

## Original article

## Effect of climatic change in children with atopic eczema

**Background:** Climate and sunlight (ultraviolet radiation) influence activity of atopic eczema.

**Objective:** To evaluate the effect of moving from a subarctic/temperate climate to a sunny subtropical climate on children's atopic eczema.

**Methods:** Children, 4–13 years, with severe atopic eczema were randomized to stay 4 weeks in Gran Canary (index patients = 30) and home in Norway (controls = 26), with a follow up of 3 months. SCORing of Atopic Dermatitis (SCORAD) was primary variable, and secondary were Children's Dermatology Life Quality Index (CDLQI), *Staphylococcus aureus* skin colonization and pharmacological skin treatment.

**Results:** SCORing of Atopic Dermatitis decreased from 37.2 (29.4–44.9) to 12.2 (9.0–15.4) [mean (95% confidence intervals)] after 4 weeks and 21.2 (17.2–25.1) 3 months thereafter in index patients ( $P < 0.0005$ ), much less in controls. Children's Dermatology Life Quality Index in the index group improved from 8.7 to 2.2 and 4.5 after 4 weeks and 3 months ( $P < 0.0005$ ), not in controls. Bacterial skin colonization with *S. aureus* decreased in the index group from 23/30 (77%) to 12/30 (40%;  $P = 0.001$ ) and 12/30 (40%;  $P = 0.005$ ) after 1 month and 3 months, and the use of local steroids decreased in index patients but not in controls.

**Conclusions:** The change from a subarctic/temperate to a subtropical climate for 4 weeks improved significantly skin symptoms (SCORAD) and quality of life, even for 3 months after return.

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Atopic eczema is a chronic inflammatory skin disease characterized by itching, lesions and lichenification especially at the predilection sites: the flexure sites of the major joints of the upper and lower extremities. The skin is often colonized by *Staphylococcus aureus*, and superinfections of the skin are common (1).

The prevalence of atopic eczema has increased especially in young children over the later years and decreases with increasing age (2, 3).

Epidemiological studies suggest that climate influences the prevalence of atopic eczema. Atopic eczema has been reported worldwide to be positively associated with latitude and negatively with temperature (4). In Norway, the prevalence of atopic eczema is higher in the North compared with the South, with a life-time prevalence in school children of 23.6% vs 12.7% respectively (5, 6). Also in Sweden, the prevalence of atopic eczema among 7- to 8-year-old children was reported to be higher in Kiruna in the North than in Gothenburg in the South (23% vs 18.7%; 7).

Atopic eczema influences negatively the quality of life in both children with atopic eczema and their caretakers (8). Pain and itching may cause depressive symptoms, social isolation and reduced self-perception (9).

How climatic factors influence atopic eczema is not fully understood, but it has been reported that sunlight (UV-A/UV-B radiation) has a positive effect on atopic eczema (10, 11). Also seawater may have a role through its antibacterial effect (12). Climate therapy has been used for many years in different parts of the world for both dermatological diseases on the North Sea and the Dead Sea (12, 13). Purschel observed favourable effects of North Sea climate on German children and adults with atopic dermatitis and/or allergic diseases treated since 1953 on the Island Norderney in the North Sea (12). This was confirmed by Menger with a lasting effect for up to 12 months after stay at the North Sea island during summer (14). However, their reports were concerned only with uncontrolled patient series (12, 14). Autio et al. (15) investigated adults with moderate to severe atopic eczema after 2–3 weeks stay on the Canary Islands in an open uncontrolled and prospective study. The patients were investigated before, after 2 or 3 weeks stay and 3 months thereafter. They found significant improvement in SCORing of Atopic Dermatitis (SCORAD; 16) after 2 weeks. After 3 months, SCORAD was still 45% lower than at inclusion (15).

The Norwegian Health Ministry has, since 1976, been funding organized 'Health Travels' for children with

asthma, first to Montenegro and since 1991, to the Canary Islands (17, 18). Since 1998, children with atopic eczema without co-existing asthma were included, after an uncontrolled nonrandomized study with major improvement of symptoms and signs of atopic eczema in children after 4 weeks' stay in Gran Canaria was reported by Rodt (19).

The main objective of the present randomized-controlled study was to investigate and evaluate the total effect of the Health Travels for children with atopic eczema, consisting of a 4 weeks stay in a subtropical climate on Gran Canary with a 3 months follow up on symptoms and signs as assessed by SCORAD as the main variable. The secondary objectives were to assess the effect upon quality of life, bacterial skin colonization and the inflammation marker, serum eosinophilic cationic protein (s-ECP).

## Patients and methods

### Design

Based on the clinical information, the patients were randomized into index and control groups. The index group stayed 4 weeks in Gran Canary, whereas the control group spent the time in their usual surroundings at home. Severity and extension of atopic eczema in the index group and the control groups were equal. One half of the index group and the control group were investigated in the spring, the other in the autumn, to account for the seasonal variations of atopic eczema.

With a power of 80% and a *P*-value of 0.05, using a change of 7.5-points in SCORAD as a minimum clinically significant change, a sample size of 28 patients in each group was found necessary to achieve statistical significance.

