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Sun exposure patterns of urban, suburban, and rural children

A dosimetry and diary study of 150 children

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Abbreviations:

UVR: ultraviolet radiation

SED: standard erythema dose

NMSC: non-melanoma skin cancer

BCC: basal cell carcinoma

CMM: cutaneous malignant melanoma

HRS: hours

What is already known about this topic:

Ultraviolet radiation (UVR) exposure to the sun begins already in childhood and is a major risk factor for skin cancer later in life. Skin cancer incidences have been observed higher in urban than in rural populations.

What this study adds:

Differences in sun exposure patterns were found between children according to place of residence. Children in the city had a more intermittent sun exposure pattern, while rural children had a higher UVR exposure on school/kindergarten days. This may be the background for higher skin cancer incidences in urban populations.

Abstract

Background: Sun exposure is the main etiology to skin cancer. Differences in skin cancer incidence have been observed between rural and urban populations. *Objectives:* As sun exposure begins in childhood; we examined summer UVR exposure doses and sun behavior in children resident in urban, suburban, and rural areas. *Methods:* Personal, electronic UVR dosimeters and sun behavior diaries were used during a summer (3.5 months) by 150 children (4-19 years of age) resident in urban, suburban, and rural areas. *Results:* On school/kindergarten days rural children spent more time outdoors and received higher UVR doses than urban and suburban children (rural: median 2.3hrs/day, median 0.9 SED/day, urban: median 1.3hrs/day, median 0.3SED/day, suburban: median 1.5hrs/day, median 0.4 SED/day) ($p<=0.007$). Urban and suburban children exhibited a more intermittent sun exposure pattern than rural children. Differences in UVR exposure doses came from high exposure days (e.g. beach days) outside Denmark. Suburban children had a total UVR exposure similar to rural children (suburban: median 109.4 SED, rural: median 103.1 SED), with days spent abroad contributing greatly to the total UVR exposure dose (total UVR on days spent abroad: suburban: median 48.0 SED, rural: median 8.0 SED). *Conclusions:* Differences in sun exposure patterns exist between children from different areas and may be the background for higher skin cancer incidences in urban populations.

Introduction

Ultraviolet radiation (UVR) exposure is a major risk factor for skin cancer[1] and residential area may play an important role in UVR-related disease outcomes. In Denmark the urban population has a higher cancer incidence than the rural population, including non-melanoma skin cancer (NMSC),[2] primarily basal cell carcinoma (BCC).[3] Another Danish study found a higher risk of cutaneous malignant melanoma (CMM) of the trunk and extremities among urban than rural populations.[4] Also, a study from the Netherlands revealed a higher incidence of CMM in areas with high population density than in areas with low population density.[5] This was also found in an Irish study showing higher BCC and squamous cell carcinoma (SCC) incidences in urban than in rural populations.[6]

Different sun-related behavior and patterns of sun exposure (intermittent exposure pattern/continuous exposure pattern) may explain differences in UVR-related disease outcomes between rural and urban populations.

A Canadian study found higher odds ratios for sunburn, mid-day sun exposure, less frequent shade seeking and less frequent sunscreen use among people aged 12 and older in rural compared to urban areas, independent of age (questionnaire method).[7] Differences in sun behavior have also been observed in Australian adolescents and adults according to residential area (questionnaire/diary method, telephone interviews).[8,9] Rural adolescents were less likely than adolescents in the city to spent time in the sun during the weekend.[8] Rural adults were more likely to be sunburnt than adults in the city.[9]

As children's sun behavior and exposure are of high relevance for later skin carcinogenesis,[10] we examined if children's sun related behavior and UVR exposure

differed according to residential area (urban, suburban, rural). Sun-related behavior was recorded in diaries and UVR exposure was objectively measured by personal dosimetry during a summer season. To our knowledge no study has examined this before.

Materials and Methods

Study design

Results from two prospective cohort studies conducted in 1999-2000[11] and 2009[12] were compared. The studies were approved by the Danish Research Ethics Committee, Region Hovedstaden (KF11-007/99 and H-D-2009-034). Written consent was obtained from all participants. Parents answered on behalf of their small children. Both studies were conducted in conformity with the Declaration of Helsinki.

