

Measures of Sun Exposure and Sun Protection Practices for Behavioral and Epidemiologic Research

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Objective: To develop, in a collaborative project, core measures of sun exposure and sun protection habits, since the lack of standard outcome measures hampers comparison of population surveys and interventions used in skin cancer prevention research.

Design: A work group of investigators evaluated available questionnaire measures of sun exposure and protection. Their deliberations led to a proposed set of core questionnaire items for adults, adolescents aged 11 to 17 years, and children 10 years or younger. These core items were used in cognitive testing by the investigators. Cross-site summaries of methods, response samples, and descriptive data were prepared.

Setting: Nine locations across the United States.

Participants: The study population comprised 81 individuals.

Results: No unusual response patterns were detected in any of the respondent groups or for any specific question. Some revisions to the survey items resulted from the need for clarification or emphasis of frames of reference such as adding or underlining key phrases in a question.

Conclusions: The combination of expert review followed by cognitive interviewing yielded standardized core survey items with good clarity and applicability for measuring sun exposure and sun protection behaviors across a broad range of populations. They are appropriate for studies tracking morbidity and/or mortality and evaluating prevention program effects.

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SKIN CANCER, THE MOST COMMON cancer in the United States,¹ is diagnosed in about 1 million Americans each year.² The incidence of skin cancer has increased dramatically worldwide in the last decade,^{1,2} establishing the 3 main types of skin cancer—malignant melanoma, squamous cell cancer, and basal cell cancer—as significant public health concerns.^{1,3} Squamous cell cancer risk increases with high levels of cumulative sun exposure, and malignant melanoma and basal cell cancer risk factors include a history of severe sunburn and intense intermittent exposure to the sun at an early age.⁴

See also page 225

Although the incidence of skin cancer is increasing, it is considered one of the most preventable types of cancer. UV radiation (UVR) exposure is the major environmental risk factor for skin cancers,⁵

and reducing UVR exposure and adopting sun protection habits (eg, wearing sunscreen, hats, shirts, and sunglasses) are the main public health recommendations for prevention.⁶

PREVIOUS SURVEYS OF SUN PROTECTION BEHAVIORS AND SUN EXPOSURE

Given the importance of increasing sun protection behaviors and reducing sun exposure, the measurement of these behavioral factors is a priority in national surveys and in evaluating intervention efforts. In the United States, several national surveys measured sun protection and sun exposure; however, because of space and/or budget restrictions there is usually 1 key measure of sun exposure (sunburn) and an array of sun-protective behavior items. In 2000, the National Health Interview Survey, a household survey of the noninstitutionalized, adult civilian population, asked questions about sunburn, and data showed that ap-

proximately 36% of US adults experienced at least 1 sunburn during the past year.⁷ The Behavioral Risk Factor Surveillance System asked about sunburns in 1999, 2003, and 2004. Data from 2003 showed that approximately 39% of the US population reported a sunburn in the past year, with higher rates in Midwestern and northern states.⁸

The National Health Interview Survey has included questions about sun sensitivity and sun protection since 1992. Despite slight variations in question wording over time, this survey indicates that sun-protective behaviors have a moderate to low prevalence and that sun exposure is high. Data from 2003 showed that 61% of adults were very likely to practice at least 1 sun protective behavior, but when it came to individual behaviors, the prevalence was low: 33% were very likely to use sunscreen, 33% were very likely to wear protective clothing, and 31% were very likely to use shade.⁹ The overall prevalence of any one of these sun protection behaviors has hovered around 30% since the early 1990s. This was confirmed by the Health Information National Trends Survey 2005, a random-digit dial telephone survey. Of the respondents, 27% reported always or often wearing sunscreen when outside for more than 1 hour on a warm sunny day; 43%, staying in the shade; 16%, wearing a long-sleeve shirt; and 45%, wearing long pants.¹⁰

