British Journal of Dermatology 1998; **139:** 428–438.

Sunbeds in current use in Scotland: a survey of their output and patterns of use

J.MCGINLEY, C.J.MARTIN AND R.M.MACKIE*

*Departments of Clinical Physics and Bio-Engineering and *Dermatology, University of Glasgow, Glasgow G12 8QQ, U.K.*

Accepted for publication 21 April 1998

Summary Spectral irradiances of 100 commercially available sunbeds in current use have been measured. Ultraviolet (UV) A and UVB doses from sunbed use have been calculated and compared with doses likely to be received from solar radiation. The majority of sunbeds use UVA fluorescent tubes for irradiating the body and filtered metal halide lamps, which have a higher proportion of UVA1, for the face. The average minimum erythemal dose per session is 0·80, but irradiances for particular models varied by a factor of two to three primarily because of decline in lamp output with age. The UVA dose from a session on a sunbed is similar to that which might be received from 20 to 30 min sunbathing at a Mediterranean resort or 1 h on a sunny day in Glasgow, while UVB doses are 20–25% of this level. Responses from 200 current users of the sunbeds indicate that 38% had skin types 1 and 2, that 17% had more than 100 annual sunbed sessions and that 35% rarely or never used the goggles provided.

Concern has been expressed about the possible long-term risk of exposure to ultraviolet (UV) radiation from the use of sunbeds for cosmetic tanning. Four groups, including our own, have found that sunbed use is a risk factor for subsequent melanoma development in case–control studies of melanoma.[1–5] However, all of these studies depended on patient recall of sunbed use, in some cases many years previously, and in none of the studies was the output of the sunbeds quantifiable.

Quantitative data have not previously been available on UV exposure from current sunbed models in sport and tanning centres and how the relative UVA and UVB dosages compare with exposure to natural UV radiation. Previous reported studies have used radiometers with broadband detectors, which do not give an accurate measure of irradiances in different parts of the UV spectrum, and have not related these measurements to the actual use of the measured beds.[6]

A survey of sunbeds in commercial use in 1997 has therefore been conducted in Scotland. UV emissions have been measured using a spectroradiometer, and questionnaires have been distributed at centres where the measurements were made in order to provide information on the current patterns of use of the beds for which outputs were measured. Data from the two components of the survey have been combined in order to estimate typical UV exposures for sunbed users.

Correspondence: Professor R.M.MacKie, Department of Dermatology, Robertson Building, University of Glasgow, Glasgow G12 8QQ, U.K.

Materials and methods

UV spectra have been recorded from 100 sunbeds in central Scotland. The beds were located in local council sports centres, swimming pools and private salons. Measurements were made on site in each centre using a Glen Spectra SpectRad 1680 Spectroradiometer system, which incorporated a double monochromator and photomultiplier, attached to a DemTruck trolley to allow easy movement. A spectrum was collected at the central position in each sunbed using an integrating sphere with the aperture positioned at 200 mm below the upper surface of the bed. An additional measurement was made at the position of the face, directly under the special facial unit, where one was present, or otherwise at 750 mm from the centre. Further measurements were made at 250 mm and 500 mm from the centre towards the top end of each sunbed, where time permitted. Measurements were recorded at 1 nm intervals over the range 280–700 nm in the centre of the sunbed, between 280 nm and 550 nm at the position of the face and over the range 280–400 nm at other positions. There was no UVC (100–280 nm) present. The sunbeds were switched on for 3 min in order to warm up and stabilize at their maximum output before

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any measurements were made, as the time required for different sunbeds to reach peak output may vary.[6] The spectral transmission of eye protection recommended by sunbed manufacturers was measured using the spectroradiometer with a Waldman PUVA 180 hand therapy unit as the source. This had a similar output spectrum to the fluorescent tubes used in sunbeds.

