Compliance with sunscreen advice in a survey of adults engaged in outdoor winter recreation at high-elevation ski areas

David B. Buller, PhD,[a] Peter A. Andersen, PhD,[b] Barbara J. Walkosz, PhD,[c] Michael D. Scott, PhD,[d] Julie A. Maloy, MS,[a] Mark B. Dignan, PhD,[e] and Gary R. Cutter, PhD[f]
Golden and Denver, Colorado; San Diego and Auburn, California; Lexington, Kentucky; and Birmingham, Alabama

Background: Adults are advised to wear sunscreen with a sun protection factor (SPF) of 15 or higher, apply it up to 30 minutes before sun exposure, and reapply it after 2 hours to reduce exposure to ultraviolet radiation in sunlight for the prevention of skin cancer.

Objective: This study investigated the extent to which adults comply with sunscreen advice.

Methods: A survey was conducted with 4837 adult skiers and snowboarders at 28 high-altitude ski areas in western North America in January through April 2001 through 2002. Respondents self-reported use of sunscreen, its SPF, time of first application, and reapplication.

Results: Only 4.4% (95% confidence interval [CI] = ±0.6) of adults were in full compliance with all sunscreen advice. Half (49.8% [95% CI = ±1.4]) complied with SPF 15 or higher advice. Of those wearing sunscreen, 73.2% (95% CI = ±1.8) applied the sunscreen 30 minutes before beginning skiing/snowboarding, but only 20.4% (95% CI = ±2.0) complied with advice to reapply it after 2 hours. Total compliance was lowest during inclement weather, on low-ultraviolet days, by men, and among respondents who believed skin cancer was unimportant and with low sun-sensitive skin. It was positively associated with wearing lip balm and hats with a brim.

Limitations: The sample was predominantly male and of high socioeconomic status; the results apply most to winter recreation when ultraviolet radiation levels are low, and sunscreen use was assessed by self-report.

Conclusion: Although the recommendation to use SPF 15 or higher sunscreen has reached many adults, the reapplication advice is heeded by few adults and needs to be highlighted in future sun safety promotions. (J Am Acad Dermatol 2012;66:63-70.)

Key words: adults; outdoor recreation; sun protection; sunscreen; sunscreen reapplication; ultraviolet radiation.

Sunscreen appears to be effective at reducing squamous cell carcinoma.[1,2] It also may reduce benign melanocytic nevi and solar keratoses, risk factors associated with skin cancer development.[3-7] A recent analysis indicated that sunscreen was a cost-effective preventive measure.[8]

Abbreviations used:

CI: confidence interval
SPF: sun protection factor
UV: ultraviolet

From Klein Buendel Inc, Golden[a]; San Diego State University[b]; University of Colorado, Denver[c]; Mikonics Inc, Auburn[d]; University of Kentucky[e]; and University of Alabama.[f]

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Reprint requests: David B. Buller, PhD, Klein Buendel Inc, 1667 Cole Blvd, Suite 225, Golden, CO 80204. E-mail: dbuller@kleinbuendel.com.

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To obtain its maximum protection, sunscreens should have a high sun protection factor (SPF), be applied before going into the sun, and be reapplied.[9,10] A minimum SPF of 15 is recommended and higher SPF should be considered when outside for extended periods or when ultraviolet (UV) radiation is extremely high. Some sunscreens need a short period of time (20-30 minutes) to be absorbed and become effective,[9,11,12] so, as a general rule, individuals are advised to apply sunscreen up to 30 minutes before going outdoors. Sunscreens need to be reapplied to compensate for initial underapplication of sunscreen[13-15] and to insure they stay effective when exposed to moisture or rubbing with sand or fabric.[12,16-18] With a few exceptions, the most commonly recommended reapplication interval is every 2 to 3 hours.[9,12] Given the published rates of sunburning among adults, however, it seems prudent and reasonable to assume that many individuals ignore part or all of the recommendations.[19]

CAPSULE SUMMARY

- Adults should wear sunscreen with sun protection factor of 15 or higher, apply it before going outside, and reapply it after 2 hours.
- Half (49.8%) of adult skiers and snowboarders interviewed at North American ski areas complied with advice to wear sunscreen with sun protection factor 15 or higher and 73.2% of sunscreen wearers applied it before going outside. Only 20.4% reapplied sunscreen. Almost no one (4.4%) followed the advice completely.
- Adults need to be convinced to follow sunscreen advice.