The included index patients were investigated one day before leaving for Gran Canary on Voksentoppen National Hospital. They were also investigated on their last day after 4 weeks on Gran Canary. Finally, they were investigated 3 months after leaving Gran Canary on Voksentoppen National Hospital. All the patients in the index group and the control group were examined by the same doctor at all visits. The SCORAD assessments were performed by three trained nurses.

The patients in the control group were investigated at the same intervals with all consultations on Voksentoppen, Rikshospitalet.

During the stay at Gran Canary, the autumn group who stayed from 13 August to 10 September had 28 days with the sun, mean temperature at 12.00 AM was 24.9°C with a range of 21–26°C, compared with 13.1°C (3.8–21.0°C), respectively, in mid-Norway (Trondheim). In Trondheim, there were 8 days of 28 without rain in the same period. Mean relative humidity during the autumn period was 67.0% in Gran Canary, compared with 79.5% in Trondheim.

The spring group (from 26 March to 23 April) had 23 sunny days out of 28 at Gran Canary, the remainder of the days slightly clouded. In Trondheim, there were 13 of 28 days without rain in the same period. Mean temperature of 12.00 AM was 4.9°C (–4.8 to 19°C) in Trondheim during the same period. Mean relative humidity in Gran Canary during the spring period was 72%, compared with 73.8% in Trondheim.

### Patients

The inclusion of the patients was based on clinical information from the referring doctors. Both the index patients and controls were selected randomly after referring to 'Behandlingsreiser' (Norwegian state Health Travels).

Twenty-nine patients during spring and 32 patients during autumn, 4–13 years of age, with moderate to serious atopic eczema, were selected for participation in the study. After selection, the patients were randomized by drawing into index group and control group by a nurse not participating in the patient evaluation with equal distribution between the groups as regards severity of atopic eczema, based upon clinical information from the referring doctor. The clinical and demographic characteristics of the index and control groups are seen in Table 1. Exclusion criteria were participation in the Health Travels during the preceding 2 years, other serious diseases influencing the participation in the study. The control group was offered travel to Gran Canary with the Health Travels a year after participating in the present study.

During the stay in Gran Canary, the children followed ordinary school teaching with Norwegian teachers at a local Norwegian school. They had 1-h gymnastics a day, 5 days a week, whereas the control children followed their regular school with 2–4 h gymnastics a week during schooldays.

While in Gran Canary, the index patients increased their stay in the sun from 30 min daily at first until 3–4 h at the end of the stay,

Table 1. Baseline characteristics of the index and the control group

	Index group (N = 30)	Control group (N = 26)	Significance ( <i>P</i> -value)
Age [years; mean (range)]	8.35 (4–13)	7.40 (3–13)	n.s. (0.18)
Gender ♂/♀ (n/n)	13/17	13/13	n.s. (0.62)
Investigated: spring/autumn (n/n)	14/16	13/13	n.s. (0.80)
Total IgE [kU/l; geometric mean (range)]	399.4 (5.3–5000)	232.4 (10.7–5000)	n.s. (0.25)
Positive SPT (n/N)	28/30	23/26	n.s. (0.66)
SCORAD [total; mean (SD)]	37.15 (20.76)	36.84 (16.94)	n.s. (0.83)
CDLQI, mean (SD)	8.73 (5.90)	10.08 (5.89)	n.s. (0.33)
Serum-ECP [µg/l; median (range)]	19.95 (5.4–56.6)	11.4 (3.0–49.2)	– (0.021)
Skin bacterial colonization ( <i>Staphylococcus aureus</i> ; %)	76.7	80.8	n.s. (0.71)

Values are given as mean (SD) unless otherwise stated. Total IgE and s-ECP were not normally distributed and values were given as geometric mean and median with range respectively.

SPT, positive skin prick test (3 mm ≥ negative control) to one or more of the eight tested allergens; s-ECP, serum eosinophilic cationic protein; CDLQI, Children's Dermatology Life Quality Index; SCORAD, SCORing of Atopic Dermatitis; IgE, immunoglobulin E.

to avoid sun burn. During their entire stay, they used a sunscreen factor >15. They bathed in seawater 1–2 h a day.

During the stay in Gran Canary, the index patients and their accompanying persons (parents) received 4 h of education about atopic eczema and its treatment. The control group and their parents received 2 h of education at their first visit; current treatment was evaluated and modified with intensifying the local anti-inflammatory treatment with steroid ointment and anti-infective therapy as well as other supplemental treatment. The treatment with topical steroids as grouped by steroid potency, the use of antihistamines as well as the use of topical antibacterial treatment was recorded on all visits.

The study was approved by the Norwegian Social Science Data Services.

### Skin prick test

Skin prick test (SPT) was performed in duplicates according to the European standardized specifications (20). A mean wheal diameter (largest + smallest diameter divided by 2) of at least 3 mm larger than negative control, read after 15 min, was defined as positive.

Antihistamines were suspended for at least 72 h, and systemic prednisolone doses exceeding 10 mg/day were suspended 24 h before testing. Allergic sensitization was defined as the presence of at least one positive SPT.