The spectroradiometer was calibrated by Glen Spectra before delivery and on site after 6 months, mid-way through the project, using a 45 W deuterium arc lamp (200–300 nm) and a 1000 W tungsten halogen lamp (300–850 nm), which had an American National Standard Institute calibration. Every 3 months, the spectroradiometer was checked against a 100 W quartz halogen lamp (QH3) running at 8 A, calibrated against a National Physical Laboratory standard over the wavelength range 280–610 nm, and every month the calibration was checked against a second quartz halogen lamp (QH4) run under the same conditions as QH3. Finally, the spectroradiometer was monitored before and after each movement to a different location using a check source incorporating a 20 W quartz halogen bulb in order to ensure that the calibration did not vary by more than ± 10%. The spectra obtained were integrated to derive irradiance values within different parts of the UV spectrum. Terms used in the results refer to the following ranges: UV (280–400 nm); UVB (280–315 nm); UVA (315–400 nm); UVA1 (340–400 nm); UVA2 (315–340 nm); and blue light (400–550 nm). Spectral measurements were also made with subjects wearing only shorts lying in two of the sunbeds, in order to determine the effect of absorption and reduction of reflections caused by the presence of a body. The integrating sphere was supported between the subject's legs at the centre of the bed with the aperture located at the height of the skin surface. These results were compared with values obtained with the integrating sphere in the normal position used for the measurements in the same beds without a body present, in order to obtain a correction factor from which the dose to the skin of a user could be calculated.

The rates at which minimum erythemal doses (MEDs) would be accumulated at the central position on each sunbed were calculated by weighting the spectral data with the McKinlay–Diffey action spectrum for the erythemal response adopted by the Commission Internationale de l'Eclairage.[7] A MED of unity is the dose required to produce a slight reddening of the skin 16–24 h after the exposure for skin type 2, equivalent to 200 J/m^2. The correction factor allowing for the presence of a body was applied to the data, and the irradiances were multiplied by the lengths of the sessions for the corresponding sunbeds in order to obtain the MED per session for each.

Questionnaires were distributed by the centres to individuals using the sunbeds, seeking information on the number of sunbed sessions that individuals had per year, their attitudes to sunbeds, their reasons for using them, whether they had experienced any adverse reactions and whether they routinely used goggles to protect their eyes. Information was also sought on their age, their skin colouring, the reaction of their skin to natural sunlight and their holiday habits.

In order to compare UV exposure from sunbeds with that from natural sources, potential UV exposure levels in each part of the UV spectrum were determined. Measurements of UV irradiances were combined with data on the lengths of sessions on corresponding beds to derive UV exposure from single sessions for each bed. The correction factor was applied to allow for the presence of a body in the bed, and the results were used to estimate UV exposure levels to the body and face for different patterns of sunbed use.

The National Radiological Protection Board (NRPB) provided UV spectral data recorded in Glasgow during the summer of 1997. Values for mean UV irradiances on sunny days during time periods 12·00–14·00, 10·00–16·00 and 09·00–17·00 British Summer Time (BST) were derived by averaging spectra recorded at 30-min intervals under cloudless conditions on 10 days distributed throughout the period May to August. The mean for the period 12·00–14·00 was 98% of the maximum and that for 10·00–16·00 was 85% for UVB, 88% for UVA2 and 90% for UVA1. An additional factor of 75% was used to take account of the presence of some cloud in order to calculate exposure on a sunny day during the period 10·00–16·00. Examination of the data indicated that the inclusion of this factor would give exposure levels equivalent to the mean for the 35 'sunniest' days during the 4 summer months. Ten such days occurred during weekends, and the doses that might have been received from ten 2-h or 6-h sunbathing sessions in Glasgow were calculated as comparators. All exposures apply to the geometry used for the detector system, i.e. a horizontal surface.