Analyses are reported describing patterns of compliance with sunscreen advice in a sample of adults at ski areas in western North America. UV levels can be dangerously high at ski areas, especially during the spring,[20] because many ski areas are at high elevation and snow reflects substantial UV.[21-25] Sunscreen is a valuable prevention strategy during skiing and snowboarding. Sun exposure is incidental to this winter recreation and length of sun exposure is dictated by factors other than a desire to tan, such as the ski area's hours of operation. Hence, sunscreen will likely reduce rather than prolong UV exposure.

METHODS

Respondents

Respondents (n = 4837 adults) were interviewed while visiting 28 ski areas in the western United States and Canada in January to April 2001 (n = 2991; 99.3% completion rate; 0.7% refused [n = 23]) and January to March 2002 (n = 1846; 99.0% completion rate; 1.0% refused [n = 24]). A total of 306 guests (n = 203 in 2001; 103 in 2002) were approached but deemed ineligible and not interviewed because they were younger than 18 years (n = 48), employed at the ski area (n = 175), previously interviewed (n = 70), or could not speak English (n = 13).

Ski areas were located in Alaska, California, Colorado, Idaho, Montana, New Mexico, Nevada, Oregon, and Utah in the United States, and in British Columbia in Canada. Areas varied in size, management and ownership structure, lift ticket prices, and guest demographics. UV measured during data collection using handheld Optix Tech SunSafe meters (Optix Tech, Inc, Washington, DC) ranged up to a UV index of 10 (direct UV index mean = 2.68, SD = 2.21).[20] All ski areas were members of the National Ski Area Association and had at least two aerial chairlifts. A description of ski area selection and recruitment was published previously.[26]

The ski areas were participating in a trial to evaluate a sun protection education program designed primarily for employees but also conveyed to guests.[26-28] Respondents included in the current analysis were guests visiting the ski areas either before randomization of ski areas to experimental condition (ie, n = 2991 in baseline season in 2001) or at ski areas assigned to the control condition during the posttesting season (n = 1846 in 2002). Both samples were cross-sectional. Guests at ski areas interviewed assigned to the intervention condition (n = 1679 in 2002) were not included because they could have been exposed to the intervention that altered their sunscreen use. Ski area employees were not analyzed because they spend more days at the ski areas and a large amount of their time outdoors occurs when working, not recreating, compared with guests.

Interview procedures

Respondents were interviewed face-to-face by trained interviewers while riding on chairlifts (and gondolas). Chairlifts had a minimum run time of 4 minutes. Interviews occurred during 3-day periods (one weekend day and two weekdays). Ski areas were visited during the same week of the winter season in both 2001 and 2002. Interviewers completed 12 to 20 surveys per day and the number of respondents interviewed at each area ranged from 52 to 359 respondents. Interviews were attempted on all eligible chairlifts; however, main chairlifts providing access to large parts of the mountain were oversampled.

Interviewers boarded the chairlifts with potential respondents, taking the outside of the seat if possible. They introduced the survey to respondents, reading a consent statement. Interviewers recruited the person seated immediately next to them for the survey (if seated in the middle, the person to the right). If the respondent refused or was ineligible, another potential respondent on the chair was recruited. Only one interview was completed per chairlift ride. Responses to the 4-minute interview were recorded in a survey booklet. All protocols for this project were reviewed by the institutional review boards where the investigators were employed at the time of the study: AMC Cancer Research Center, Denver, CO; California State University, Chico; San Diego State University; and University of Colorado, Denver. These institutional review boards approved the project as exempt under Code of Federal Regulations (CFR) 46.101(b)(2).