The following prevalent allergens in Norway were examined: histamine chloride 10 mg/ml (positive control), glycerol (negative control), birch, timothy and mug worth pollen, cat, dog and horse dander, house dust mite (*Dermatophagoides pteronyssinus*) and *Cladiosporium herbarum* (Soluprick, ALK, Hørsholm, Denmark).

### Total IgE

Serum samples taken on all the clinical investigations were analysed for total immunoglobulin E (IgE) by using UniCAP fluoroenzyme immunoassay (FEIA) according to the manufacturer's instruction (Pharmacia, Uppsala, Sweden).

### Serum eosinophilic cationic protein

Blood was drawn and allowed to clot at stable room temperatures for an hour before centrifugation. The pipetted serum was stored at –70°C. Serum-ECP was measured by the Pharmacia CAP system ECP FEIA method, according to the instructions of the manufacturer (21, 22). Briefly, monoclonal anti-ECP antibodies covalently coupled to immunoCAP (Pharmacia), were allowed to react with the patients' serum samples and subsequently, after washing with monoclonal anti-ECP antibodies containing fluorogenic labelling. The level of fluorescence after adding fluorogenic substrate was measured by Fluorocount 96 (Pharmacia). The measuring range was 2–200 µg/l in undiluted serum. The cross-reactivity with other proteins from granulocytes is <0.1% according to the specification of the manufacturer (22).

### Bacterial skin cultures

Samples for bacterial cultures were taken from all the patients in all the investigations from three different body regions with active atopic eczema. With no lesions of atopic eczema, samples were taken from the cervical, axillar or the inguinal regions.

The Venturi Transystem pencil and coal medium for transport were used. The bacterial culture samples were analysed at the Department of Microbiology, National Hospital, Oslo, Norway.

### Scoring of atopic eczema

The distribution and the intensity of the atopic eczema were measured by a standardized scoring system (SCORAD) and used as the main variable (16, 23).

SCORing of Atopic Dermatitis is made of three parts: part A for the degree of extension of the eczema, part B for the severity (grade of inflammation, lichenification, rubor, fissures or infection) and part C for the subjective severity by grading pruritus and sleep disturbances. The scoring was carried out by specifically educated nurses or the doctor. SCORing of Atopic Dermatitis assessment was carried out on every investigation for both the groups.

### Quality of life (CDLQI)

All the patients and the parents together completed a standardized quality of life questionnaire on every clinical investigation. The validated Children's Dermatology Life Quality Index (CDLQI) questionnaire was employed (24, 25).

### Pharmacological treatment

The use of pharmacological treatment for the eczema was recorded at baseline and at examinations at 4 weeks and 3 months thereafter. The type and the potency of local steroid treatment, the use of antihistamines and type of and use of local antibacterial treatment of the skin were recorded.

### Statistical evaluation

All statistical analyses were performed by using Statistical Package for Social Sciences (SPSS, Chicago, IL, USA) version 10. Demographic data are given as mean with standard deviation unless otherwise stated. Results are given as mean values with 95% confidence intervals (CI), except when not normally distributed when results are given as median with range (demographic data) or median with 95% CI for comparisons between groups. For IgE, results are given as geometric mean with range (Medcalc® statistical system version 7.6; MedCalc Software, Mariakerke, Belgium).

Categorical results were analysed by the chi-square test. Differences between the two groups were analysed with *t*-test when the data satisfied normal distribution, otherwise with the nonparametric Mann–Whitney *U*-test for two independent samples as well as by the chi-square test. Differences between the two patient groups for SCORAD and CDLQI at the three visits were assessed by repeated measures ANOVA test. Differences between the two patient groups for s-ECP values at three visits were calculated by the nonparametric Kruskal–Wallis test. All the tests were two-tailed with a significance level of 5%. SCORing of Atopic Dermatitis was used as the main variable (16, 23, 26).

## Results

Two of the 32 index patients and three of the 29 control subjects were excluded because of the presence of other skin disease. Thirty patients with atopic eczema (♂/♀: 13/17) remained among the index group, and 26 (♂/♀: 13/13) in the control group. Demographic variables and baseline results for total SCORAD, CDLQI and s-ECP are seen in Table 1. The two groups did not differ significantly as regards total

IgE and positive SPTs (Table 1). Eight index patients suffered from concomitant asthma compared with 14 controls ( $P = 0.06$ ), 11 index patients suffered from allergic rhinoconjunctivitis compared with 17 controls ( $P = 0.06$ ). The results of SCORAD, CDLQI and s-ECP did not differ significantly whether the patients had concomitant asthma and/or allergic rhinitis.

SCORAD

The results of SCORAD total scores (Fig. 1) and the scores for SCORAD extent, intensity and symptoms are seen in Table 2. Mean total SCORAD improved significantly from baseline to 1 month (on the Canary Islands) and 3 months thereafter in the index group [37.2 (29.4–44.9); mean (95% CI) to 12.2 (9.0–15.4) after 1 month ( $P < 0.0005$ ), and to 21.2 (17.2–25.1) 3 months thereafter respectively ( $P < 0.0005$ ). A slight improvement in the control group was observed from 36.8 (30.0–43.7) vs 31.2 (24.2–38.2) after 1 month ( $P = 0.043$ ) and 3 months thereafter to 30.6 (24.1–37.1) respectively ( $P = 0.049$ ). The change in SCORAD was significantly less among the control subjects than in the index group ( $P = 0.045$ ; Fig. 1).

