidewalks because of their fear of falling. Sidewalks detached from the street were the most preferred for safety reasons and also because of the possibility of having trees in the buffer zone that provide shade on the sidewalk.

Most interviewees related their preference for lawns and trees to the shade and "cool and fresh" quality of such a landscape. Many acknowledged the benefits of xeriscaping for water conservation; however, they still emphasized that they would prefer trees and grass for walking and felt that xeriscapes conveyed a feeling of a hot and arid environment. Most people mentioned the maintenance of landscape as an important factor that affected their choice of street for walking. The word "manicured" was repeated several times as a quality of a preferred landscape.

Participants provided recommendations to create more shade in public realms by planting more trees, keeping the existing mature trees, and installing canopies and shade structures. They also acknowledged the required time to grow full foliage and concluded that installing shade structures might be a more feasible solution. They specifically advocated for more shade at schools, playgrounds, and sport fields where children and their parents spend a lot of time in direct sun.

Two interviewees suggested installing sunscreen dispensers at parks and other public places, so that people have access to sunscreen when outdoors.

Reliance on protective clothing and sunscreen

All participants relied on sunscreen and/or protective clothing to protect themselves against sun exposure while doing outdoor activities. Most participants emphasized the frequent application of sunscreen as their primary preventive measure. Wearing hats was the second most important tactic to reduce sun exposure. A few participants emphasized wearing wide-brim hats outside; the rest relied on baseball caps. Only a few interviewees (mainly women) reported wearing long sleeves for sun protection. Most interviewees relied heavily on sunscreen and preferred this sun safety practice to wearing covered clothing or avoiding sun in general. A few interviewees (women), however, mentioned their reluctance to apply excessive chemicals on their skin; they preferred to avoid the sun or wear sun-proof clothing instead. Women interviewees, in particular, were more proactive in searching new sun safety advances; they pointed out their use of UV protective umbrellas, apparel, and swimwear. People showed a tendency to cover or protect parts of their bodies that were previously affected by melanoma more so than the rest of their bodies.

Most people started the routine use of sunscreen after their diagnosis with melanoma. One or two female interviewees mentioned that they had applied sunscreen regularly before their diagnosis not because of melanoma concerns but to prevent skin spots and freckles or avoid the pain from sunburns.

Fig. 2 Three environments that were not favored for walking

Participants were aware of and worried about the risk of melanoma for their relatives and children. Some interviewees were not sure that their advice about applying sunscreen and protective clothing would be effective for their small and teenage kids; thus, they made sure to bring their kids for annual skin check-ups.

Generally, responses were consistent across age groups, but variant between genders and different levels of education. Women and people with a higher level of education stated more awareness of the risk of sun exposure and showed stricter sun protection practices compared to men and those with lower levels of education. The time since diagnosis did not seem to be related to responses.

Discussion

Our interviewees pointed out having limited knowledge of melanoma, its risk factors, and its symptoms, and little motivation to take sun protection measures prior to their diagnosis. A melanoma diagnosis, however, led to changes in patients' perceptions of the risk of sun exposure and related sun safety habits. Our interviewees did not show changes in their level of outdoor activity as a result of melanoma. Instead, they tried to curtail the risk of sun exposure through sun safety practices, such as using sunscreen and sun-protective clothing. Our respondents showed their preference for shade, trees, and groundcover in urban streets to avoid both sun exposure and excessive heat. The type and quality of sidewalks and the maintenance of the landscape were other streetscape features that were shown to affect their preference for the street for PA.

Similar to our findings, other studies suggest a shift in risk perception and sun protection after diagnosis with melanoma [24, 27]. A diagnosis with keratinocyte carcinoma does not usually lead to such a shift in sun protection [13, 25]. One possible explanation for this difference in behavior change between melanoma and keratinocyte carcinoma patients is that the diagnosis and treatment that keratinocyte carcinomas patients experience might be less impactful than what melanoma patients do. Another possible explanation for inadequate sun protection among keratinocyte carcinomas patients is that their risk perception of future melanoma is low [13].

