

# Evaluation of Sunburn Protection by a Single Application of an SPF 70 Formulation at High Altitudes under Extreme Sun Conditions

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## Abstract

**Background/Objectives:** Risk of sunburn and long-term sun damage is exaggerated at high altitudes as a result of decreased ozone filtration. Sunscreens can provide effective protection if they contain adequate and photostable UV filter systems, and are applied appropriately. However, consumers often under-apply and do not reapply their sunscreens. This study was aimed at evaluating the protective effect of a single application of a new SPF 70 formulation containing a patented photostable sunscreen system against sunburn while skiing under the extreme sun exposure conditions at high altitudes.

**Methods:** The protective effect was evaluated on 75 subjects during a whole day of skiing in December at Vail, CO (elevation 8500 ft). UVB and UVA irradiation from the sun were measured with a radiometer at 1-hour intervals. Participants applied the sunscreens in the morning prior to skiing and returned on the next morning for skin evaluation by a dermatologist, photography, and self-assessment via questionnaire.

**Results:** 71 subjects completed the study. Dermatologist grading results showed that although subjects skied an average of 5.3 hours, no sunburn was observed on 70 out of 71 subjects. One subject showed slight erythema on the nose where she admitted to have under-applied the sunscreen. Subjects did not report any significant windburn or chapping, and felt that their skin was well moisturized.

**Conclusions:** A single application of the new SPF 70 formulation containing the patented photostable sunscreen system effectively protected against sunburn during over five hours of skiing at high altitudes.

## Introduction

The skin-damaging effects of ultraviolet B (UVB) radiation from sun exposure have been known for years. However, growing evidence also suggests a role for UVA exposure ( $\geq 320$  nm), which penetrates more deeply into the dermis than UVB, in acute and chronic injury to the skin, including photoaging, immuno-suppression, and carcinogenesis.<sup>1-4</sup> Therefore, sunscreens should provide effective and long-lasting protection over the entire UV spectrum. Such protection can, however, be affected by other factors including those related to patient practices. One patient-related factor that hinders adequate sun protection is underapplication of sunscreen. Mean application rates in some studies have ranged from 0.79 to 1.5 mg/cm<sup>2</sup>, far below the 2 mg/cm<sup>2</sup> application rate used to determine the sun protection factor (SPF) of sunscreens.<sup>7</sup> It has been reported that very sensitive skin subjects may require as high as SPF 90 for adequate protection under "typical" application.<sup>8</sup>

A patented, photostable sunscreen system<sup>9</sup> that combines avobenzone, oxybenzone, and the photostabilizer diethylhexyl 2,6-naphthalate (DEHN) to provide exceptional and long-lasting absorbance through the UVA and UVB spectrum has been introduced into various sun protection products. This paper describes the efficacy of a single application of this patented sunscreen system when formulated as SPF 70 on protecting against sunburn at high altitudes where some of the most extreme UV light conditions are found.<sup>10</sup>

## Materials & Methods



**Figure 1 –** The study site conditions in Vail, Colorado (8,000 to 11,000 feet above sea level), on the day of the study (December 30, 2006.) Some of the most extreme UV light conditions are found at high altitudes, where every 1000 feet above sea level increases UV radiation by 8%.<sup>10</sup> This is compounded in winter months during which the snow provides reflectivity. Additionally, particulate matter, which helps diffuse UV radiation, is often lacking in clean air at higher altitudes. Therefore, the risk of sunburn and sun damage is exaggerated at high altitudes.

UVA and UVB intensity readings were taken throughout the study period using an IL 1400 UV radiometer.

A total of 75 skiers were asked to participate and provided written informed consent. Each participant completed a form for age and phenotypic demographics. An initial examination for skin status was conducted by a dermatologist prior to entry into the study. Each participant was given an unmarked container of SPF 70 sunscreen. All participants applied sunscreen once before beginning skiing for the day, and were instructed not to re-apply sunscreen.

The efficacy of the sunscreen formulation was evaluated by dermatologist assessment of erythema/sunburn the morning after the day of skiing. Additionally, at the end of the study, each participant completed a poststudy questionnaire evaluating the sunscreen. Responses were rated on a 5-point Likert scale (1 = strongly agree; 5 = strongly disagree).

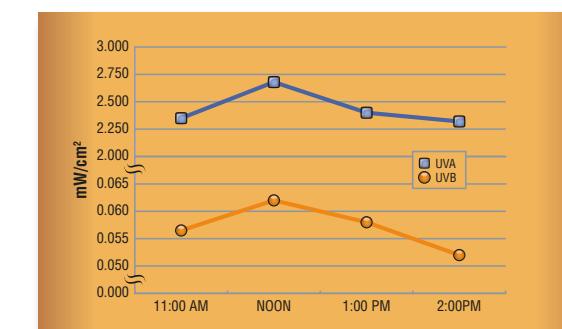
## Results

**Table 1 – Patient Demographics**

Age, mean	40 years
Gender	Number of participants
Female	26 (37%)
Male	45 (63%)
Skin type	Number of participants
I/II	34 (48%)
III/IV	37 (52%)
Eye color	Number of participants
Blue	26 (37%)
Green	8 (11%)
Hazel	15 (21%)
Brown	22 (31%)

- A total of 71 subjects completed the study. Demographic characteristics are shown in the Table 1.
- Approximately half of the study panel (48%) were skin types I/II, who would be expected to burn within 25 to 30 minutes on the day of the study without sun protection.

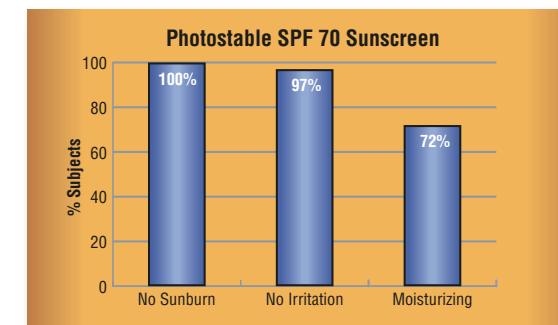
**Figure 2 –** UV intensity readings in Vail, Colorado, at the base of the mountain (8,500 feet above sea level) on the day of the study.



- On the day of the study, as expected UVA and UVB intensity was highest at noon (Figure 2). The average time to sunburning (1 minimal erythema dose) in unprotected skin types I/II at noon was 25 to 30 minutes. Mean Skiing Time = 5.3 hours per subject (range: 2 to >6 hours).

According to dermatologist evaluation, 70 of 71 subjects had no evidence of sunburning on exposed sites. One subject had mild erythema on the nose; however, it is noteworthy that this same subject reported that she had under-applied sunscreen on her nose.

**Figure 3 – Subject Self-Assessment of Sunscreen Performance**



- 100% of participants reported that they did not experience sunburn
- 97% agreed or strongly agreed that the sunscreen formulation was non-irritating
- 72% agreed or strongly agreed that the sunscreen formulation was moisturizing.

## Conclusions

The new photostable SPF 70 sunscreen provided exceptional protection against sunburn under extreme conditions at high altitude after a mean of 5 hours of sun exposure following a single application of sunscreen. In this study in which 71 subjects participated, total protection was achieved in 100% of subjects under these harsh conditions. Even in the one patient who acknowledged under-applying the sunscreen to her nose, only mild erythema was observed. This particular point is of importance, given that many people do not apply enough sunscreen, yet the SPF 70 formulation was still able to protect against sunburn under extreme conditions with a single application. The SPF 70 sunscreen was non-irritating and also had moisturizing properties. The aesthetic elegance of the product may be of benefit in enhancing compliance with sunscreen use.

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