Setting

Recruited children were all living in Denmark (latitude range: 54°44′N-55°55′N). The children were grouped according to area of residence (rural/suburban/urban) and data were compared from June 16 (mid Summer) to September 30. Rural residence was defined as living on a farm in the countryside, suburban residence as living in a suburb of Copenhagen, the Danish capital, and urban residence as living centrally in Copenhagen. The participants in the first study all had suburban or urban residence, while the participants in the second study all had rural residence. The study period covered the school holiday period of typically 7 weeks during June, July and August, and the first weeks of the school year starting from approximately the 2nd week of August. The mean air temperatures in Denmark during June, July and August 1999 were 13.5, 17.2 and 16.5 degrees Celcius, respectively. In 2000, the corresponding figures were: 13.7, 14.9 and 15.2 degrees Celcius, and in 2009 they were: 13.9, 17.2 and 17.4 degrees Celcius. The number of cumulated sunlight hours for the three months during the same years were: 821, 657, and 700, respectively.[13]

Study population

Children were included if they were between 4 and 19 years of age, lived at home with their parents, attended kindergarten or school, were of Nordic origin with skin types I-IV, and had no previous history of psoriasis, atopic dermatitis or polymorphic light eruption. No disabled children or children taking sun-sentitizing medication were included. 154 children were included in the study, 90 children from the study in 1999-2000[11] and 64 children from the study in 2009.[12]

UVR dosimeter (SunSaver)

All participants wore a personal UVR dosimeter (SunSaver) during the study period. The dosimeter is worn as a wristwatch and measures personal, time-stamped UVR doses in standard erythema doses (SED),[14] calibration traceable to the UK National Physical Laboratory. The SunSaver contains a silicon carbide photodiode sensor, with a spectral response that mimics the erythema action spectrum.[15] All participants were instructed to wear the dosimeter uncovered every day from at least 7am to 7pm. A newer SunSaver version was used in the 2009 study, for which reason data from the 2009 study were corrected to match the sensitivity of the previous SunSaver version used in the 1999-2000 study, making the measurements from the two studies directly comparable. Since the SunSaver makes time-stamped measurements, both UVR doses and measurements of time spent outdoors can be derived from it.

Diary

All participants filled out a personal diary on sun behavior every day during the study period.[16] Generally, participants were instructed to fill in their own diary, but parents were allowed to fill in the diary on behalf of small children. Participants made an entry if they were in school or kindergarten, were abroad, sunbathed, used a solarium, exposed their

shoulders to the sun without intentionally sunbathing, were at the beach, used sunscreen, or obtained a sunburn (defined as any degree of erythema obtained that day).

We defined ”risk days” as days with ”risk behavior” (intentional sunbathing, exposure of shoulders to the sun doing activities such as playing in the garden, or using a solarium).

SunSaver and diary days used for the analysis

Diary and SunSaver data were combined for the same dates. Only complete daily SunSaver data and diary data for the same days were used for analysis. Only children with more than 30 complete SunSaver and diary days between June 16 (midsummer) and September 30, and a minimum 21 of these days in the peak summer months of June/July/August[17,18] were included in the analysis. This produced a total of 150 children. The variables used for analysis are given in Tables 1-2. UVR doses in percentage of ambient UVR were calculated for days spent in Denmark, with erythemally weighted ambient UVR measurements derived from a UV-biometer, model 501 (Solar Light Co. Inc., Glenside, PA, U.S.A.) on the roof of our hospital in Copenhagen in the 1999-2000 study, and from the Danish Meteorological Institute (DMI) for the 2009 study.

Skin type, hair color, and eye color

Skin type was defined according to the Fitzpatrick classification system. Hair and eye color were objectively assessed and graded on 5-point scales: red, light blond, dark blond, brown or black (hair), and blue, green, grey, hazel brown or dark brown (eyes).

Questionnaire

A questionnaire was filled out by each participant regarding general present and past sun behavior, e.g. if they lived in a house with a garden, if they had ever engaged in any

outdoor sports (water sports, ball games, skiing, horse riding, golf, fishing, cycling, running, or others) and how many sun holidays they had taken during their entire lives.