Measures

The questionnaire contained measures of sunscreen compliance developed by the investigators and reviewed for face validity. The survey was pilot tested for feasibility with adult skiers and snowboarders in a previous study.[29] Current sunscreen use was measured with 4 questions: "Are you wearing sunscreen on your skin today, or not" (yes/no) and if yes, "what is the SPF of that sunscreen" (number), "at what time did you first put on that sunscreen" (hour:minute), and "have you reapplied the sunscreen today" (yes/no). Respondents were also asked the time they started skiing or snowboarding that day (hour:minute), which served as a proxy measure for the time they first went outdoors in the sun. Interviewers recorded the time of the interview (hour:minute).

These data were used to create dichotomous measures (yes/no) of compliance with 3 sunscreen recommendations. Respondents who reported wearing sunscreen with an SPF of 15 or more were considered compliant with the first criterion of the recommended protocol (SPF ≥ 15 when outdoors). Respondents who reported that the time they first applied sunscreen was 30 minutes before the time they started skiing/snowboarding that day were compliant with the second criterion to apply sunscreen before going outdoors. Finally, respondents who were interviewed 2 hours or more after the time that they first applied sunscreen and reported that they had reapplied sunscreen were compliant with the reapplication criterion. Respondents who were interviewed within 2 hours of first applying sunscreen were assigned missing values for compliance with reapplication advice, as it did not yet apply to them. Each respondent was assigned a total compliance score, which was given a value of 1 if the respondent reported wearing sunscreen with SPF of at least 15, applied sunscreen more than 30 minutes before started skiing, and reapplied sunscreen (unless interview time was <2 hours after starting, then the total compliance score was assigned a missing value).

A series of questions were included to assess potential predictors of sunscreen compliance. These included respondents' history of sunburns while skiing/snowboarding this season and at any time in the past (yes/no), contemporaneous use of other sun protection (self-report of sunscreen lip balm use [yes/no] and its SPF; observed head, ear, face, and neck covering [yes/no] and sunglass/goggle use [yes/no]), perceived self-efficacy for sun protection and importance of skin cancer (5-point Likert scales), skin sun sensitivity (always burn and is unable to tan/usually burns but can tan if I work at it/sometimes mildly burns and then tans easily/rarely burns and tans easily), observed gender, self-reported age, self-reported education level, and observed equipment (ski/snowboard). In addition, 3 predictor indices were created. A skill index was calculated by summing z-scores for the respondents' self-reported snow sport expertise (beginner/intermediate/expert) and days reported skiing/boarding during the current season. A weather index was created by summing z-scores for observed cloud cover (clear/partly cloudy/cloudy), precipitation (none/flurries or light snow/heavy snow or other), and wind (calm/light/moderate/strong). Finally, a UV intensity index was developed by summing z-scores for days since the winter solstice, ski area latitude, and altitude at ski area base.

Statistical analysis

Respondent characteristics and sunscreen compliance patterns are reported as percentages. Statistical tests of the association between sunscreen use and potential predictors were performed in separate multiple regression models. In the regressions, each outcome variable was modeled against all predictor variables using software (SAS Proc Mixed, SAS Institute Inc, Cary, NC) with a random ski area effect. Nonsignificant variables were removed and reduced models were run with only the significant predictors. Regression parameters are reported for continuous predictor variables and least square means are reported for categorical variables.