There is inconsistency in the literature regarding changes in sun protection behaviors (e.g., sunscreen and protective clothing use) after melanoma diagnosis. Mujumdar (2008) suggests that the rate of sun protection among melanoma survivors does not exceed general population estimates [19]. Our findings, however, are consistent with Oliveria's 2011 study results that suggest an expansion in sun protection due to melanoma diagnosis [27]. Other studies confirm our finding about prioritizing the use of sunscreen over other protective strategies (wearing a hat or protective clothing) [19, 45]. Sunscreen by itself, however, may not be an adequate sun protection measure and should be supplemented with clothing, hats, and sun avoidance [46, 47]. Similar to Holterhues (2011), our study shows that women survivors are more vigilant about sun protection behavior than men [24]. Moreover, all participants were more committed to applying sunscreen in the summer than winter, which is also consistent with literature [24]. People also rely on their subjective perception of ambient UV based on things like temperature and cloud cover to protect themselves. Temperature and cloud coverage, however, are inaccurately assessed and associated with UV by individuals [48] resulting in an underestimate of ambient UV, resulting in less sun protection in winter. Sun safety programs in areas like Colorado should provide specific information about sun protection in winter because of high altitude, clear sky, and snow reflection, which elevate the risk of UV exposure during the winter months.

Our interviewees were mindful about sun exposure while going out and reported abstaining from sun tanning. They, however, claimed no or very slight changes in their outdoor activity behaviors. This result is not consistent with previous research suggesting that melanoma survivors spend less time outdoors than the general population [14, 19] or refrain from outdoor activities in places without shade [27]. Levels of outdoor activity behavior before diagnosis and also the availability of outdoor opportunities in Colorado may affect people's decisions to maintain their outdoor activities after diagnosis. Our interviewees in general were athletic or likely to engage in outdoor activity before diagnosis and stayed engaged in enjoyable outdoor activities after diagnosis, which is consistent with the statewide statistics about Coloradans and their physical activity behaviors and use of the outdoors [49, 50].

Even though melanoma survivors understand the benefits of shade to reduce UV radiation exposure, they find it more desirable to apply sunscreen or wear protective clothing rather than to constrain their outdoor activity. There is not sufficient consecutive shade over large expanses of space to facilitate outdoor activity for many exercise purposes. On the other hand, people do not want to change their behaviors in the outdoors including contact with nature and outdoor events. Without adequate shade, it is necessary to use other tactics to protect oneself. The inherent passion for outdoor activities and positive effects of PA on the quality of life after a cancer diagnosis underscore the importance of building into the environment sun safe corridors and public spaces, where individuals and families can maintain active and sun safe lifestyles in the outdoors.

Shade and trees, overall maintenance of the streetscape, and sidewalk type have been shown to affect people's preference of the street for walking [42]. The underlying reasons to choose shade, however, may be different for general public and melanoma survivors. While members of the general public prefer shady streets to escape high temperatures in the summer [42], our respondents, especially women, stressed seeking shade for both UV and heat avoidance. Survivors also showed a preference for grass over stones or concrete in the landscape. Although people may not technically know about albedo, the intensity of solar radiation from surfaces, they intuitively selected surfaces with lower albedos [51] as these surfaces felt "cooler" and "fresher" according to respondents. Also, our respondents' preference for sidewalks detached from the streets was partially due to the higher possibility of shade on the sidewalk. Aside from shade and tree canopy, nuances like the landscape materials, and the type of sidewalk, are important perceived factors that make the street environment desirable, specifically for melanoma survivors.

People's preference for neighborhood trees and vegetation has been extensively discussed in the walkability literature [52, 53]. This literature focuses mainly on the aesthetic and restorative qualities of vegetation while examining the relationship between greenness and walkability. The triangle of greenness, sun safety, and walkability needs more attention and should become a subject for future research. The study of the link between sun safety and walkability, however, should not be limited to vegetation as shade structures and pervious surfaces are other elements that should be investigated. Buller (2017) et al. show in a randomized trial that the presence of shade structures can increase park use [54]. Similar studies should examine the impacts of adding shade structures in other outdoor spaces on site usage and level of PA.

Our findings reflect the perspective of a group of melanoma survivors who live in Colorado—one of the states known to have the highest rate of active people in the nation [55] and extensive opportunities for outdoor activity. These facts limit the generalizability of results. Future studies should consider expanding the perspective by including melanoma and keratinocyte carcinoma survivors, and others at risk from other states, where PA is not a norm. Also, we recruited participants from a single clinic that may attract a certain type of people. For instance, our sample was highly educated and almost all married. A different socio-economic group might produce different results. Also, the degree of social desirability and recall bias in the interviews is unknown and could have affected the results.