Statistical analysis

For demographic data, a Chi Square test was used to examine relations between categorical variables, and a One-Way ANOVA test was used to examine relations between categorical and continuous variables. For UVR exposure data (number of days, time spent outdoors, UVR doses) non-parametric tests (Mann-Whitney test) were used for analysis, since a large part of the variables were not normally distributed (Kolmogorov-Smirnov test). Values are given in medians and ranges. All statistically significant UVR exposure variables were then entered into three backward binary logistic regression models (rural vs. urban, rural vs. suburban, and urban vs. suburban), to examine the impact of the variables when combined in one model. Backward binary logistic regression models were also used to examine the effect of age and gender on UVR exposure data. The Spearman Correlation test was used to test correlations between age and UVR exposure data. The significance level was set at 0.05. SPSS Statistics 19.0 (IBM, Armonk, New York, USA) was used for the analysis.

Results

Study population

150 children were included in the analyses. 61 children had rural residence, all living on farms in the countryside, 45 had suburban residence (93% lived in a house with a garden), and 44 had urban residence (36% lived in a house with a garden). We found no significant differences between groups in age, gender, skin type, hair color, or eye color (Table S1).

Combined dosimetry and diary data

No significant differences in number of participation days were found between groups, but suburban children had more school/kindergarten days during the 3.5 months study period than the urban children (urban: 37 days, suburban: 40 days, $p=0.032$) (Table 1).

UVR exposure doses on school/kindergarten days

Rural children spent significantly more time outdoors than both urban and suburban children on school/kindergarten days (rural: 2.3 hrs, urban: 1.3 hrs, $p<0.001$, suburban: 1.5 hrs, $p=0.007$). They also had a significantly higher UVR exposure on these days (rural: 0.9 SED, urban: 0.3 SED, $p<0.001$, suburban: 0.4 SED, $p<0.001$) (Table 1 & Figure 1).

Between urban and suburban children there was no significant difference in time spent outdoors on school/kindergarten days, but suburban children had a significantly higher UVR exposure on school/kindergarten days (suburban: 0.4 SED, urban: 0.3 SED, $p=0.021$) (Table 1 & Figure 1).

As described above, a significant difference was found between all groups in UVR exposure on school/kindergarten days. This also applied for the percentage of ambient UVR received; here the figures were 4.7% for rural children , 2.8%, for suburban children, and 2.1% for urban children ($p<0.001$ (rural vs. suburban), $p<0.001$ (rural vs. urban), $p=0.003$ (suburban vs. urban)) (Table 2).

UVR exposure doses on days off, risk days, beach days, sunscreen days and sunburn days

Rural children had significantly less days using sunscreen than both urban and suburban children (rural: 3 days, urban: 7 days, $p=0.004$, suburban: 8 days, $p<0.001$). They also had significantly less risk days and beach days than suburban children (rural: 11 risk days, suburban: 16 risk days, $p=0.014$), (rural: 5 beach days, suburban: 10 beach days, $p=0.005$). Rural children had a significantly lower UVR exposure on beach days than both urban and suburban children (rural: 3.0 SED, urban: 5.0 SED, $p=0.019$, suburban: 5.1 SED, $p=0.006$), and they had a significantly lower UVR exposure than urban children on sunburn days (rural: 4.6 SED, urban: 6.3 SED, $p=0.044$). On days off and risk days, rural children also had a significantly lower UVR exposure than suburban children (days off: rural: 1.5 SED, suburban: 1.7 SED, $p=0.041$), (risk days: rural: 2.7 SED, suburban: 3.6 SED, $p=0.046$) (Table 1).

Between urban and suburban children, no significant difference was found in number of or UVR exposure on risk days, beach days, sunscreen days, or sunburn days (Table 1).

UVR exposure doses on days spent in Denmark and days spent abroad

Both urban and suburban children spent a significantly higher number of days abroad during the study period than rural children (urban: median 1 day (range: 0-21 days), suburban: median 4 days (range: 0-28 days), rural: median 0 days (range: 0-19 days),

p<0.001 for both) (Table 1). We therefore calculated the UVR exposure on days spent in Denmark to examine if the differences in UVR exposure were due to holidays abroad (Table 2).