Average facial exposures for individuals working outdoors were also derived for comparison. Mean irradiances on cloudless days over the period 09·00–17·00 BST were 74%, 80% and 83% of the peak values for the UVB, UVA2 and UVA1 parts of the spectrum, respectively. Days over the period May–August were

Table 1. Data on types of sunbed tested during the survey

Make code	Type of sunbed	Tube type[a]	No. of sunbeds	No. of burners[b]	Power of burners[b]	Shorthand
1	ALISUN Q 28F	1	4	1		Ali
2	JK Ergoline 26	1	7	1	400 W	JKE26
3	JK Ergoline 38	1	12	3	400 W	JKE38
4	Jomi Seabreaze	1	11	2	400 W	JSB
5	Miami Sun-Power House (supplier)	1	6	1	500 W	PH
6	Spectrum Professional	1	2	3	–	SP
7	Ultrabronz 300 Series	1	3	1	1000 W	UB300
8	Ultrabronz 400 Series	1	3	3	1000 W	UB400
9	Ultrasun Professional (2800/3000)	1(2)	26	1, 2 or 3	500 W	UP
10	Ultrasun Professional High Intensity (3500/4300)	1(2)	7	3 or 4	500 W	UPHI
11	Ultrasun Professional Magnum Power	2(1)	8	5	1000 W	UPMP
12	Ultrabronz 800 Series	Burners only[b]	5	10	1000 W	UB800
13	Ultrasun Professional High Pressure	Burners only[b]	5	10	1000 W	UPHP
13	Ultrasun Professional Turbo Power	Burners only[b]	1	10	1000 W	UPTP

[a] Type 1, normal; type 2, higher power (see text).
[b] Filtered metal halide lamps.

divided into five categories based on average UV irradiances and, from this, an average level of UV exposure over the summer period was calculated to be 47% of that on a sunny cloudless day. A factor of 0·5 was therefore applied to give an average irradiance for a typical day. These data were used to calculate the exposure of an individual working outside for five 8-h days per week for a 4-month period, with a further factor of 0·5 applied to take account of the proportion of time that solar radiation was on one side of the face.

An assessment of the UV exposure that might be received during a 1-week holiday in the Mediterranean was made from UV spectral data recorded at 13·30 GMT (solar noon) and 15·00 during 1 sunny day, 4 July 1997, at Thessaloniki, Greece. The peak irradiances at solar noon were calculated, and exposures to this irradiance were derived for a 2-h period centred around the solar noon, again assuming that the mean irradiance for this period was 98% of the maximum. In order to evaluate the exposure that a person might receive from sunbathing for a 6-h period centred around solar noon in early July, the variation in UVB, UVA2 and UVA1 solar irradiances were assumed to follow relationships similar in form to those observed in the U.K. Irradiances derived from the two sets of spectral data recorded in Thessaloniki were fitted to this relationship in order to determine the time dependence of the variation during the 6-h period. The average irradiances were 87% of the maximum for UVB, 90% for UVA2 and 93% for UVA1. An additional 75% factor was applied to take account of cloud cover. These irradiances were used to estimate the UV exposure that might be received by an individual on a 1-week holiday in which sunbathing was a significant component.

Results

The 100 sunbeds studied comprised 13 models from seven manufacturers (Table 1). Altogether, 85 of the sunbeds used fluorescent tubes to irradiate the body with additional panels that contained filtered high-pressure metal halide lamps (sometimes referred to as burners) in the top section to which the face would be exposed. Four beds used only fluorescent tubes and 11 only filtered metal halide lamps.

Sunbeds using fluorescent tubes

A typical measurement from the centre of a sunbed incorporating fluorescent tubes has a broad spectrum mainly in the UVA with characteristic peaks at 313 nm and 365 nm. The fluorescent tubes used in sunbeds are of two types. The spectra are similar in form, but that for type 2 is shifted by 1 nm towards the shorter wavelength UVB, and the relative magnitude of the 313 nm peak is greater (Fig. 1a). The proportion of the output in the UVB is 0·6% for type 1 and 1·2% for type 2. Type 1 fluorescent tubes are mainly Philips Cleo Performance P 100 W tubes, although some units use 80 W Philips, Cosmulux 100 W UVA and JK Ergoline tubes. The type 2

