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Sun behaviour and personal UVR exposure among Europeans on short term holidays

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ABSTRACT

Solar ultraviolet radiation (UVR) is known to be the main cause of skin cancer, the incidence of which is rising with national differences across Europe. With this observation study we aimed to determine the impact of nationality on sun behaviour and personal UVR exposure on sun and ski holidays. 25 Danish and 20 Spanish sun-seekers were observed during a sun holiday in Spain, and 26 Danish and 27 Austrian skiers were observed during a ski holiday in Austria. The participants recorded their location and clothing in diaries. Personal time-logged UVR data were recorded as standard erythema doses (SEDs) by an electronic UVR dosimeter worn on the wrist. Danish sun-seekers were outdoors for significantly longer, received significant higher percentages of ambient UVR, and received greater accumulated UVR doses than Spanish sun-seekers. Danish skiers were also outdoors for significantly longer than Austrian skiers, but the behaviour of the Danish skiers did not result in significantly greater accumulated UVR doses. Both Danish and Spanish sun-seekers and Danish and Austrian skiers received substantial UVR doses. The behaviour's influence on the UVR doses received by the Danish participants may indicate an explanation of the higher skin cancer incidence among Scandinavians compared with other European populations.

1. Introduction

Each year millions of Europeans take sun holidays with exposure to short-term high-dose solar ultraviolet radiation (UVR) [1]. In Denmark, with a population of 5.5 million, 1.2 million tours to sunny destinations are sold each year, of which 600,000 are estimated to be for sunbathing purposes only (The Danish Travel Organization). Solar UVR is the main cause of skin cancer [2,3]. Intermittent UVR exposure has been found to be a risk factor for malignant melanoma [3,4]. There are geographical variations in skin cancer incidence in Europe with the highest incidence of malignant melanoma in Scandinavia [5].

(The incidence in Denmark is 3.9% and in Spain 1.8%) [6]. One reason for variations in incidence may be differences in sun travel activity and sun behaviour by different nationalities.

Human exposure to UVR can be measured in standard erythema doses (SED), with 1 SED equivalent to an erythemally effective radiant exposure of 100 J/m^2 [7]. The typical annual UVR doses received by indoor workers in Denmark, without sun travel activity, is 135 SED [8,9] when measured by personal UVR dosimeters on the wrist. In Spain and Austria, the typical annual UVR doses have been estimated by diaries and ambient measurements to be 272 SED [10] and 134 SED [11] respectively.

We investigated the sun-seeking habits on a sun and a ski holiday. We consider Danes to represent a sun-seeking population in Scandinavia, while Spaniards and Austrians represent populations that have ready access to enjoy sun or skiing in their local environ-

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ment, with a consequently more balanced sun behaviour. The studies were conducted on Tenerife (Spain) and in a ski resort in Austria, as these are typical destinations for Northern European holidaymakers. In the northern latitudes sunshine is sparse and it is cold, especially in the winter, and our hypothesis was that Danes would exhibit a more pronounced sun-seeking behaviour reflected by higher personal UVR doses than Spaniards and Austrians. For Northern European populations, it is estimated that up to one-fourth of the annual UVR exposure can occur during two weeks of sun holidays in Southern Europe [1]. We also found it important to include skiers, although they are exposed on a small skin area, because the face is a very common site for skin cancer [12]. Using on-site investigators, personal diaries with 30 min registrations, continuous ground station measurements of ambient UVR, and personal electronic UVR dosimeters (SunSaver) [13] worn on the wrist we collected detailed data from our participants. This work is an objective study, whereas epidemiological study generally are larger and rely on selfreport. The data in this paper are a continuation of the results presented in a previous paper [14], where some of the data from the Danish volunteers were presented.

2. Material and methods

2.1. Participants

The Danish participants were recruited through the intranet at Bispebjerg Hospital, Copenhagen, Denmark. The Spanish and Austrian participants were recruited among staff, as well as their friends and family, of the Centre for Research in Environmental Epidemiology (CREAL), Barcelona, Spain and from the University of Veterinary Medicine Vienna, Austria.

The inclusion criteria for the sun holiday were: sun-seekers of Scandinavian or Spanish ancestry defined as those who had been on at least 5 sun holidays in the previous 10 years with the primary goal being to enjoy the sun on the beach and/or by the pool.

The inclusion criteria for the ski holiday were: proficient skiers of Scandinavian or Austrian ancestry, respectively, expected to be skiing most of the day. Participants were required to be able to read Danish, Spanish or German, respectively, and to participate in a pre- and post-examination. 98 volunteers were recruited in total, with similar numbers of participants in each group. The volunteer characteristics are shown in Table 1.