For urban and rural children, the difference in UVR exposure dose on beach days vanished, but a significant difference in percentage of ambient UVR on beach days in Denmark remained (urban: 20.3%, rural: 12.2%, p=0.021). There was still a difference in UVR exposure dose on sunburn days (urban: 6.3 SED, rural: 4.4 SED, p=0.029), and also in percentage of ambient UVR (urban: 25.2%, rural: 13.9%, p=0.003). A significant difference in daily UVR exposure dose appeared for days spent in Denmark when examined alone (urban: 0.8 SED, rural: 1.2 SED, p=0.008), likewise for percentage of ambient UVR (urban: 3.8%, rural: 5.8%, p=0.003).

For suburban and rural children, the differences in UVR exposure dose on days off, risk days and beach days vanished when examining only days spent in Denmark. Likewise, no differences in percentage of ambient UVR were found on these days (Table 2).

Total UVR exposure doses during the study period

For rural children, a median of 103.1 SED was received by each child during the entire study period. The corresponding figures for suburban and urban children were 109.4 SED and 75.3 SED, respectively. The figures for rural and suburban children were significantly higher than for urban (rural vs. urban: p=0.034, suburban vs. urban: p=0.015) (Table 2). For rural children, a median of 103.1 SED was received by each child during days spent in Denmark. For suburban and urban children, the figures were 76.3 SED and 54.1 SED, respectively, with rural children significantly higher than urban (p<0.001) (Table 2). For rural children spending days abroad, a median of 8.0 SED was received by each child

during these days. For suburban and urban children, the figures were 48.0 SED and 9.4 SED, respectively, with suburban children significantly higher than rural (p=0.007) (Table 2).

Number of lifetime sun holidays (questionnaire data)

Urban children had had a median of 3 sun holidays (range 0-20) during their lives, suburban 2 sun holidays (range 0-30), and rural 1 sun holiday (range 0-9). The figure was significantly higher for urban and suburban children than for rural children (urban vs. rural: p=0.004, suburban vs. rural: p=0.003).

Extreme outliers

Two extreme outliers were observed (one urban and one suburban). These were still included in our analysis. Both children lived in a house with a garden and engaged in outdoor sports and activities. *The urban child* had risk behavior on 55% of all days, went to the beach on 24% of all days and had a sunburn on 12% of all days. *The suburban* child had risk behavior on 59% of all days, went to the beach on 33% of all days and had a sunburn on 2% of all days.

Binary logistic regression modelling

With urban children as reference category, one significant variable (UVR dose received on beach days) was found for rural children with an estimated odds ratio (OR) of 0.67 (p=0.012), which means that the higher the personal UVR dose received on beach days is, the lower are the odds of having a rural residence.

With suburban children as reference category, three significant variables were found for rural children (number of sunscreen days, UVR dose received on school/kindergarten days,

and UVR dose received on days off). Estimated ORs were 0.90 (p=0.007) for number of sunscreen days, 12.89 (p=0.001) for UVR dose received on school/kindergarten days, and 0.28 (p=0.003) for UVR dose received on days off. This means that the higher the number of sunscreen days is and the higher the UVR dose received on days off is, the lower are the odds of having a rural residence. Also, the higher the UVR dose received on school/kindergarten days is, the higher are the odds of having a rural residence.

For urban versus suburban children all variables turned insignificant when combined in one model.

Discussion

The aim of the present study was to compare the UVR exposure patterns of children living in urban, suburban, and rural areas. The distribution of age, gender, skin type, and hair and eye color were similar for the three groups. Likewise, the number of participation days was similar for all groups, making comparisons between groups reasonable.

Most children engaged in risk behavior (exposing upper body to the sun), went to the beach and used sunscreen during the study period. Around half the children reported sunburns. More than half the children in the city (urban and suburban) spent days abroad during the study period, while only one fourth of the rural children did.

Differences in UVR exposure doses between children from the different residential areas were primarily seen for school/kindergarten days, when rural children received the highest UVR doses and urban children the lowest (Figure 1). This is in line with the finding that rural children spent more time outdoors on these days (Table 1). Rural children attended school or kindergarten just like the urban and suburban children, so differences in UVR exposure and time spent outdoors may be explained by factors like easier outside access in rural areas, which may have resulted in more activities or school classes being conducted outdoors than in urban/suburban areas, and children helping or playing outdoors at the farm after school/kindergarten hours. Also, environmental differences at schools/kindergartens may play a role in UVR exposure, e.g. urban areas may provide more shade than rural areas, due to taller buildings and higher density of buildings.[19] On days off the children spent a similar amount of time outdoors, irrespective of residential area and received comparable UVR doses (Table 1).