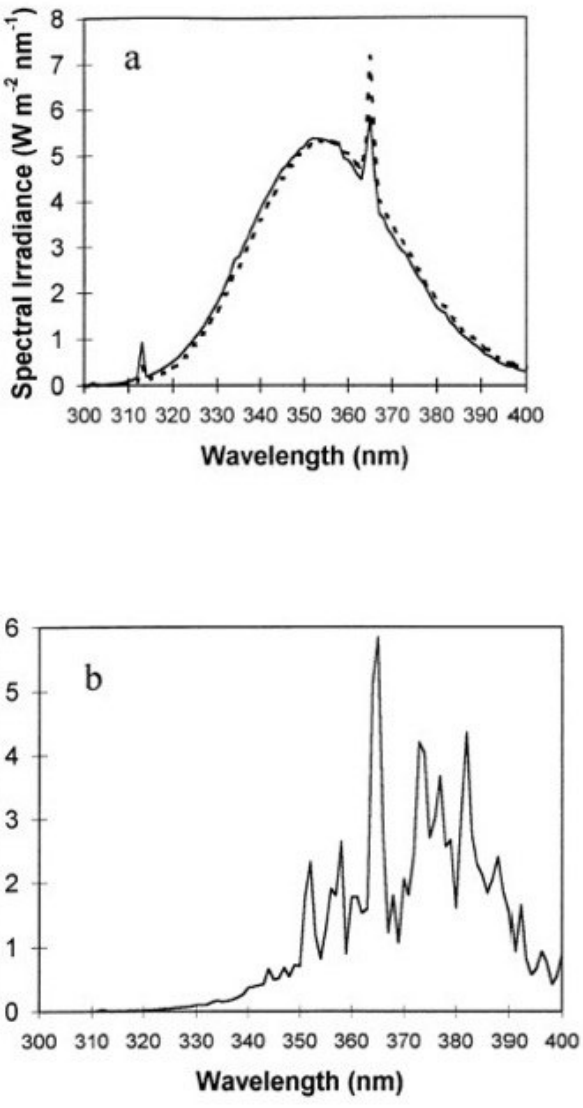


Figure 1. Plot of spectral irradiances for (a) fluorescent tubes type 1 (dashed curve) and type 2 (solid curve) with similar total ultraviolet (UV) outputs and (b) a filtered high-pressure metal halide lamp measured in sunbeds.

tubes are Sunfit 100 W and 140 W. Type 2 tubes are fitted in some Professional Magnum Power and other Ultrasun sunbeds, although similar models are encountered with type 1 tubes.

Irradiances in the UVA and UVB, measured at the centres of sunbeds using fluorescent tubes, are shown in Figure 2. UVA and UVB irradiances for individual beds of the same type generally vary by factors of 2–3, but the range for UVB is higher for beds in which type 1 or 2 tubes may be fitted. The UVA irradiances range from 54 to 244 W/m^2 for sunbeds using tube type 1 and from 113 to 295 W/m^2 for those with tube type 2, while UVB irradiances are 0·2–1·2 W/m^2 with tube type 1 and 1·1–2·8 W/m^2 for tube type 2. The standard deviations in the measured proportion of UVB among individual sunbeds of similar models with type 1 tubes were ± 2–8%, excluding one ALI, two JKE38 and three UP sunbeds, for which the proportions of UVB were 20–40% different from the means for the remainder. Irradiances decrease away from the centre of the bed, with the mean value at 25 cm from the centre being 95 ± 5% of the central value and that at 50 cm being 81 ± 10%.

The output from UV fluorescent tubes declines with the number of hours of use, so much of the variation in measured irradiances from sunbeds of the same type is likely to result from the varying ages of the tubes. Although information about the number of hours for which sunbeds had been operated was not available, dates when fluorescent tubes had been replaced were obtained for sunbeds operated by Glasgow City Council. Figure 3 shows a steady decline in UV irradiance with time after retubing for UP sunbeds, demonstrating that differences of a factor of three in irradiance result from the age of the tube. Scatter in the data is as might be expected from differences in the relative use of sunbeds at the various centres.