The baseline SCORAD scores for the extent, intensity and subjective symptoms did not differ between the index cases and the controls, but were significantly lower in the index compared with the control group both after 1 month ( $P \leq 0.001$ ) and 4 months ( $P = 0.05$ ,  $P = 0.009$  and  $P = 0.028$ , respectively; Table 2).

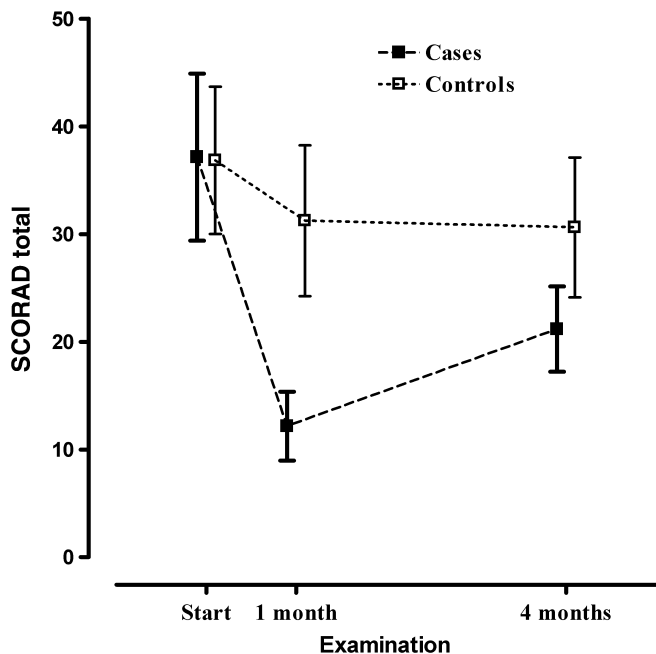


Figure 1. Total SCORing of Atopic Dermatitis (SCORAD) baseline, after 1 month and after follow up for 3 months (4 months from baseline). Results are shown as mean values with 95% confidence intervals.

Table 2. SCORAD at inclusion, after 1 month and 4 months

	Index group (n = 30)	Control group (n = 26)	Significance (P-value)
SCORAD (total)			
Baseline	37.15 (29.40–44.90)	36.84 (30.00–43.69)	n.s. (0.83)
1 month	12.19 (8.99–15.38)	31.24 (24.24–38.24)	– (<0.001)
4 months	21.18 (17.24–25.130)	30.62 (24.13–37.11)	– (0.011)
SCORAD (A – extent)			
Baseline	26.06 (16.57–35.55)	23.56 (15.47–31.65)	n.s. (0.69)
1 month	5.56 (3.45–7.68)	20.22 (12.71–27.73)	– (0.001)
4 months	9.17 (4.35–14.00)	17.78 (10.46–25.11)	– (0.05)
SCORAD (B – intensity)			
Baseline	6.87 (5.60–8.13)	6.65 (5.45–7.86)	n.s. (0.81)
1 month	2.60 (1.94–3.26)	5.85 (4.61–7.09)	– (<0.001)
4 months	4.23 (3.49–4.98)	5.96 (4.85–7.07)	– (0.009)
SCORAD (C – subjective symptoms)			
Baseline	8.45 (6.61–10.29)	8.87 (6.78–10.95)	n.s. (0.76)
1 month	2.37 (1.42–3.32)	7.46 (5.69–9.23)	– (<0.001)
4 months	4.62 (3.27–5.96)	7.06 (5.25–8.86)	– (0.028)

Mean values with 95% confidence intervals in parenthesis. SCORAD, SCORing of Atopic Dermatitis.

Quality of life (CDLQI)

In the index group CDLQI decreased from 8.7 (6.5–10.9) to 2.2 (1.3–2.2) [mean (95% CI)] after 1 month ( $P < 0.0005$ ) and to 4.5 (2.8–6.2) 3 months thereafter ( $P < 0.0005$ ) vs in control subjects 10.1 (7.7–12.5) at inclusion, 8.0 (5.9–10.1) after 4 weeks ( $P = 0.038$ ) and after 3 months follow up 7.4 (6.1–8.8) respectively ( $P = 0.01$ ). Children’s Dermatology Life Quality Index did not differ significantly between the index cases and the controls at baseline, but were significantly lower in the index group at 1 month ( $P < 0.001$ ) and 3 months thereafter ( $P = 0.009$ ) respectively (Table 3 and Fig. 2).

Serum-ECP

Serum-ECP at baseline was significantly higher among index patients [23.3 µg/l (18.0–28.6)] than controls [15.3 µg/l (10.7–20.0);  $P = 0.021$ ], after 1 month 27.7 µg/l (17.4–37.9) and 11.1 µg/l (7.5–14.9;  $P = 0.005$ ), respectively, but with no significant difference 3 months thereafter, 13.4 µg/l (8.9–17.8) vs 12.23 µg/l (8.09–16.36) respectively ( $P = 0.70$ ; Table 3 and Fig. 3). However, the reduction from baseline to 4 months was significantly greater in the index [–9.85 (–17.22 to –2.47)] than in the control group [–3.12 (–7.79 to 1.55);  $P = 0.047$ ].