RESULTS

Table I describes the characteristics of the adults interviewed. The sample was predominantly male, non-Hispanic white, college educated, and young (67.9% were aged ≤ 45 years). This reflects the

Table I. Respondent characteristics

Characteristic	Value	Percent
Gender	Male	72.6 (3471/4779)
Race	White, non-Hispanic	94.5 (3771/3990)
Education	≤ High school graduate	9.8 (440/4505)
	Trade school or some college	22.8 (1028/4505)
	College graduate/ postgraduate	67.4 (3037/4505)
Age, y	18-25	15.8 (767/4837)
	26-45	52.1 (2518/4837)
	>45	32.1 (1552/4837)
Equipment	Skis	79.5 (3774/4750)
	Snowboard	20.5 (976/4750)
Level	Beginner	5.8 (278/4819)
	Intermediate	54.5 (2629/4819)
	Expert	39.7 (1912/4819)
Local vs destination	Local	57.7 (2678/4639)
Days skied/ snowboarded this winter	>5	53.7 (2581/4804)

demographics of the sports of skiing and snowboarding. The sample comprised respondents who were predominantly skiers, of intermediate or expert ability, spent more than 5 days skiing/snowboarding during the season, and lived locally (within 200 miles of the ski area).

Compliance with sunscreen advice

Compliance with sunscreen advice was inconsistent (Table II). Overall, 49.8% (95% confidence interval [CI] = ±1.4) of adults were compliant with advice to wear sunscreen with SPF 15 or higher. Of these, 73.2% (95% CI = ±1.8) complied with advice to apply sunscreen 30 minutes before sun exposure and 20.4% (95% CI = ±2.0) complied with advice to reapply it after 2 hours. However, only 4.4% (95% CI = ±0.6) of all respondents were in total compliance with sunscreen advice (ie, complied with all 3 recommendations). The most common pattern was to wear sunscreen with SPF 15 or higher and apply it at least 30 minutes before going outdoors (36.0% [95% CI = ±1.4] of all respondents), with just 6.3% wearing a sunscreen with SPF 15 or higher and reapplying it and 4.0% (95% CI = ±0.6) only wearing sunscreen with SPF 15 or higher. Almost half of adults (45.6% [95% CI = ±1.4]) did not comply with any of these sunscreen recommendations.

Predictors of complete compliance with sunscreen advice

Several weather and personal factors predicted whether adults were in complete compliance with the sunscreen advice (Table III). Complete compliance was lowest during inclement weather, on days with lower UV intensity, by men, among respondents who believed skin cancer was unimportant, and who reported low sun-sensitive skin.

Table II. Response to sunscreen compliance questions

Wearing sunscreen today	Wearing sunscreen with SPF ≥ 15	Sunscreen applied ≥ 30 min before starting skiing/snowboarding	Sunscreen reapplied after 2 h	N
No				2152
Yes (n = 2678)	No (n = 271)	No (n = 78)	No	32
			Yes	10
			n/a	36
			Missing response	0
		Yes (n = 178)	No	108
			Yes	7
			n/a	60
			Missing response	3
		Missing response (n = 15)	No	0
			Yes	0
			n/a	2
			Missing response	13
	Yes (n = 2407)	No (n = 638)	No	193
			Yes	97
			n/a	340
			Missing response	8
		Yes (n = 1741)	No	998
			Yes	213
			n/a	510
			Missing response	20
		Missing response (n = 28)	No	0
			Yes	1
			n/a	10
			Missing response	17
Missing response				7
Total				4837

n/a, Reapplication questions not applicable because respondent applied sunscreen <2 h before interview (n = 958); *SPF*, Sun protection factor.

Association of complete compliance with other sun protective behaviors

Adults who were in complete compliance with sunscreen advice also were likely to practice other sun protection behaviors (Table III). Specifically, complete compliance with sunscreen advice was higher among those also using sunscreen lip balm (8.0% using lip balm vs 3.1% not using lip balm, F

Table III. Results of multivariate regression of total compliance on various predictor variables

Predictor	Regression coefficient/SE	Least square means	F value	DF	*P* value
UV intensity index	0.007/0.002		9.70	1, 4522	.002
Weather index	0.007/0.001		30.72	1, 4522	<.001
Skin cancer importance		Strongly agree = 0.066 Agree = 0.045 Neutral = 0.029 Disagree = 0.024 Strongly disagree = 0.010	5.31	4, 4522	<.001
Skin sun sensitivity		Always burns = 0.049 Usually burns = 0.039 Sometimes burns = 0.034 Rarely burns = 0.019	3.29	3, 4522	.012
Gender		Female = 0.155 Male = 0.081	21.45	1, 4522	<.001

DF, Degrees of freedom; *UV*, ultraviolet.