Since 1999, the Youth Risk Behavioral Survey, a school-based survey of students in the 9th through 12th grades, has contained the same question on sunscreen use. Data from 2003 showed that even the most common sun-protective behavior among adolescents, sunscreen use, has remained low, with approximately 17% of white adolescents reporting they use it most of the time or always. This prevalence has not changed markedly over the 5-year period.¹¹

There are few national sun protection surveys of children younger than 11 years. In 1998, the Centers for Disease Control and Prevention conducted a survey with parents of white children aged 6 months to 11 years. They found that children spent a median of 20 hours a week outdoors during the summer. Sunscreen and shade were the most frequently used protection methods (62% and 26.5%, respectively). They also found that approximately 43% of white children experienced 1 or more sunburns in the past year.^{12,13}

Sunscreen is the most frequent method of sun protection used across all age groups in Australia and internationally.¹⁴ The other forms of recommended sun protection (hats and clothes) were more likely to occur among the very young, older adults, and men. Differences across countries exist for sun exposure and sun protection for adults, adolescents, and children.¹⁵ In the United States, most of the surveys report low prevalence of protection and high prevalence of sunburns. The prevalence of these behaviors has not changed markedly in the last 2 decades. Surveys vary in content and questions, making comparisons within and between countries and age groups problematic.

MEASUREMENT NEEDS IN SKIN CANCER PREVENTION

The majority of studies use verbal reports or self-reports to measure habitual sun exposure and solar protection behaviors.¹⁶ Despite well-known limitations of ver-

bal reports, these measures are the most practical for both population surveillance and intervention research. A central concern in monitoring progress and summarizing the evidence for effective prevention strategies with broad applicability is the comparability of assessments across population-based surveys and outcome measures used in intervention research. The present article describes the process and results of a collaborative national effort to develop a recommended set of core items for surveys and intervention research in skin cancer prevention.

METHODS

INVESTIGATOR WORKSHOP AND WORK GROUP ON SUN EXPOSURE AND SUN PROTECTION MEASURES

In December 2005, the National Cancer Institute and the Emory Prevention Research Center convened a 2-day workshop for skin cancer prevention investigators from across the United States, with the aim of developing a consensus-based set of core survey questions on UVR exposure and protection behaviors. Two workgroups were formed: work group A focused on outdoor sun exposure and sun protection, and work group B addressed indoor tanning behaviors. This article is limited to the methods used by work group A (see "Additional Information" at the end of this article for list of members).

Prior to the workshop, participants were asked to submit relevant questionnaire measures that they were currently using, along with scoring algorithms and available psychometric data. Questionnaires from 13 investigators were received and compiled for review before and during the workshop. Additional measures from the published literature were also included.¹⁶

Work group members used an "expert evaluation" process to review the available questionnaire measures. The group considered the following factors in evaluating the measures: (1) What are the most important skin cancer prevention-related behaviors to measure that should be recommended for assessment in all skin cancer prevention research efforts? (2) For each behavior, what questionnaire wording will be most applicable across geographic regions, climate conditions, and populations? (3) What item wording would be most adaptable across survey modalities and formats (ie, self-administered, telephone, or personal interview)? (4) What response options will be most understandable across populations, be useful in discriminating between levels of behavior, and capture an appropriate range of behaviors? (5) What would be the most appropriate time frame for answering behavioral questions (eg, behavior in a typical week; behavior during a particular time of day; behavior on weekends vs weekdays)?

Through consideration of these key questions and review of existing measures, the group reached consensus on 7 core questionnaire items for adults, 8 core items for adolescents aged 11 to 17 years, and 7 core items for parents reporting for children 10 years or younger. Consensus was also reached for secondary items (5 for adults, 2 for adolescents, and 3 for parents reporting for children 10 years or younger).