Differences were found between the three groups in UVR exposure on the following days indicating extreme sun behavior: risk days (rural vs. suburban) and beach days (rural vs. suburban and urban) (Table 1). We found that these differences were explained by UVR exposure on days spent abroad (Table 2). Suburban and urban children spent more days abroad than rural children during the study period, and we speculated if rural children spent days abroad outside the summer and harvesting period, e.g. on sun holidays during the winter period when farming activities are low. We found, however, that rural children had had significantly fewer lifetime sun holidays than both suburban and urban children.

When looking at total UVR exposure doses during the study period, we found that rural and suburban children received the highest exposure. For suburban and urban children, UVR doses received on days abroad contributed markedly to their total UVR exposure (Table 2 & Figure 2).

Results in relation to skin cancer incidence

An ”urban to rural excess” of skin cancer has been described in several studies.[2,4-6] In Denmark both NMSC and CMM at specific body locations have shown an urban excess in incidences.[2,4] Assuming that people remain in the setting where they spent their childhood, the excess of CMM and BCC may be explained by a more intermittent sun exposure pattern[10] in city children than in rural children, as highlighted by the present results. SCC has been linked to cumulative (total) UVR dose throughout life.[10] Risk behavior may contribute considerably to the cumulative UVR dose,[20] and in the present study UVR doses received on days abroad contributed to the total UVR exposure of suburban children to an extent that they received total UVR doses similar to those of the rural children.

Limitations of the study

Previous studies have shown that age and gender may influence UVR exposure.[21-23] In the present study the small sample size did not permit a subdivision of participants by age and gender but backward binary logistic regression models including age and gender as covariates revealed no influence of these factors on our results (data not shown here). We performed analysis for all children as a group, examining relations between age, gender and UVR exposure (data not shown here). We found significantly negative correlations between age and hours spent outdoors (on a daily basis, on school/kindergarten days, and between 12 noon and 3pm) and between age and UVR exposure doses on school/kindergarten days. The negative correlation between age and hours spent outdoors, may very well be explained by a longer school schedule for older children. We found significantly positive correlations between age and number of sunburn days, and age and UVR exposure doses on days off, risk days, and beach and sunscreen days. No correlation was found between age and overall daily UVR dose or total UVR exposure dose. We found significant gender differences, with girls having more days off, more risk days, beach days, sunscreen days, sunburn days, and higher UVR doses on days off, risk days, and beach days than boys (Figure S1).

Ideally, all participants should have been followed during the same year, thus limiting differences in personal behavior and UVR exposure due to different weather conditions from year to year. We tried to eliminate this factor, by using the fraction of ambient UVR received. The ten-year gap between the two studies may also have generally changed people's sun behavior and exposure (i.e. increased focus on sun behavior and protection), and the sun behavior and travel activity of a present day urban/suburban group may differ from that of a comparable group 10 years ago.

Strengths of the study

The strength of the present study was the similar set up of the two studies to be compared. Both studies included children of all age groups, had similar objective measurements of UVR (dosimetry), registration of personal sun behavior (diary), and covered a similar study period (summer) in Denmark. The children in the three groups had comparable skin types, hair color and eye color, therefore, differences found in the present study are not likely explained by different sun sensitivity.

In conclusion, even in a small country like Denmark with an expectedly homogenous population, differences in UVR exposure were found between children according to residential area. On school/kindergarten days, an increasing UVR exposure was observed with increasing distance from the urban area, probably reflecting the easier outdoor access and relative lack of shade in the countryside. Urban and suburban children had a more intermittent sun exposure pattern than rural children, and suburban children actually had the highest total UVR exposure during the study period, with UVR received on days abroad as the major contributing factor. The results found in the present study may contribute to the understanding of the urban to rural excess of skin cancer.

Conflict of interest

The authors state no conflict of interest.