Bacteriological skin colonization

Positive bacteriological culture findings for *S. aureus* did not differ significantly between the index cases (76.7%) and the controls (80.8%; n.s.) at baseline, nor after 1 month (40.0% and 66.7%, respectively; n.s.) and 4 months (40.0% and 57.7%, respectively; n.s.). However, the reduction in positive bacterial culture findings

Table 3. Children's Dermatology Life Quality Index (CDLQI), serum-ECP and positive bacterial culture findings for *Staphylococcus aureus* at baseline, after 1 month's stay at Gran Canary and after 3 months follow up (4 months from baseline)

	Index group (n = 30)	Control group (n = 26)	Significance (P-value)
CDLQI [mean (95% CI)]			
Baseline	8.73 (6.53–10.93)	10.08 (7.70–12.45)	n.s. (0.40)
1 month	2.23 (1.31–3.15)	8.04 (5.94–10.13)	– (<0.001)
4 months	4.50 (2.80–6.20)	7.42 (6.07–8.77)	– (0.009)
s-ECP [median (95% CI)]			
Baseline	19.95 (12.36–32.31)	11.4 (6.75–21.05)	– (0.021)
1 month	22.60 (17.28–28.71)	9.25 (5.64–12.09)	– (<0.001)
4 months	9.55 (6.72–14.38)	8.35 (5.75–12.84)	n.s. (0.61)
Positive skin bacterial culture findings ( <i>Staphylococcus aureus</i> ; %)			
Baseline	76.7	80.8	n.s. (0.76)
1 month	40.0	62.5	n.s. (0.17)
4 months	40.0	57.7	n.s. (0.28)

CDLQI results were normally distributed and results given as mean (95% CI), s-ECP values were not, and results are given as median (95% CI). s-ECP, serum eosinophilic cationic protein; CDLQI, Children's Dermatology Life Quality Index.

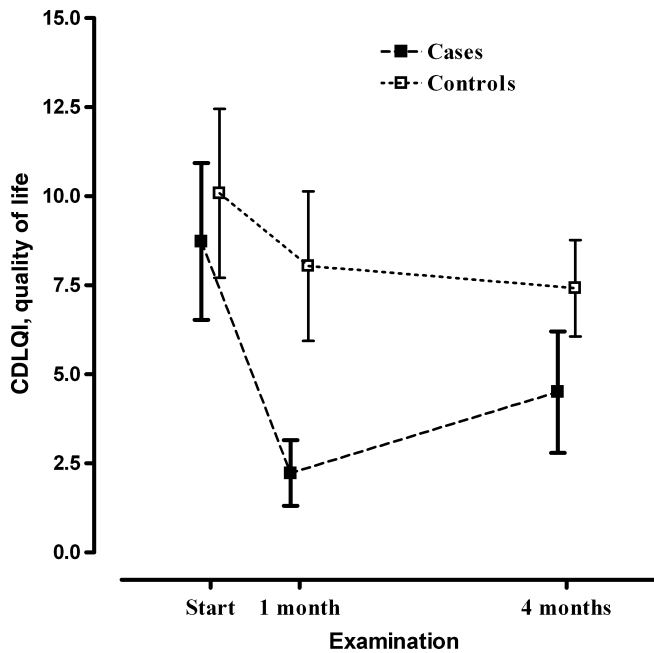


Figure 2. Children's Dermatology Life Quality Index (CDLQI) at baseline, after 1 month and after follow up for 3 months (4 months from baseline). Results are shown as mean values with 95% confidence intervals.

for *S. aureus* was statistically significant from baseline to after a month's stay in Gran Canary for index cases (36.7% reduction;  $P = 0.001$ ), but not for controls (18.3% reduction;  $P = 0.10$ ) and from baseline to 4 months in the index group (36.7%;  $P = 0.005$ ), but not in the control group (23.1%;  $P = 0.08$ ; Table 3).

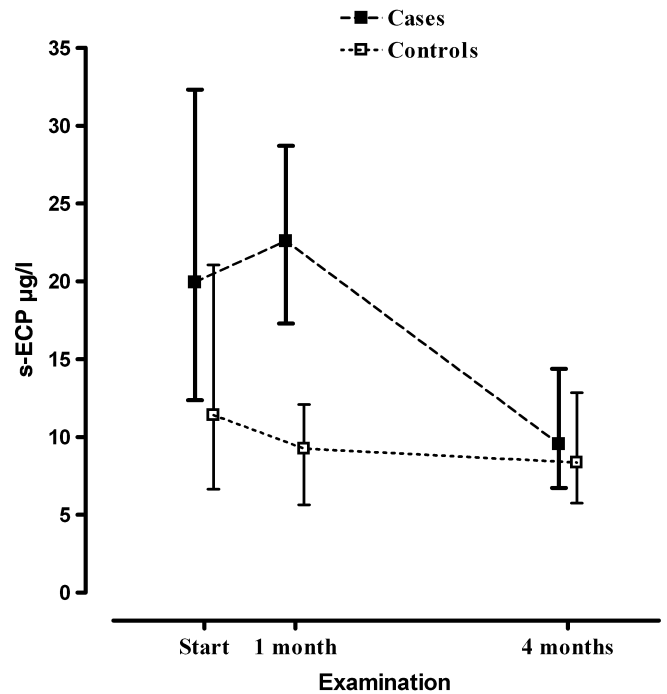


Figure 3. Serum eosinophilic cationic protein (ECP) at baseline, after 1 month and after follow up for 3 months (4 months from baseline). Results are shown as median values with 95% confidence intervals.