COGNITIVE INTERVIEWING TO REDUCE SYSTEMATIC ERROR OF SELECTED ITEMS

Rationale for Cognitive Interviewing

To further develop core measures that would be widely applicable to skin cancer prevention surveillance and behavioral research, the proposed core items were cognitively tested among

the intended participants (ie, adults, adolescents, and parents reporting for children). Cognitive interviewing is a commonly used technique to aid in the improvement of questionnaire development.¹⁷ Typically, one-on-one interviews are conducted with participants after they complete survey items to help uncover cognitive processes that are used when answering the items (eg, how well a person understands and interprets survey questions, issues of memory retrieval, and how a particular subject responds to a question).¹⁷ In short, cognitive interviewing can be particularly useful in helping to identify and decrease sources of systematic error in self-report measures before the main fielding of the survey, thereby potentially increasing the validity and reliability of the measure.¹⁷ It is commonly used to pretest survey items going into national surveys, such as the National Health Interview Survey and Health Information National Trends Survey.^{18,19} This method was used recently to help develop core self-report measures of colorectal cancer screening.²⁰

Cognitive Interviewing Protocol

Four of the coauthors (L.A.C., J.K.R., K.G., and A.L.Y.) developed a cognitive interviewing moderator's protocol. The protocol was slightly modified to be specific for each of the 3 populations in which it would be tested (ie, adults, adolescents, and parents reporting for children). The protocol was used as a standardized guide to help elicit feedback from the subjects on their cognitive processes for answering the questions, including comprehension of the questions. Before cognitive testing, a conference call was conducted to review procedures and discuss site investigators' questions about procedures.

DATA COLLECTION PROCEDURES

To obtain a wide variety of respondents from different geographical settings, 9 study sites were available to conduct cognitive interviewing. The institutional review boards of Emory University (Atlanta, Georgia), Fox Chase Cancer Center (Philadelphia, Pennsylvania), Klein Buendel Inc (Golden, Colorado), Memorial Sloan-Kettering Cancer Center (New York, New York), Northwestern University (Chicago, Illinois), University of Colorado Health Sciences Center (Denver), University of Hawaii (Honolulu), University of South Florida (Tampa), and Virginia Commonwealth University (Richmond) approved the research protocol. Specific recruitment methods varied according to the site's location and targeted study population. Five university sites used on-campus recruitment strategies such as e-mail announcements, fliers, visiting classes, and approaching individuals. One site recruited adolescents aged 11 to 17 years through acquaintances. Three sites that targeted patients with a history of skin cancer or their first-degree relatives recruited people who had participated in previous studies or in person during visits for dermatologic examination.

Participants were screened for eligibility according to each site's inclusion criteria. People who worked in the tanning industry or lived with people employed in the tanning industry and those in marketing research, advertising, or public relations were ineligible. All written surveys were completed on-site, and cognitive interviews were conducted in person and audiotaped.

The protocol began by having interviewers thank participants for participating and informing them of the purpose of the study and that the interviews would be audiotaped. Before completing survey items, participants were told by interviewers that they would be asked to "think aloud" about how they answered particular questions. *Thinking aloud* was defined as stating everything that participants were thinking from the time they read each question until they wrote down the answers. The participants were instructed to act as if they were alone in a

room and speaking to themselves, which would include talking out their thoughts about a particular question. After the participants completed all of the survey items, they were queried about each individual survey item (eg, how they came up with the answer and whether the items were difficult to answer). Specific probes were used to help prompt them to discuss their thought processes in deriving their answers. For instance, one item asked, "On average, how many hours are you outside between 10 AM and 4 PM in the summer on weekdays?" One main probe for this item was, "how did you come up with this number?" If more follow-up was needed, participants were asked "Did you do any calculations in your head or did you ball park this?" This was completed for all of the individual survey items, and participants' responses were written down by researchers and audiotaped.

DATA ANALYSIS

Preliminary data analysis was completed at each data collection site by a researcher who reviewed written notes and questionnaire notations and listened to the audiotapes. Data analysts prepared a site report summarizing their recruitment procedures, response rates, and the results of cognitive interviews and sent documentation to the coordinating center at Emory University. Cross-site summaries were then prepared.