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Tables

Table 1. Overall sun behavior and exposure during the study period

All days	Residential area			Comparisons[1]		
Participants	Rural (n=61)	Suburban (n=45)	Urban (n=44)	Rural vs. Suburban	Rural vs. Urban	Suburban vs. Urban
Number of days (median, range)				p-values		
Participation days	90 (31-107)	87 (47-106)	85 (43-107)	NS	NS	NS
School/kindergarten days	38 (6-64)	40 (8-49)	37 (5-48)	NS	NS	P=0.032
Days off	52 (20-73)	48 (13-71)	47 (8-70)	NS	NS	NS
Risk days	11 (0-55)	16 (2-53)	12 (0-45)	P=0.014	NS	NS
Beach days	5 (0-28)	10 (0-25)	8 (0-30)	P=0.005	NS	NS
Sunscreen days	3 (0-32)	8 (0-34)	7 (0-26)	p<0.001	p=0.004	NS
Sunburn days	0 (0-6)	0 (0-6)	1 (0-7)	NS	NS	NS
Abroad	0 (0-19)	4 (0-28)	1 (0-21)	P<0.001	P<0.001	NS
Hours outdoors per day (median, range)				p-values		
Daily (all days)	2.4 (0.4-4.8)	2.1 (0.8-4.5)	2.1 (0.4-5.2)	NS	P=0.013	NS
12-15	0.9 (0.2-1.6)	0.9 (0.3-1.6)	0.8 (0.1-2.0)	NS	NS	NS
School/kindergarten days	2.3 (0.1-4.9)	1.5 (0.1-4.5)	1.3 (0.3-5.7)	P=0.007	P<0.001	NS
12-15	1.0 (0.0-1.8)	0.7 (0.1-1.8)	0.6 (0.1-2.1)	NS	P=0.005	NS
Days off	2.6 (0.7-4.7)	2.5 (0.9-4.8)	2.4 (0.4-5.1)	NS	NS	NS
12-15	1.0 (0.3-1.7)	1.1 (0.3-1.7)	0.9 (0.1-2.0)	NS	NS	NS
UVR exposure in SED per day (median, range, n)[2]				p-values		
Daily (all days)	1.3 (0.3-2.6)	1.3 (0.3-4.2)	1.0 (0.1-4.3)	NS	NS	NS
12-15	0.6 (0.2-1.3)	0.6 (0.2-2.6)	0.5 (0.0-2.7)	NS	NS	P=0.044
School/kindergarten days	0.9 (0.1-2.3)	0.4 (0.1-2.6)	0.3 (0.1-3.6)	P<0.001	P<0.001	P=0.021
Days off	1.5 (0.3-3.1)	1.7 (0.4-7.3)	1.6 (0.0-6.8)	P=0.041	NS	NS
Risk days[2]	2.7 (0.2-9.3), 59	3.6 (0.3-12.3)	3.2 (0.1-11.1), 42	P=0.046	NS	NS
Beach days[2]	3.0 (0.2-11.8), 57	5.1 (0.6-16.7), 41	5.0 (0.5-12.2), 40	P=0.006	P=0.019	NS
Sunscreen days[2]	5.1 (0.9-16.6), 46	5.1 (0.7-19.1), 39	5.6 (0.1-18.3), 40	NS	NS	NS
Sunburn days[2]	4.6 (0.0-17.2), 26	8.5 (0.4-29.2), 22	6.3 (0.5-26.9), 24	NS	P=0.044	NS

[1] Green cells flag significant p-values, yellow cells flag p-values that are non-significant when Bonferroni corrected with 3.

[2] N is only given if different from initial value.

