Sun Exposure, Sun Protection, and Vitamin D

**ARCHIVES OF DERMATOLOGY**

Sunscreen Use Related to UV Exposure, Age, Sex, and Occupation Based on Personal Dosimeter Readings and Sun-Exposure Behavior Diaries

Elisabeth Thieden, MSc(Pharm); Peter A. Philipsen, PhD, MSc(Engin); Jane Sandby-Møller, MD, PhD; Hans Christian Wulf, MD, DSc

**Objectives:** To examine during what behaviors people apply sunscreen and to assess the relationship to UV exposure monitored by personal dosimetry and diaries.

**Design:** Open prospective observational study.

**Setting:** University hospital.

**Participants:** A convenience sample of 340 Danish volunteers: children, adolescents, indoor workers, sun worshippers, golfers, and gardeners (age range, 4-68 years).

**Intervention:** Subjects recorded sunscreen use and sun-exposure behavior in diaries and carried personal, electronic UV dosimeters, measuring time-stamped UV doses continuously, during a median of 119 days covering 346 sun-years (1 sun-year equals 1 subject participating during 1 summer season).

**Main Outcome Measures:** Associations between sunscreen use and age, sex, skin type, occupation, sunburn, UV exposure doses, and behavior; and adequate application density and sun protection factor required to prevent sunburn.

**Results:** There were great variations in sunscreen use, which was highly correlated with risk behavior (sunbathing or exposing the upper body) \( r = 0.39; P < .001 \). Sunscreens were used on a median of 5 days per sun-year (range, 1 day for gardeners to 16 days for sun worshippers). Ten percent of females and 41% of males never used sunscreens. Females used sunscreens more but also had more unprotected risk behavior than males (8 days vs 4 days; \( P < .001 \)). Sunscreen use was not correlated with age, and children had as much unprotected risk behavior as adults. Sunscreens were used on 86% of the days with risk behavior in southern Europe vs 20% in northern Europe \( (P < .001) \). The UV doses were significantly higher on days with sunscreen \( (P < .03) \) and on sunburn days \( (P < .001) \). The median sun protection factor was 10.5. The sun-protecting effect corresponded to an application density of 0.5 mg/cm².

**Conclusions:** Days with sunscreen correlated not with days without risk behavior, but with days “sunbathing with the intention to tan,” indicating that sunscreens were used as tanning aids to avoid sunburn.

*Arch Dermatol.* 2005;141:967-973

Commentary by June K. Robinson, MD

Despite using sun protection, many fair-skinned readers of this issue of *JAMA* experienced sunburn this summer. The personal experience of a tender sunburn makes it easy to identify with sun protection behaviors reported in the study published in the August issue of the *Archives of Dermatology*, in which Thieden et al measured UV exposure in conjunction with sunscreen use. Sunscreen use is correlated with high-risk activities such as gardening and deliberate sun exposure with intention to tan. While many individuals remember to use sunscreen when they expect to be exposed to the sun, most do not apply sunscreen every day, even though daily sunscreen use has been demonstrated to prevent squamous cell carcinoma.²

The study by Thieden et al resolves the conundrum between retrospective epidemiological studies and prospective studies of sunscreen use. Although more recent, controlled epidemiological studies have shown protective effects from sunscreen use,³⁴ previous epidemiological studies of sunscreen use show increased skin cancer risk associated with sunscreen use.⁶¹⁰ The early reports of association of sunscreen use with increased skin cancer risk was not supported by prospective controlled sunscreen trials, which have uniformly shown protection from sun-induced tumors.¹¹¹³ One explanation is that sunscreen use is sometimes a marker for those receiving larger short-wave UV doses that is not completely compensated for by the protective effect of sunscreen.

In this same issue of the *Archives of Dermatology*, Dupuy et al examined the effect of sunscreen labeling (sun
protection factor [SPF]) among those at French vacation sites. Vacationers volunteered to be randomly assigned to 3 different sunscreen groups for a week during their holiday. Two groups were given SPF 40 sunscreen labeled either “basic protection” or “high protection,” but were blinded to the actual SPF number. The third group received SPF 12 labeled as “basic protection.” There was no difference in sunscreen use between the SPF 40 groups, suggesting that the “high protection” label did not lead to more intentional UV exposure or less sunscreen use than the same SPF 40 sunscreen labeled “basic protection.” Those who received SPF 12 sunscreen used more than those in the SPF 40 groups, which suggests that experiencing erythema may cause individuals to use more sunscreen. While sunscreens are not the method of choice for sun protection (avoidance and clothing are preferred), the policy of recommending a high SPF sunscreen is sound. The most common form of sun protection used is sunscreen. Usually, once the sunscreen is applied, the user forgets to reapply it or to limit the duration of sun exposure. Several national and international studies of sun exposure and sun protection behaviors showed that the amount of daily incidental sun exposure the average person receives is considerable.15-17

A recent health concern of some patients is that practicing sun protection may decrease intake of vitamin D. The benefits of vitamin D are well-known, including improved bone health, fracture prevention, better muscle health, and reduced risk of falling in older individuals. Recent widely reported epidemiological studies have shown a beneficial effect of vitamin D for colon cancer,18 multiple sclerosis,19 insulin resistance,20,21 osteoarthritis,22 hypertension,23-25 periodontal disease,26 and a variety of other cancers.27,28 Daily incidental sun exposure is adequate for vitamin D production to occur in fair-skinned individuals. Exposing 5% of the body surface in fair-skinned persons 2 to 3 times a week for 5 minutes of noontime summer sun exposure is equivalent to an intake of 430 IU/d of vitamin D, which satisfies the recommended vitamin D intake of 200 IU/d for young adults.29 Nonetheless, vitamin D deficiency does exist in healthy adolescents and has been reported in the winter months in both younger and older adults.30 For persons aged 51 to 70 years, the recommended vitamin D intake is 400 IU/d, and 600 IU/d for those older than 70 years.