Qualitative analysis of the cognitive testing results was completed following the methods outlined by Willis.¹⁷ A code book was developed to synthesize cross-site issues related to the proposed questions, including categories such as clarity, knowledge/memory, response categories, instructions, and sensitive wording. Two research team members coded the response summaries for each question and each site. Coding discrepancies were discussed in meetings, and a final decision about how to code discrepant comments was made in consultation with the lead author (K.G.). Coded comments were then compiled into a summary table by question and by site, and problem areas were identified.

The coordinating center reviewed the results of the cognitive testing and used them to recommend revisions to the initial set of core measures. All participating investigators were asked to provide comments by e-mail, and a conference call was convened to discuss the results and make final recommendations for the core questionnaire items.

RESULTS

SAMPLE CHARACTERISTICS

A total of 81 respondents completed the cognitive interviewing across 9 study sites. Response rates ranged from 6% to 66% for patients with skin cancer and 70% to 100% for nonpatient samples. There were 72 respondents for the adult survey, 19 of whom were parents of children aged 1 to 10 years who also completed the child-specific questions. Nine adolescents (aged 11-17 years) completed cognitive interviewing. Overall, 72% of the sample were female and 72% were white, with an age range from 11 to 74 years and a median age of 31 years. Fifty-five percent of participants had a college degree or higher.

SURVEY ITEM REVISIONS

Examination of descriptive statistics for the responses revealed distributions similar to those found in the investigators' previous research and in national surveys. Because there were no unusual response patterns detected

A Final Core Items - ADULTS

For each question listed, please select the one answer that is the best response to the question.

Section 1 - Sun Habits

1. In the summer, on average, how many hours are you outside per day between 10 AM and 4 PM...on WEEKDAYS (Monday-Friday) ?

- 30 minutes or less
- 31 minutes to 1 hour
- 2 hours
- 3 hours
- 4 hours
- 5 hours
- 6 hours

2. In the summer, on average, how many hours are you outside per day between 10 AM and 4 PM...on WEEKEND DAYS (Saturday & Sunday) ?

- 30 minutes or less
- 31 minutes to 1 hour
- 2 hours
- 3 hours
- 4 hours
- 5 hours
- 6 hours

3. In the past 12 months, how many times did you have a red OR painful sunburn that lasted a day or more?

- 0
- 1
- 2
- 3
- 4
- 5 OR MORE

For the following questions, think about what you do when you are outside during the summer on a warm sunny day.

4. How often do you wear SUNSCREEN? NEVER RARELY SOMETIMES OFTEN ALWAYS

5. How often do you wear a SHIRT WITH SLEEVES that cover your shoulders?

6. How often do you wear a HAT?

7. How often do you stay in the SHADE or UNDER AN UMBRELLA?

8. How often do you wear SUNGLASSES? **

9. How often do you spend time in the sun in order to get a tan? **

- NEVER
- RARELY
- SOMETIMES
- OFTEN
- ALWAYS

10. What is the color of your untanned skin? **

- Very Fair
- Fair
- Olive
- Light Brown
- Dark Brown
- Very Dark

SECTION 2 - Skin Examination

11. Have you EVER had your skin checked for skin cancer from head to toe by a health professional? **

- No → Skip to question 13
- Yes ↓

12. If yes, what is the month and year when you last had your skin checked from head to toe? / /

Write Month/Year

13. In the last 12 months, have you or a partner examined your entire body, including your back, for skin cancer?

- No
- Yes ↓

14. If yes, how many times?

Write number

B Final Core Items - ADULT for CHILD age 1 to 10 years

For each question listed, please think about your CHILD who is 1 to 10 years old and select the one answer that is the best response to the question.

If you have more than one child who is 1 to 10 years old, please answer this survey thinking about your OLDEST child who is 1 to 10 years old.