Conclusion

According to 2015 National Health Interview Survey, less than 70% of American adults use at least one form of sun protection (sun screen, protective clothing, or shade). This number is lower among men and young women (ages 18–24) [56]. An even smaller percentage of people may go for regular skin check-ups or do skin self-examination regularly [57, 58]. Also, as a "sneaky disease," melanoma may go unnoticed for a while before it is diagnosed. This suggests that the general public and keratinocyte carcinoma patients need more education about melanoma symptoms, and the risk of excessive sun exposure. Further investment in environmental interventions to increase sun safety in public areas such as residential streets, parks, schools, and sport fields can improve opportunities for outdoor physical activity that is sun safe. Given that melanoma survivors may not want to limit their outdoor activity, the PA guidelines for cancer patients should include sun safety considerations. Also, municipalities can provide public areas inherently safe and usable for people with a history of skin cancer or those who are sensitive to sun exposure by adopting and applying sun safety considerations in design guidelines. More research is warranted to investigate the link between PA, sun safety, and the built environment in urban settings.

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Compliance with ethical standards

Disclaimer The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Conflict of interest The authors declare that they have no conflict of interest.

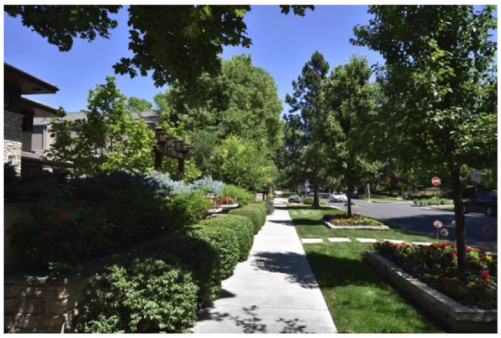
Ethical approval The interview procedure was approved by the University of Colorado Boulder's Institutional Review Board. All procedures performed in this study were in accordance with the ethical standards of the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

Appendix

Selected 26 pictures, their environmental characteristics, and preference measures

1.



Sidewalk	5
Maintenance	5
LS_Diversity	5
Trees	3
Shade	3
LS_Type	4
Investment	3
Openness	2
Architecture	5
Surveillance	2
Preference% (choice task)	0.67±0.16
Preference (Rating task)	8.25±2.12

Sidewalk	3.6
Maintenance	3.2
LS_Diversity	4
Trees	4
Shade	4
LS_Type	4
Investment	2.2

2.

Openness	1.8
Architecture	3.4
Surveillance	2
Preference% (choice task)	0.56±0.19
Preference (Rating task)	7.01±2.28

3.

Sidewalk	2.7
Maintenance	2.8
LS_Diversity	3.3
Trees	3.3
Shade	3.5
LS_Type	2
Investment	1.8
Openness	3.3
Architecture	2.8
Surveillance	1.7
Preference% (choice task)	0.40±0.19
Preference (Rating task)	6.95±2.51

4.

Sidewalk	4.8
Maintenance	4.8
LS_Diversity	3.8
Trees	3
Shade	3
LS_Type	4
Investment	2.8
Openness	2.4
Architecture	4.6
Surveillance	2.8
Preference% (choice task)	0.66 ± 0.18
Preference (Rating task)	7.6 ± 2.17

Sidewalk	2
Maintenance	1.2
LS_Diversity	2.4
Trees	1.4
Shade	1.6
LS_Type	1.2
Investment	1

5.

Openness	2.2
Architecture	1.2
Surveillance	1.4
Preference% (choice task)	0.19 ± 0.17
Preference (Rating task)	4.63 ± 2.81

6.

Sidewalk	2
Maintenance	2
LS_Diversity	2
Trees	4
Shade	3
LS_Type	2
Investment	1
Openness	3
Architecture	3
Surveillance	3
Preference% (choice task)	0.47 ± 0.19
Preference (Rating task)	5.54 ± 2.42

7.

Sidewalk	3.2
Maintenance	2.8
LS_Diversity	4
Trees	3.2
Shade	3
LS_Type	2.3
Investment	1.7
Openness	1.8
Architecture	3.2
Surveillance	2
Preference% (choice task)	0.54±0.20
Preference (Rating task)	5.00±2.49

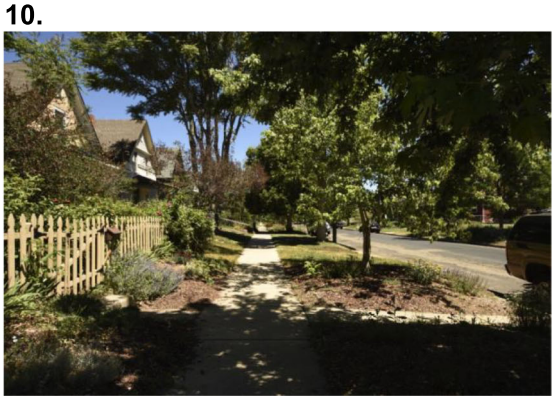
8.

