Photodermatol Photoimmunol Photomed 2004; 20: 270–271
Blackwell Munksgaard

Photodermatology
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Brief communication

Exposure to solar ultraviolet radiation and respiratory tract symptoms in 1-year-old children

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In several animal studies, it was demonstrated that ultraviolet radiation (UVR), even at sub-erythemal doses, has the potential to suppress immune responses and impair the resistance to infections (1). Epidemiological evidence for an unfavourable effect of ambient UVR on infections in humans, however, is scarce. In some studies, peak incidences of herpes simplex and herpes zoster recrudescences during sunny season were observed, lending support to the presence of an unfavourable effect of UVR for certain infections in humans (2). In a recent study, a higher lifetime-cumulative exposure to solar UVR was associated with a lower prevalence of human papilloma virus (HPV), whereas episodes of sunburn in the past were independently associated with a higher prevalence of HPV (3). This finding indicates that the effect of solar UVR on infections in humans may be considerable at doses that cause erythema. As UVR can induce immunosuppression both at the site of irradiation (i.e., local immunosuppression) and at distant non-irradiated sites (i.e., systemic immunosuppression), the resistance to non-skin-associated infections may be influenced as well (4). In the present analysis, we examined the relationship between exposure to solar UVR and higher respiratory tract symptoms. This was done among 1-year-old children, who had been recruited for a cohort study on allergy and asthma. It was reasoned that these symptoms are mainly driven by (viral) infections and that respiratory allergy has a low prevalence among infants. A once-only 6-week retrospective questionnaire on outdoor behaviour and sunburn was used to assess the child's exposure to solar UVR. This questionnaire has been described and evaluated in detail elsewere (5). Personal exposure data were coupled to data on respiratory tract symptoms during the preceding 4 weeks. These data were reported by one of the parents in the yearly questionnaire that was administered at the time of the child's first birthday. The analysis was restricted to the months April–September (1998). Especially during sunny season, differences in outdoor behaviour and weather conditions may lead to considerable differences in personal exposure to sunlight among the participating children.

The data of 785 children were included in the present study. The reported data on sunlight exposure of these children were consistent and complete and could be coupled to the (simultaneously) reported data on respiratory symptoms. In a multivariate logistic regression analysis, a higher exposure to ambient UVR as estimated for the 4 weeks preceding the filling out of the questionnaires appeared to be, independent of the season, significantly associated with a lower occurrence of respiratory symptoms in the same period, especially 'coughing' and 'runny nose' (Table 1). On the other hand, the reporting of sunburn appeared to be unfavourably associated with symptoms, especially 'earache/runny ear'. The odds ratios in the models of Table 1 were also adjusted for other factors that appeared to be relevant to the occurrence of respiratory symptoms (month of filling out the questionnaires, male gender, presence of other children in the household, and contacts with other children at day care centres).

The favourable relationship between exposure and symptoms was also found after excluding the data of those children with probably more severe symptoms, as evidenced by associated fever, doctor's attendance, or presence of one or more severe respiratory diseases during the first year of life (such as pneumonia, bronchitis, and whooping cough). Severe respiratory symptoms often lead to staying indoors. As a consequence, 'reverse causation' might ensue, i.e.,

Table 1. Multivariate logistic regression analysis: associations between personal exposure to solar UVR as estimated by means of a 6-week retrospective questionnaire (5) and respiratory tract symptoms

	1. Coughs		2. Runny nose		3. Earache/runny ear	
	OR	95% CI	OR	95% CI	OR	95% CI
Personal exposure, first 2 weeks (cumulative)						
<4.5 weighted hours	1.00	.	1.00	.	1.00	.
4.5–25.8 (weighted hours)	0.88	0.54–1.44	1.16	0.70–1.90	1.11	0.54–2.29
25.8–419 (weighted hours)	0.86	0.49–1.50	1.24	0.70–2.18	0.65	0.28–1.54
Personal exposure, last 4 weeks (cumulative)						
<16.7 weighted hours	1.00	.	1.00	.	1.00	.
16.7–85.8 (weighted hours)	1.06	0.66–1.71	0.72	0.44–1.17	0.85	0.41–1.74
85.8–1095 (weighted hours)	**0.46**	**0.26–0.81**	**0.33**	**0.19–0.59**	1.03	0.45–2.39
The reporting of sunburn						
No	1.00	.	1.00	.	1.00	.
Yes	1.57	0.81–3.07	1.49	0.76–2.94	**2.44**	**1.05–5.64**
Hosmer and Lemeshow goodness-of-fit test		$P = 0.60$		$P = 0.56$		$P = 0.88$

OR, odds ratio; CI, confidence interval.
The odds ratios (OR) were also adjusted for month of filling out the questionnaire, male gender, presence of other children in the household, and contacts with other children at day care centres.
Values printed in bold represent statistical significance ($P<0.05$).

when sickness caused a diminished personal exposure to sunlight in a substantial number of participating children, a spuriously favourable association between exposure and symptoms might appear. Furthermore, similar results were found when the cumulative doses of ambient UVR for the weeks that were covered by the participating child's questionnaire were used as measure for (maximum) solar exposure, instead of the questionnaire-based personal estimate. Daily doses of ambient UVR received on a horizontal plane were measured independently during the study period at the Dutch National Institute of Public Health and the Environment (RIVM) UVR monitoring site with a DILOR XY spectroradiometer (Jobin Yuon S.A.S., Villeneuve d'Ascq, France) (data not shown).

These results suggest that exposure to solar UVR may have unfavourable consequences for the resistance to respiratory infections in humans at doses that cause erythema. This is in accordance with experimental human data that demonstrate systemic effects of solar-simulated UVR on suppression of contact hypersensitivity (4). At sub-erythemal doses, however, no adverse effect on the resistance to respiratory infections could be detected. This contrasts with data from experimental animal studies. In the human situation, the postulated acute immunosuppressive effect of solar UVR is possibly subtle at sub-erythemal doses and hence may have been overruled by other (favourable) factors that determine the incidence of respiratory tract symptoms and that are associated with exposure to sunlight. For example, the beneficial influence of sunlight on production of $1,25(OH)_2D_3$ in human skin needs consideration when assessing the relevance of UVR-induced suppression of host resistance for the human situation. Further studies are required to explore the association between the erythema-inducing and immunomodulatory effects of UVR in humans, e.g., by examining the influence of skintype on the potential of UVR to exert a biologically relevant effect (6). This is probably relevant to both the resistance to infections and the pathogenesis of various types of skin cancer, as in both instances immunological mechanisms play an important role (2).

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Accepted for publication 30 June 2004

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