Table 2. Sun exposure in Denmark and abroad

	Residential area			Comparisons[1]		
Participants	**Rural (n=61)**	**Suburban (n=45)**	**Urban (n=44)**	**Rural vs. Suburban**	**Rural vs. Urban**	**Suburban vs. Urban**
UVR exposure in SED per day (median, range, n[2]) and % of ambient UVR (median) (Days in Denmark)				**p-values**		
Daily (all days)	**1.2 (0.3-2.3)**	**1.0 (0.3-3.1)**	**0.8 (0.1-4.1)**	**NS**	**P=0.008**	**NS**
-% of ambient UVR	**5.8%**	**4.5%**	**3.8%**	**NS**	**P=0.003**	**NS**
12-15	**0.6 (0.2-1.1)**	**0.5 (0.1-1.6)**	**0.4 (0.0-2.5)**	**NS**	**P=0.044**	**NS**
School/kindergarten days	**0.9 (0.1-2.3)**	**0.4 (0.1-2.6)**	**0.3 (0.1-3.6)**	**P<0.001**	**P<0.001**	**P=0.021**
-% of ambient UVR	**4.7%**	**2.8%**	**2.1%**	**P<0.001**	**P<0.001**	**P=0.003**
Days off	**1.4 (0.2-3.1)**	**1.4 (0.4-3.8)**	**1.1 (0.0-4.2)**	**NS**	**NS**	**NS**
-% of ambient UVR	**5.9%**	**5.5%**	**4.3%**	**NS**	**NS**	**NS**
Risk days[2]	**2.7 (0.2-8.1), 57**	**2.8 (0.3-12.3)**	**3.0 (0.1-8.8), 42**	**NS**	**NS**	**NS**
-% of ambient UVR	**9.5%**	**10.5%**	**12.2%**	**NS**	**NS**	**NS**
Beach days[2]	**3.1 (0.2-11.8), 55**	**4.2 (0.6-13.4), 39**	**5.0 (0.0-10.6), 38**	**NS**	**NS**	**NS**
-% of ambient UVR	**12.2%**	**14.6%**	**20.3%**	**NS**	**P=0.021**	**NS**
Sunscreen days[2]	**4.8 (0.9-16.6), 44**	**4.8 (0.7-16.2), 36**	**5.0 (0.1-17.7), 37**	**NS**	**NS**	**NS**
-% of ambient UVR	**15.4%**	**17.1%**	**19.5%**	**NS**	**NS**	**NS**
Sunburn days[2]	**4.4 (0.0-14.3), 25**	**7.1 (0.5-29.5), 17**	**6.3 (0.5-21.3), 24**	**NS**	**P=0.029**	**NS**
-% of ambient UVR	**13.9%**	**23.5%**	**25.2%**	**NS**	**P=0.003**	**NS**
Total UVR exposure in SED: median and (sum) of all participants' doses, n[2]				**p-values**		
Entire study period	**103.1 (6549)**	**109.4 (5472)**	**75.3 (4290)**	**NS**	**P=0.034**	**P=0.015**
Days in Denmark	**103.1 (6316)**	**76.3 (4000)**	**54.1 (3077)**	**NS**	**P<0.001**	**NS**
Days abroad[2]	**8.0[3] (233), 16**	**48.0[3] (1471), 25**	**9.4[3] (1213), 24**	**P=0.007**	**NS**	**NS**

[1] Green cells flag significant p-values, yellow cells flag p-values that are non-significant when Bonferroni corrected with 3.

[2] N is only given if different from initial value.

[3] Mean values for rural:14.6 days , suburban: 58.8 days, and urban: 50.5 days.

Figure legends

Figure 1. UVR exposure differences on school/kindergarten days

Boxplots show daily personal UVR exposure in SED on school/kindergarten days according to residential area (urban/suburban/rural). The box length represents the interquartile range, while the line in the box represents the median. The whiskers represent the value of 1.5 x the height of the box. Outliers are marked with a circle and extreme outliers with an asterix.

Figure 2. UVR exposure in Denmark and abroad

Pie charts show UVR exposure doses (sum of all participants doses in SED) on days in Denmark and days abroad expressed as percentage of total UVR exposure doses for the entire study period according to residential area, urban (a), suburban (b), and rural (c).

Figure 1

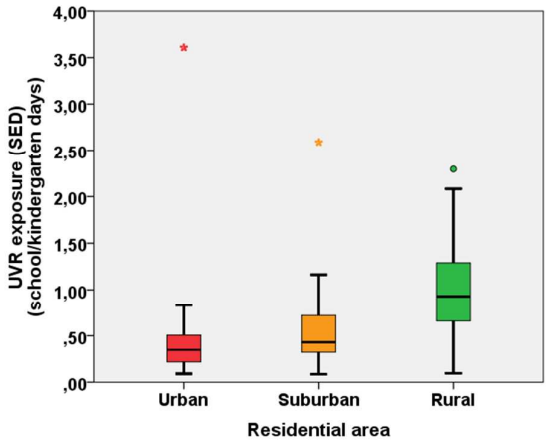

Figure 2