Sidewalk	4
Maintenance	5
LS_Diversity	5
Trees	3
Shade	4
LS_Type	4
Investment	3
Openness	3
Architecture	4
Surveillance	2
Preference% (choice task)	0.71±0.17
Preference (Rating task)	8.24±2.24

9.

Sidewalk	2.8
Maintenance	3.6
LS_Diversity	4.2
Trees	3.6
Shade	2.8
LS_Type	2
Investment	1.8
Openness	2.6
Architecture	4.2
Surveillance	2.4
Preference% (choice task)	0.45±0.16
Preference (Rating task)	7.68±2.41

10.



Sidewalk	4.3
Maintenance	3.3
LS_Diversity	4.3
Trees	3.8
Shade	3.7
LS_Type	2
Investment	2.5
Openness	1.3
Architecture	3.5
Surveillance	2.3
Preference% (choice task)	0.54±0.22
Preference (Rating task)	6.93±2.12

11.

Sidewalk	4.8
Maintenance	4.3
LS_Diversity	3.2
Trees	3.3
Shade	2.8
LS_Type	3.7
Investment	2.7
Openness	2.5
Architecture	3.5
Surveillance	2.5
Preference% (choice task)	0.57±0.20
Preference (Rating task)	7.10±1.96

12.

Sidewalk	1
Maintenance	2
LS_Diversity	2.8
Trees	2.2
Shade	1.2
LS_Type	1.6
Investment	1.4
Openness	2.2
Architecture	2.2
Surveillance	1.8
Preference% (choice task)	0.19±0.20
Preference (Rating task)	6.72±2.34

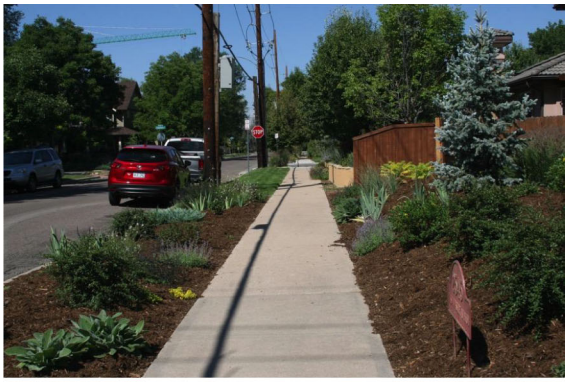
13.

Sidewalk	2.3
Maintenance	1.5
LS_Diversity	2.5
Trees	1.3
Shade	1.2
LS_Type	1.3
Investment	1
Openness	3
Architecture	1.8
Surveillance	1.8
Preference% (choice task)	0.30±0.19
Preference (Rating task)	5.44±2.16

14.

Sidewalk	3
Maintenance	3
LS_Diversity	2
Trees	1
Shade	1
LS_Type	3
Investment	2
Openness	4
Architecture	3
Surveillance	2
Preference% (choice task)	0.24±0.18
Preference (Rating task)	7.71±2.13

15.



Sidewalk	4.3
Maintenance	4.5
LS_Diversity	5
Trees	2.2
Shade	1.5
LS_Type	2.3
Investment	2.8
Openness	3.2
Architecture	3.7
Surveillance	1.7
Preference% (choice task)	0.56±0.19
Preference (Rating task)	8.00±2.26

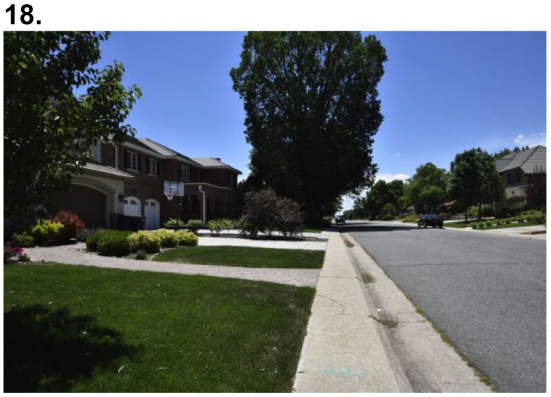
16.

Sidewalk	4
Maintenance	3
LS_Diversity	3
Trees	3
Shade	3
LS_Type	3
Investment	2
Openness	2
Architecture	3
Surveillance	3
Preference% (choice task)	0.47±0.20
Preference (Rating task)	8.40±2.23

17.

Sidewalk	3
Maintenance	3.2
LS_Diversity	2.6
Trees	1.6
Shade	1.2
LS_Type	2.8
Investment	1.6
Openness	2.8
Architecture	2.8
Surveillance	1.8
Preference% (choice task)	0.43±0.20
Preference (Rating task)	6.91±2.23

18.