While there is evidence that many individuals in the United States, particularly older adults and darker-skinned individuals, may have vitamin D levels lower than those necessary for optimum health, increasing exposure to either natural or artificial (UV) light is not recommended as a supplemental source of vitamin D.31 Vitamin D levels are lower in the elderly than in younger persons perhaps due to their thin epidermis having less 7-dehydrocholesterol, the source compound for the generation of vitamin D by suberythemal UV doses. The melamin pigment of the epidermis of darker-skinned individuals absorbs the UV photons responsible for the photochemical reactions producing pre-vitamin D. Photosynthesizing vitamin D through natural sunlight is maximized after 20 minutes of UV-B exposure. Extended sun exposure provides no additional benefit but does increase the likelihood of photo-related damage, skin cancer, and eye damage.

Sources of vitamin D that do not carry a risk of skin cancer are vitamin D supplements or food sources. Multivitamins usually contain 400 IU of vitamin D per tablet. In the United States, milk is supplemented and contains about 100 IU of vitamin D per 8-oz glass. One multivitamin tablet taken with a glass of milk provides 500 IU of vitamin D, which meets the current daily recommendations for those younger than 70 years.29 Some suggest that these recommendations may fail to bring most individuals up to the desired serum levels of 80 nmol/L. In particular, those who are lactose intolerant and consume less milk may need to take nutritional supplements of vitamin D and consume foods rich in vitamin D such as fatty fish (eg, salmon and mackerel). While supplements containing vitamin D and foods fortified with vitamin D can increase the serum levels, there are concerns about consistent compliance. Although supplements are inexpensive, they are not free and the population most at risk for vitamin D deficiency, darker-skinned individuals who are lactose intolerant, may be least able to afford them.

The recent increasing incidence of skin cancer, especially melanoma, is a cause for concern. Current estimates are that 1 in 5 individuals living in the United States will develop skin cancer during their lifetime. In 2005, it is estimated that 105 750 melanomas will be diagnosed in the United States: 59 580 invasive melanomas and 46 170 cases of melanoma in situ.32 Melanoma will claim about 7770 lives in 2005.33 One in 4 individuals who develop melanoma is younger than 40 years; and their death changes the lives of their young children. The direct cost of treating melanoma will exceed $563 million with most of the expense attributed to treating advanced stages.34

Physicians can help stem the tide of increasing incidence of melanoma by providing educational counseling about sun protection to those at greatest risk: the families of those with a history of skin cancer and those with fair skin that tans poorly and sunburns readily. Physician nonjudgmental counseling supports adopting sun protection to prevent unnecessary exposure to carcinogenic UV light by using the 4 sun protection recommendations: (1) avoidance of deliberate tanning with indoor or outdoor light, (2) seeking shade when outdoors, (3) wearing protective clothing such as a hat with a 4-inch brim, sunglasses, and a long-sleeved shirt whenever possible, and (4) applying a broad-spectrum sunscreen with an SPF of 15 or higher before going outdoors.35,36

In the United States, adolescents, particularly females, widely use indoor UV tanning and are particularly susceptible to discount pricing incentives.37 Physician leadership in state health departments should consider prohibiting youth discounts, particularly in states with indoor tanning youth access regulations. Parents and peers can be effective in leading individuals to reduce harmful behaviors.38
REFERENCES

3. Rodenas JM, Delgado-Rodriguez M, Herranz MT, et al. Sun exposure, pigmen-
10. Autier P, Dore JF; EPIMEL and EORTC (European Organization for Research and Treatment of Cancer) Melanoma Cooperative Group. Influence of sun expos-
11. Naylor MF, Boyd A, Smith DW, et al. High sun protection factor (SPF) sun-
12. Thompson SC, Jolley D, Marks R. Reduction of solar keratoses by regular sun-
development of new nevi in white children: a randomized controlled trial. JAMA.
Randomized controlled trial testing the impact of high-protection sunscreens on sun-
17. Robinson JK, Rigol DS, Amonette RA. Sunscreen use protection used by
18. Feskanich D, Ma J, Fuchs CS, et al. Plasma vitamin D metabolites and risk of
19. Munger KL, Zhang SM, O’Reilly E, et al. Vitamin D intake and incidence of
20. Chiu KC, Chu A, Go VL, Saad MF. Hypovitaminosis D is associated with in-

©2005 American Medical Association. All rights reserved.

Disclaimer: Dr Robinson was not involved in the editorial evaluation or editorial
decision to accept this work for publication.