#### Influence of seasonal variation

One group of index cases were treated in Gran Canary during autumn ( $n = 16$ ) and the other during spring ( $n = 14$ ). Also the controls were divided into two groups: one in autumn and one in spring ( $n = 13$  during autumn,  $n = 13$  during spring). Apart from a slight improvement at visit 2, in total SCORAD for the index cases during autumn compared with spring [mean difference 6.2 (0.15–12.27);  $P = 0.05$ ], no differences were found between the index group and the control group as regards seasonal variation. For CDLQI, no seasonal variation was found either for index cases or for controls.

#### Side effects

Some children in the index group had temporarily low-grade sun burn. Apart from this, no negative effects were observed among the children who travelled to Gran Canary (index group). All the children used a sunscreen of factor 15 or higher during the stay at Gran Canary.

#### Pharmacological treatment

The use of topical steroids, antihistamines and topical antibacterial treatment did not differ between the index and control group at baseline (Table 4), whereas all forms of treatment were significantly lower among the index

Table 4. Use of topical steroids according to potency (1–4), use of antihistamines and use of local antibacterial treatment at the different visits

	Visit	Potency of steroid ointment [mean (95% CI)]		Significance ( <i>P</i> -value)
		Index group ( <i>n</i> = 30)	Control group ( <i>n</i> = 26)	
Group of topical steroids	1	2.03 (1.57–2.50)	2.34 (1.90–2.69)	n.s. (0.32)
	2	1.27 (0.76–1.78)	2.62 (2.25–2.98)	– (<0.001)
	3	2.13 (1.69–2.58)	2.85 (2.60–3.09)	– (0.003)
Number of patients treated (%)				
Antihistamine use	1	18 (60)	12 (46.2)	n.s. (0.30)
	2	3 (10)	11 (42.3)	– (0.006)
	3	9 (30)	11 (42.3)	n.s. (0.30)
Topical antibacterial treatment	1	17 (56.7)	9 (34.6)	n.s. (0.10)
	2	11 (36.7)	20 (76.9)	– (0.03)
	3	21 (70)	21 (80.8)	n.s. (0.36)

cases when compared with the controls at visit 2 (after 4 weeks at Gran Canary, or at home, respectively). At the follow-up visit after 3 months, the use of topical steroids was still significantly lower in the index group, whereas the use of antihistamines and topical antibacterial treatment did not differ significantly at follow up (Table 4).

## Discussion

In the present study, we found that 4 weeks' stay in a subtropical climate in Gran Canary reduced the severity of atopic eczema significantly in 30 Norwegian children both in the index group when compared with baseline and between the index and the control group with comparable atopic eczema and demographic characteristics. Improvement in index cases was found after 4 weeks' stay, and was also present after a further follow up 3 months after returning home in Norway. Positive skin bacterial culture findings of *S. aureus* did not differ between the index group and the control group at baseline, but there was a significant higher reduction in the culture findings from baseline to after 1 month stay in Gran Canary and after 3 months' further follow up in the index compared with the control group. After an increase after 4 weeks, s-ECP improved in the index group from baseline to the 4 months' follow up, but not so for controls.

Thus, the children improved both in severity of the eczema, in quality of life and bacterial skin culture finding, after 4 weeks and 4 months, and with some improvement in s-ECP 3 months after returning home. The stay in Gran Canary thus led to a lasting improvement for the children.

SCORing of Atopic Dermatitis as a scoring system of atopic eczema, developed for a long-lasting clinical trial in children with atopic eczema (26), has been shown to be reproducible and has increasingly been used in studies of atopic eczema (16, 23). The use of SCORAD as an assessment tool in the present study helps to ensure the objectiveness of the assessment. Our SCORAD findings from a randomized-controlled study confirm the findings

of Autio et al. in a noncontrolled study of adults with atopic eczema (15).

Children's Dermatology Life Quality Index, as an objective assessment of quality of life for children with atopic eczema, has been validated (24). By employing CDLQI in the present study, the impact of atopic eczema on daily life in the children and their parents could be assessed.

Serum-ECP as a marker of eosinophilic inflammation varies with the severity of atopic eczema (27, 28). Our finding that s-ECP was reduced in the index group after 3 months' follow up, may reflect a long-term impact of the stay in a warmer and sunny climate.

Bacterial colonization of the skin with *S. aureus* is a well-known problem of atopic eczema, and was found in as many as 76.7% of the children in the index group and 80.8% in the control group. The bacterial culture findings were reduced to the half in the index group.