[1,4011] = 54.48, $P < .0001$) and those wearing a hat with a brim (6.7% using hats vs 4.4% not using hats, F [1,4011] = 6.89, $P = .0087$). No other variables were statistically associated with complete compliance at the .05 level of significance.

DISCUSSION

Even though half of the respondents followed advice to wear SPF 15 or higher sunscreen, very few complied with all of the advice that maximizes sunscreen's efficacy (ie, apply it before going outdoors and reapply it). Advice to use sunscreen with SPF 15 or higher has been conveyed through commercial advertising and in public health messages and seems to have been taken to heart by at least half of the winter sports enthusiasts surveyed.

Communication regarding preapplication and reapplication needs to be stressed in future campaigns. The effectiveness of sunscreen, particularly those that are not waterproof or water resistant and bind well with the skin, can degrade over time and result in very little photoprotection.[12,17,18] Unfortunately, too, many adults underapply sunscreen[15] so reapplication is important to correct this, especially within 30 minutes of initial application.[12] Failure to preapply and reapply sunscreen means that many of the respondents in this survey may have risked sunburns when spending the entire day outdoors.[16,30]

The prevalence of SPF 15 or higher sunscreen use in this sample was higher than that recorded in general population surveys. Other research has found similar elevated use during recreation and activities that involve prolonged periods of sun exposure (eg, beach going, golfing, gardening).[31,32] Individuals may use sunscreen to prolong the time that it takes to become sunburned when intentionally engaged in sun exposure,[9,19,32-35] including outdoor recreation. However, sun exposure is incidental in many recreational pursuits, and length of sun exposure is determined by factors other than an intentional desire to obtain a tan. Thus, sunscreen use during such recreation may not prolong time in the sun and instead be a photoprotection strategy that actually reduces overall UV exposure. Also, the sun exposure achieved during recreation should be balanced against its physical and mental benefits.

It was encouraging that nearly 3 in 4 adults who used sunscreen had applied it to the skin at least 30 minutes before going outdoors. Compliance with preapplication advice also was far higher in this study than in a study of sunscreen use by Lebanese adolescents at beaches.[36] Still, many respondents did not report reapplying sunscreen. Low rates of reapplication were seen in another study (20%-30% depending on the body location).[15]

The lower compliance with sunscreen advice by men is consistent with their infrequent sun protection behaviors of all type (an exception being hats used by men).[15,19,31,32,36] The lower compliance with sunscreen advice during inclement weather and by adults with less sun-sensitive skin, seen elsewhere,[15,31] may indicate that some adults are judging whether to use sunscreen based on environmental or personal cues to their risk.

Implications for skin cancer prevention

The next generation of sun safety promotions needs to move beyond simply recommending the use of sunscreen to teaching adults how to maximize its effectiveness through preapplication and reapplication. There are several benefits from stressing reapplication. It can help to overcome consumers'

reluctance to initially apply the large amount of sunscreen needed to obtain its full benefit (perhaps because it feels greasy and leaves a film on the skin[37]). Those who reapply can substantially improve the effectiveness of an initial application of sunscreen.[12] Also, stressing reapplication introduces some novelty in the sun safety messages compared with repeating the simple and oft heard message to use sunscreen. Granted, reapplication may not have been necessary in mid winter (January) or on cloudy days in the winter, when UV radiation levels were low[38] in this study, but we found that UV radiation levels measured during spring skiing (March and April) at the participating ski areas can be very high.[20]

In addition, sun protection promotions should stress the use of other forms of protection such as clothing and reducing overall time in the sun, and the use of sunscreen, to help achieve a beneficial balance. Decisions to wear head, ear, face, and neck covering in the winter may be done so for warmth, which may explain why they did not associate with sunscreen compliance.