Sidewalk	4
Maintenance	4
LS_Diversity	4
Trees	3
Shade	2
LS_Type	3
Investment	2
Openness	3
Architecture	4
Surveillance	2
Preference% (choice task)	0.43±0.21
Preference (Rating task)	5.68±2.95

19.

Sidewalk	2.8
Maintenance	2.4
LS_Diversity	3.4
Trees	1.8
Shade	2
LS_Type	1.6
Investment	1.4
Openness	2.6
Architecture	2.4
Surveillance	1.8
Preference% (choice task)	0.31±0.17
Preference (Rating task)	8.09±2.11

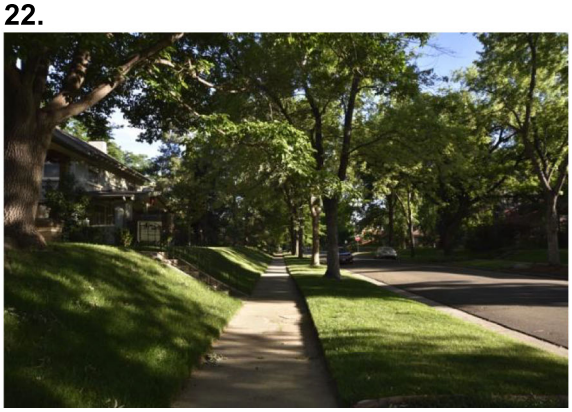
20.

Sidewalk	3.8
Maintenance	3.2
LS_Diversity	3
Trees	3.8
Shade	3.7
LS_Type	2.7
Investment	1.7
Openness	2
Architecture	3.3
Surveillance	2
Preference% (choice task)	0.59±0.20
Preference (Rating task)	6.60±2.10

21.

Sidewalk	4
Maintenance	4
LS_Diversity	4
Trees	2
Shade	2
LS_Type	4
Investment	2
Openness	3
Architecture	4
Surveillance	2
Preference% (choice task)	0.57±0.22
Preference (Rating task)	7.66±2.29

22.



Sidewalk	4.7
Maintenance	4.7
LS_Diversity	3.2
Trees	3.8
Shade	3.7
LS_Type	3.3
Investment	2.7
Openness	2.3
Architecture	3.8
Surveillance	2
Preference% (choice task)	0.73±0.17
Preference (Rating task)	5.71±2.34

23.

Sidewalk	1
Maintenance	3.8
LS_Diversity	2.5
Trees	2.5
Shade	2
LS_Type	2.8
Investment	1.8
Openness	3.5
Architecture	3.5
Surveillance	2.2
Preference% (choice task)	0.34±0.23
Preference (Rating task)	8.19±2.12

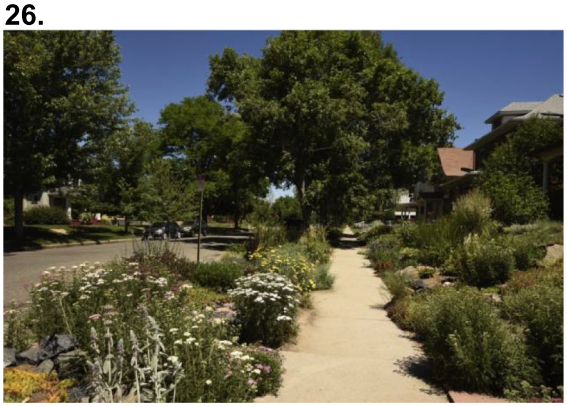
24.

Sidewalk	3.4
Maintenance	3.2
LS_Diversity	3.8
Trees	2.6
Shade	3
LS_Type	2.6
Investment	1.8
Openness	2
Architecture	2.8
Surveillance	2
Preference% (choice task)	0.64±0.16
Preference (Rating task)	4.31±2.37

25.

Sidewalk	2.4
Maintenance	2
LS_Diversity	4
Trees	3.6
Shade	3.4
LS_Type	1.6
Investment	2
Openness	1.8
Architecture	4
Surveillance	1.6
Preference% (choice task)	0.46±0.20
Preference (Rating task)	6.22±1.96

26.



Sidewalk	4.2
Maintenance	4.2
LS_Diversity	4.7
Trees	2.8
Shade	2.2
LS_Type	1.8
Investment	2.5
Openness	2.7
Architecture	3.8
Surveillance	2.5
Preference% (choice task)	0.55±0.21
Preference (Rating task)	7.09±2.07

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