Previous documentation of the effect of climate therapy in children with atopic eczema has mainly been reports of patients series without control groups (19). The present study was a randomized open-controlled study with similar baseline characteristics of index cases and controls except for lower s-ECP values in controls. The treatment and follow up of the control group was similar to the index group except for the stay in Gran Canary. This design strengthens the results of the present study as also does the follow up of 3 months after 4 weeks' stay in Gran Canary.

The positive results of the stay at Gran Canary are also reflected by the reduction in the use of topical steroids, antihistamines and topical antibiotics during the stay when compared with the control group who stayed in Norway. The reduction in the use of local steroids was statistically significant also at the follow up after 3 months back in Norway, reflecting a long-lasting effect of the stay in Gran Canary.

The patients both in the index group and the control group were at all visits examined by the same doctor, and the same group of nurses were responsible for assessing the SCORAD score. This increases the reliability of the findings.

The temperature during the stays at Gran Canary was much higher and most of the days were sunny, whereas in Norway, there were mostly rainy days with a colder temperature. The relative humidity was approximately comparable in Gran Canary when compared with Norway. The main treatment effects of the stay in Gran Canary are probably because of the exposure of the skin to sunrays and effect of bathing in seawater as has previously been found beneficial in adults with atopic eczema (15). In the present study, several different parameters improved, in agreement with each other. The control group did not show similar improvement although receiving the follow-up treatment and education about atopic eczema. One potential benefit for the index patients was the day-to-day follow up by health personnel, whereas the controls were seen at baseline, after 4 weeks and after 3 month's follow up.

It has previously been reported that sunlight has an excellent effect on atopic eczema (29, 30). Ultraviolet radiation of different wavelengths (UV-A and UV-B), being parts of the sunrays, has been reported to cause local cell-mediated immunosuppression in the skin (31, 32). Our finding that climate therapy has an effect, lasting over several months, is supported by the study of Autio et al. in adults (15). Sunrays (UV-A and UV-B) have been reported to have an antibacterial effect on the skin by a suppressive effect on superantigen production by *S. aureus* (10). Also exposure to seawater might have contributed to the improvements in the skin, as it was shown that the strength of attachment of *S. aureus* isolates from atopic dermatitis lesions was suppressed by the presence of 10% NaCl or 10% sea salts (33). Thus, a part of the beneficial effect of climate therapy may be

due to the antibacterial effects of the sun and the seawater.

The present study thus demonstrates a marked positive effect of the Health Travel stay at Gran Canary for several different variables, including the use of topical treatment, and with a prolonged effect up to at least 3 months.

## Conclusion

In an open randomized-controlled study, we found significant improvements in atopic eczema in children by a 4 weeks' stay in a warm subtropical climate (on Gran Canary), assessed objectively by SCORAD, a quality of life index (CDLQI) and skin bacterial colonization. The results support the effects of the present programme for climate travels for children with atopic eczema as organized by the Norwegian Health Authorities.

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## References

- Breuer K, Haussler S, Kapp A, Werfel T. *Staphylococcus aureus*: colonizing features and influence of an antibacterial treatment in adults with atopic dermatitis. *Br J Dermatol* 2002;**147**:55–61.
- Aberg N, Hesselmar B, Aberg B, Eriksson B. Increase of asthma, allergic rhinitis and eczema in Swedish school-children between 1979 and 1991. *Clin Exp Allergy* 1995;**25**:815–819.
- Wuthrich B, Schmid-Grendelmeier P. The atopic eczema/dermatitis syndrome. Epidemiology, natural course, and immunology of the IgE-associated ('extrinsic') and the nonallergic ('intrinsic') AEDS. *J Investig Allergol Clin Immunol* 2003;**13**:1–5.
- Weiland SK, Husing A, Strachan DP, Rzehak P, Pearce N. Climate and the prevalence of symptoms of asthma, allergic rhinitis, and atopic eczema in children. *Occup Environ Med* 2004;**61**:609–615.
- Steen-Johnsen J, Bolle R, Holt J, Benan K, Magnus P. Impact of pollution and place of residence on atopic diseases among schoolchildren in Telemark County, Norway. *Pediatr Allergy Immunol* 1995;**6**:192–199.
- Dotterud LK, Kvammen B, Bolle R, Falk ES. A survey of atopic diseases among school children in Sor-Varanger community. Possible effects of subarctic climate and industrial pollution from Russia. *Acta Derm Venereol* 1994;**74**:124–128.
- Hesselmar B, Aberg B, Eriksson B, Aberg N. Allergic rhinoconjunctivitis, eczema, and sensitization in two areas with differing climates. *Pediatr Allergy Immunol* 2001;**12**:208–215.
- Ben-Gashir MA, Seed PT, Hayt RJ. Are quality of family life and disease severity related in childhood atopic dermatitis? *J Eur Acad Dermatol Venereol* 2002;**16**:455–462.
- Kiebert G, Sorensen SV, Revicki D, Fagan SC, Doyle JJ, Cohen J et al. Atopic dermatitis is associated with a decrement in health-related quality of life. *Int J Dermatol* 2002;**41**:151–158.
- Yoshimura-Mishima M, Akamtsu H, Namura S, Horio T. Suppressive effect of ultraviolet (UVB and UVB) radiation on superantigen production by *Staphylococcus aureus*. *J Dermatol Sci* 1999;**19**:31–36.