The exclusion criteria for both studies were: psoriasis or active eczema; all types of present or previous skin cancer; diseases with increased UVR sensitivity; organ transplant recipients; physical handicap; intake of medicine that increases photosensitivity. Mostof the costs were covered by the project grant to enhance compliance (Food and lift card were paid by the participants).

The participants were requested to behave as they normally would on a ski and a sun-seeking holiday except for completing a daily diary. At least 6 full study days were completed in both studies and all 98 participants complied with all the requirements. In both studies exactly 6 days were included in all the analyses.

Table 1
Volunteer characteristics.

	Sun holiday		Ski holiday	
	Danes	Spaniards	Danes	Austrians
N	25	20	26	27
Female	14 (56%)	14 (70%)	10 (38%)	15 (56%)
Male	11 (44%)	6 (30%)	16 (62%)	12 (44%)
Age[a]	39 (29–51)	38 (27–61)	39 (24–55)	40 (30–54)
Skin type I	0	0	2 (7.7%)	3 (11%)
Skin type II	11 (44%)	6 (30%)	16 (61.5%)	8 (29.6%)
Skin type III	11 (44%)	9 (45%)	8 (30.8%)	14 (51.5%)
Skin type IV	3 (12%)	5 (25%)	0	2 (7.4%)

[a] Mean (range).

2.2. Setting

The sun holiday study was performed at a beach holiday resort on the "Playa de Las Americas", Tenerife (Canary Islands, Spain, 28°N, 16°W). The ski holiday study was performed at a ski resort in Wagrain, Austria (47°N, 13°E) with altitudes between 850 and 2680 m above sea level. The sun holiday study was conducted on March 1–6th, 2010 and the ski holiday study on March 21–26th, 2010.

2.3. Personal electronic UVR dosimeter "SunSaver"

Participants wore an updated version of the personal electronic UVR dosimeter (SunSaver) from sunrise to sunset [13]. The SunSaver, which is battery-driven, records continuous time-logged UVR data and comprises a sensor and a data logger, which was set to measure every 5th sec and to store an average of the last 24 measurements every 2 min along with the time of day. A Silicon Carbide Photodiode (JEC1I-DE ERYCS 2; Laser Components, Olching, Germany) was chosen as a sensor. The sensor has a built-in diffuser and has a cosine response. The spectral response is similar to the Comisión Internacional de la Iluminación (CIE) erythema action spectrum [15]. The measurement range of the dosimeter is 0.03–30 standard erythema doses (SED/hour). The stability of the SunSaver was tested against a UV Biometer Model 501 Radiometer (Solar Light Company Inc.) under clear sky conditions in Denmark on 21 June–21 July 2010 and showed a maximal daily variation of 3%. Furthermore, each dosimeter was individually calibrated against a spectroradiometer (Bentham DMc-150f double-grating monochromator plus a photomultiplier tube, Bentham Instruments, Reading, UK) using clear sky sun as a UVR source. The spectroradiometer was calibrated using a lamp traceable to the UK National Physical Laboratory [16]. Participants were instructed to wear the SunSaver uncovered on the dorsal aspect of the right wrist, in place of their usual wristwatch. The wrist has been shown to be a reliable body site for personal dosimetry of UVR [8]. Furthermore, the SunSaver monitors temperature so its use can be verified. The SunSaver data were downloaded to a computer every evening. For four participants UVR data were missing for one or two days, which was 5 out of a total of 588 days, and their total UVR doses were estimated by adding their average personal UVR dose of the observation days with intact data. SunSaver ground stations were placed on the hotel roof (Tenerife), on the roof of a cable car station and on a shadow less football ground (Austria), where they measured ambient UVR.

2.4. Sun exposure diary

The participants were asked to report their location and clothing in a diary every 30 min. in the daylight hours from 07:00 to 18:30 h (sun-seekers) and from 08:00 to 18:30 h (skiers).

- Location (sun-seekers): (a) beach; (b) pool; (c) balcony; (d) other locations outdoors (mountains, city or other; (e) indoor.
- Location (skiers): (a) slopes; (b) sunbathing (sitting in the sun); (c) other locations outdoors (city or other); (d) indoor.
- Clothing (sun-seekers) was documented with a code (1–5) that was described in the diary for the upper and lower parts of the body (supplementary material).
- Clothing (skiers) was assumed to cover full body except face, and if the skiers exposed more skin, they made a note in the diary about skin site and time.