Section 1 - Background Information

1. Thinking of your oldest child between the ages of 1 and 10, what is the age of this child?

- Less than 1 year old
- 1-3 years old
- 4-6 years old
- 7-10 years old

2. Is this child a...?

- Boy
- Girl

Section 2 - Sun Habits

3. In the summer, on average, how many hours is this child outside per day between 10 AM and 4 PM...on WEEKDAYS (Monday-Friday) ?

- 30 minutes or less
- 31 minutes to 1 hour
- 2 hours
- 3 hours

- 4 hours
- 5 hours
- 6 hours

4. In the summer, on average, how many hours is this child outside per day between 10 AM and 4 PM on WEEKEND DAYS (Saturday & Sunday) ?

- 30 minutes or less
- 31 minutes to 1 hour
- 2 hours
- 3 hours
- 4 hours
- 5 hours
- 6 hours

5. In the past 12 months, how many times did this child have a red OR painful sunburn that lasted a day or more?

- 0
- 1
- 2
- 3
- 4
- 5 OR MORE

For the following questions, think about what this child does when outside during the summer on a warm sunny day.

6. How often does this child wear SUNSCREEN? NEVER RARELY SOMETIMES OFTEN ALWAYS

7. How often does this child wear a SHIRT WITH SLEEVES that cover the shoulder?

8. How often does this child wear a HAT?

9. How often does this child stay in the SHADE or UNDER AN UMBRELLA?

10. How often does this child wear SUNGLASSES? **

11. How often does this child spend time in the sun in order to get a tan? **

- NEVER
- RARELY
- SOMETIMES
- OFTEN
- ALWAYS

12. What is the color of this child's untanned skin? **

- Very fair
- Fair
- Olive
- Light brown
- Dark brown
- Very dark

C Final Core Items - ADOLESCENTS

For each question listed, please select the one answer that is the best response to the question.

1. In the summer, on average, how many hours are you outside per day between 10 AM and 4 PM...on WEEKDAYS (Monday-Friday)?

- 30 minutes or less
- 31 minutes to 1 hour
- 2 hours
- 3 hours
- 4 hours
- 5 hours
- 6 hours

2. In the summer, on average, how many hours are you outside per day between 10 AM and 4 PM...on WEEKEND DAYS (Saturday & Sunday)?

- 30 minutes or less
- 31 minutes to 1 hour
- 2 hours
- 3 hours
- 4 hours
- 5 hours
- 6 hours

3. In the past 12 months, how many times did you have a red OR painful sunburn that lasted a day or more?

- 0
- 1
- 2
- 3
- 4
- 5 OR MORE

For the following questions, think about what you do when you are outside during the summer on a warm sunny day.

4. How often do you wear SUNSCREEN? NEVER RARELY SOMETIMES OFTEN ALWAYS

5. How often do you wear a SHIRT WITH SLEEVES that cover your shoulders?

6. How often do you wear a HAT?

7. How often do you stay in the SHADE or UNDER AN UMBRELLA?

8. How often do you wear SUNGLASSES? **

9. How often do you spend time in the sun in order to get a tan?

- NEVER
- RARELY
- SOMETIMES
- OFTEN
- ALWAYS

10. What is the color of your untanned skin? **

- Very fair
- Fair
- Olive
- Light brown
- Dark brown
- Very dark

**Secondary Items (all others are Primary Core Items)

Figure. Core skin cancer prevention items for adults (A), adults reporting for children 10 years or younger (B), and adolescents aged 11 to 17 years (C).

in any of the respondent groups or for any specific question items, the cognitive interviewing results were used to guide further revisions to the core items.

The main revisions to survey items resulted from the need for clarification or emphasis of frames of reference such as adding or underlining key phrases in the question. For example, for the survey item "How often do you wear a shirt with sleeves?" the phrase "that covers your shoulders" was added to the end of the question because several respondents mentioned that they were unsure of what length of sleeve to consider in their answer. On the set of items for which adults were asked to report on their child, several respondents who had more than 1 child indicated the need for greater clarity about which child to report on; thus, the instructions were revised to clarify that parents were to answer the survey while considering their oldest child aged between 1 and 10 years.