11. Abeck D, Schmidt T, Fesq H, Strom K, Mempel M, Brockow K et al. Long-term efficacy of medium-dose UVA1 phototherapy in atopic dermatitis. *J Am Acad Dermatol* 2000;**42**(2 Pt 1):254–257.
12. Purschel W. Dermatological climato-therapy on the North Sea. Clinical-analytical studies of constitutional eczematoid with – without bronchial asthma and – or atopic rhinitis. *Dermatologica* 1973;**146**(Suppl. 1):1–98.
13. Harari M, Shani J, Seidl V, Hristakieva E. Climatotherapy of atopic dermatitis at the Dead Sea: demographic evaluation and cost-effectiveness. *Int J Dermatol* 2000;**39**:59–69.
14. Menger W. Indications and successes of climate therapy of children. *Offentl Gesundheitswes* 1989;**51**:470–476.
15. Autio P, Komulainen P, Larni HM. Heliotherapy in atopic dermatitis: a prospective study on climatotherapy using the SCORAD index. *Acta Derm Venereol* 2002;**6**:436–440.
16. Severity SCORing of Atopic Dermatitis: the SCORAD Index. Consensus Report of the European Task Force on Atopic Dermatitis. *Dermatology* 1993;**186**: 23–31.
17. Sosial-og helsedepartementet (Norway). Behandlingsreiser til utlandet. Et offentlig ansvar: NOU, Norges offentlige utredninger, 2002:2.
18. Mork C, Wahl A. Improved quality of life among patients with psoriasis after supervised climate therapy at the Canary Islands. *J Am Acad Dermatol* 2002;**47**:314–316.
19. Rodt A. Atopisk eksem – sol og saltvann. *Allergi i praksis* 1997;**3**:43–48.
20. Dreborg S, Frew A. Allergen standardization and skin tests. *Allergy* 1993;**48**(Suppl. 14):48–82.
21. Dahl R, Venge P, Olsson J. Blood eosinophil leukocytes and eosinophil cationic protein: diurnal variation in normal subjects and in patients with bronchial asthma. *Scand J Respir Dis* 1978;**59**:323–325.
22. Peterson CGB, Enander I, Nyshand J, Andersson AS, Nilsson L, Venge P. Radioimmunoassay of eosinophil cationic protein (ECP) by an improved method: establishment of normal levels in serum and turnover in vivo. *Clin Exp Allergy* 1991;**21**:561–567.
23. Gutgesell C, Heise S, Seubert A, Stichtenoth DO, Frolich JC, Nuemann C. Comparison of different activity parameters in atopic dermatitis: correlation with clinical scores. *Br J Dermatol* 2002;**147**:914–919.
24. Lewis-Jones MS, Finlay AY. The Children's Dermatology Life Quality Index (CDLQI): initial validation and practical use. *Br J Dermatol* 1995;**132**:942–949.
25. Herd RM, Tidman MJ, Ruta DA, Hunter JAA. Measurement of quality of life in atopic dermatitis. *Br J Dermatol* 1997;**136**:502–507.
26. Oranje AP, Stalder JF, Taieb A, Tasset C, de Loungeville M. SCORing of Atopic Dermatitis by SCORAD using a training atlas by investigators from different disciplines. ETAC Study group. Early treatment of the atopic child. *Pediatr Allergy Immunol* 1997;**8**:28–34.
27. Amon U, Memmel U, Stoll R, Amon S. Comparison of severity SCORing of Atopic Dermatitis values and serum levels of eosinophil cationic protein and mast cell tryptase for routine evaluation of atopic dermatitis. *Acta Derm Venereol* 2000;**80**:284–286.
28. Carlsen KH, Halvorsen R, Pettersen M, Carlsen KCL. Inflammation markers and symptom activity in children with bronchial asthma. Influence of atopy and eczema. *Pediatr Allergy Immunol* 1997;**8**:112–120.
29. Reynolds NJ, Franklin V, Gray JC, Diffey BL, Farr PM. Narrow-band ultraviolet B and broad-band ultraviolet A phototherapy in adult atopic eczema: a randomised controlled trial. *Lancet* 2001;**357**:2012–2016.
30. Tzaneva S, Seeber A, Schwaiger M, Honigsmann H, Tanew A. High-dose vs medium-dose UVA1 phototherapy for patients with severe generalized atopic dermatitis. *J Am Acad Dermatol* 2001;**45**:503–507.
31. Cooper KD. Cell-mediated immunosuppressive mechanisms induced by UV-radiation. *Photochem Photobiol* 1996;**63**:400–406.
32. Heck DE, Gerecke DR, Vetrano AM, Laskin JD. Solar ultraviolet radiation as a trigger of cell signal transduction. *Toxicol Appl Pharmacol* 2004;**195**:288–297.
33. Akiyama H, Yamasaki O, Kanzaki H, Tada J, Arata J. Effects of various salts and irradiation with UV light on the attachment of *Staphylococcus aureus* strains. *J Dermatol Sci* 1998;**16**:216–225.