The results also indicate that certain subgroups should be high-priority populations for sunscreen promotion. Men may be less concerned with the appearance and health of their skin, and may consider the use of skin lotions such as sunscreen to be less normative than women. They also may not be as anxious about skin cancer as women. Adults who believe that skin cancer is not an important health concern complied less with sunscreen advice.

Finally, redoubled efforts are needed to teach adults how environmental features affect UV radiation levels.[20] Inclement weather (ie, cloud cover) reduces UV radiation only partially especially when UV radiation levels are high in spring and summer, so depending on inclement weather for sun protection decisions can result in risky sun exposure. Moreover, the high elevation and high reflectivity of the snow surface at ski areas increased UV radiation[22-25] and adults should consider taking precautions even in winter months.

Strengths and weaknesses of the study

There are several strengths and limitations to this analysis of sunscreen compliance. The large sample provided substantial statistical power and the 28 ski areas in 9 states/provinces and two countries increased the potential generalizability of the findings. Although ski areas were located only in western North America, respondents lived in all part of North America and in countries outside the United States and Canada. Still, the analysis is most applicable to outdoor recreation enthusiasts who are male and of high socioeconomic status. The sample was almost entirely non-Hispanic white but this is the highest risk population for skin cancer.[39] The results apply most to winter recreation, a time when UV radiation levels are low (although UV can be high and sufficient to sunburn[20,21]) and large portions of the skin are covered. Vitamin D levels can decrease in the winter, raising concern about recommending sun protection. However, several studies on sunscreen use in practice (rather than in controlled clinical measurement) found little evidence of reduced vitamin D levels.[40-44] Dietary supplementation may be the best way to maintain vitamin D levels in winter.[45,46] Another strength is that participants were asked to recall use of sunscreen on the day of the interview rather than at some time in the past, which should have reduced memory errors. Still, these were self-reports and subject to social desirability biases and demand effects. Also, the measure did not determine whether adults selected the SPF in their sunscreen by choice or availability (few low-SPF sunscreens are available). Fortunately, measures of other sun protection behaviors were obtained through observation, which is less subject to recall errors and such biases. A final limitation is the age of the data, collected nearly a decade ago. Since then, information on the health benefits of vitamin D and concerns about the quality of, and chemical in, sunscreens have been in the news, which may have reduced adults' compliance with sunscreen advice.

Future research

The results suggest several additional avenues of inquiry. This analysis of compliance with sunscreen advice needs to be replicated with adults in summertime settings and with children and adolescents. The inclement weather during winter requires more clothing and this may explain why so many adults applied sunscreen before going outdoors.[38] Frequent compliance with preapplication advice may not occur in summer where it is easier to apply outdoors when more skin is exposed. It would be useful to determine whether these compliance patterns occur in other outdoor venues and during other outdoor activities, or among a broader sample of at-risk adults who are perhaps older and less interested in physical recreation, or live outside North America. Similarly, it would be instructive to determine which forms of sun protection promotion achieves complete compliance with sunscreen advice, eg, public health campaigns, advice from clinicians, or social pressure from family and friends. These results should be compared with locations where promotions have been more intensive such as Australia to

see whether complete compliance can be elevated. Finally, the association of sunscreen lip balm use with complete compliance needs further exploration. It may be that these products are frequently recommended together and considered by many adults to be part of the general sunscreen advice. Alternatively, the concomitant use of these two products, along with brimmed hats, indicated that there is a group of highly sun-safe individuals who have internalized the entire sun protection protocol. If so, they should be described and the means by which their full compliance was achieved should be investigated to provide insights into effective sun protection promotions.

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