Response options for questionnaire items were also revised to reflect answers most commonly used and understood by respondents. For the item "What is the color of your untanned skin?" the response options of "light brown" and "dark brown" were added, while "dark" and "black"—options that had been found confusing—were dropped. Response options were kept uniform across all 3 survey types.

Respondents noted inherent limitations to self-reports that could not be solved by altering the questions. For example, some parents expressed concerns that they did not always know what their child did for sun protection because they were often separated from the child.

RECOMMENDED MEASURES

The recommended core items are listed in the **Figure**. These measures are recommended for use in population-based surveillance and both descriptive and experimental behavioral research. The work group suggests that researchers make minor adaptations to the questions based on their study aims, relevant geographic or seasonal considerations, and unique population characteristics such as race/ethnicity and skin cancer history. In addition, researchers are encouraged to evaluate the reliability and validity of these measures in various research contexts.

COMMENT

It is well recognized that the measures used to assess UVR exposure and sun protection practices vary, making comparisons between populations problematic.^{14,15} The development and adoption of standardized core survey items will advance the science in a number of ways. First, studies that track morbidity and/or mortality and evaluate the success of intervention programs would be more feasible and precise. Second, the field could achieve greater comparability between populations. A strength of the present effort is that it was conducted in a much larger sample of participants than is typical of cognitive interviewing studies.¹⁷

This study reflects a growing trend in behavioral sciences to highlight and address the quality of self-report measures through multiple strategies, including but not limited to cognitive interviewing. While use of self-

reports has been recommended as the most feasible measure for large population surveys and intervention studies,¹⁶ the paucity of data on psychometric properties of behavioral measures of skin cancer prevention is an important limitation for research in this area. Self-report measures are limited by individuals' recall errors, difficulty in estimating the frequency of common habits, and social desirability. Still, self-reports will likely remain the most commonly used assessment method, as they are in many other health behavior arenas (eg, diet, physical activity, and tobacco use). Thus, ongoing examination of feasibility, reliability, and validity of self-report measures is an important priority. Cognitive interviewing helped to improve our items and responses in terms of clarity, accuracy, specificity, and breadth, improving feasibility and establishing face validity.

This study is an important first step in the development, cognitive testing, and recommendation of a set of core items. The results of this study could be augmented by doing further quantitative evaluation to evaluate internal consistency, test-retest reliability, and concurrent and criterion validity (eg, by comparing the current items to objective measures such as observation, skin reflectance, personal dosimetry, skin swabbing, and inspection of moles).¹⁶ Also, the items need to be tested across differing administration modalities such as paper and pencil, face to face, telephone, and computer, possibly with modifications to reduce potential biases introduced by mixed-model interviewing.²¹

One strength of this study involved the inclusion of a wide age range of participants. The questions can be used in a variety of cohorts and easily compared, and they may be easily adapted to other cohorts or specific time frames. A limitation of the present study is that the sample consisted mainly of female and white individuals. We also recognize that these core items cannot serve all study purposes (eg, assessing children's behavior at events when parents are absent). They may need to be adapted to study goals, population, and geographic locale.

In conclusion, this project brought together many of the leading skin cancer prevention researchers to create a core set of self-report items and test them on a diverse range of participants. There remains an important need for further measure development work to increase reproducibility and decrease redundancy across many studies and cohorts. Efforts such as this will improve our ability to track health risk behaviors with increased accuracy and reliability and provide the opportunity for more informed and tailored recommendations regarding UVR and sun protection practices.

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Author Contributions: Dr Glanz had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Glanz, Yaroch, Dancel, Saraiya, Crane, Buller, Manne, O'Riordan, Heckman, Hay, and Robinson. *Acquisition of data:* Glanz, Dancel, Crane,

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