Sunbeds with filtered high-pressure metal halide lamps

Eleven sunbeds encountered in the survey used only filtered high-pressure metal halide lamps, and 85 other sunbeds had facial units using these lamps. Figure 1(b) shows a typical spectrum from a sunbed with filtered Philips high-pressure metal halide lamps (type HPA 400/30S) running at 400 W. A total of 12·5% of the irradiance from an unfiltered lamp is in the UVB, but this is virtually eliminated by the filter, and 99% of the output from metal halide lamps in UB800 and UPHP sunbeds is in the UVA1, with 96% for the UPTP bed. Irradiances from filtered metal halide lamps for the different sunbed types are shown in Figure 4. Total UVA outputs for metal halide lamps tend to be higher than for fluorescent tubes. The normal maximum UVA output encountered is 450 W/m^2, although one facial unit had an irradiance of 850 W/m^2. This compared with a maximum UVA irradiance for sunbeds using fluorescent tubes of 295 W/m^2. Mean irradiances in different parts of the UV spectrum for sunbeds using fluorescent tubes and metal halide lamps to irradiate the body are compared in Table 2. Irradiances in the UVA1 from sunbeds with filtered metal halide lamps are double those for ones with fluorescent tubes, while irradiances in the UVA2 and UVB regions are only 10% and 30%, respectively, of the levels for fluorescent

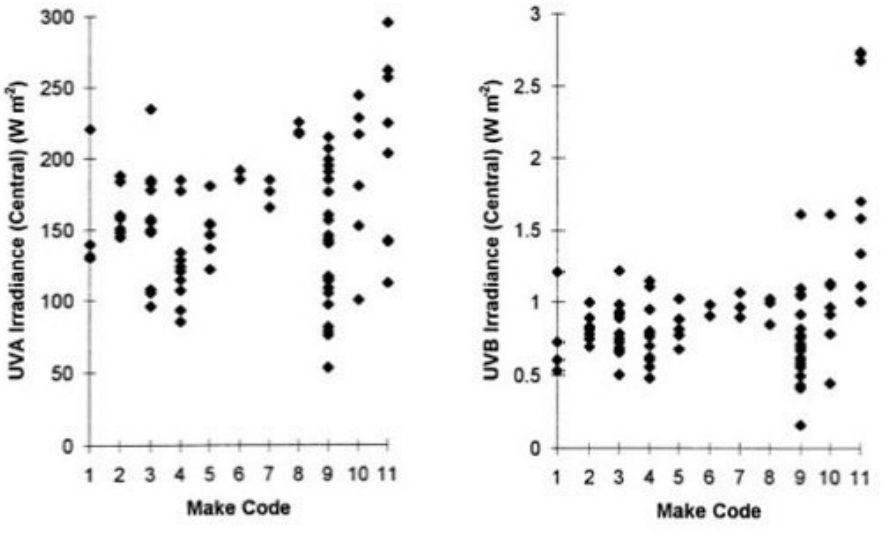


Figure 2. Irradiances for sunbeds with fluorescent tubes measured in the central position in the UVA and UVB parts of the spectrum. Numbers correspond to sunbed codes given in Table 1.

tubes. Irradiances for the metal halide lamps vary by a factor of 2–5 for the same model of bed (Fig. 4), which is greater than the variation for fluorescent tubes in the same beds. No relationship was found between the outputs of metal halide lamps and the times since the beds had been serviced.

Minimum erythemal doses from sunbed sessions

Comparison of output measurements with and without a body in two sunbeds gave correction factors of 0·82 and 0·83, which are similar to the factors found for PUVA therapy units.[8] A correction factor of 0·825 was therefore applied to the measured irradiance to derive skin irradiances and doses from output measurements. The rates of accumulation of MEDs were calculated for each sunbed, and the results are plotted against total UV irradiance in Figure 5. They show clear differences between beds using type 1 and type 2 fluorescent tubes and for beds using filtered metal halide lamps, which give higher UV doses but lower rates of accumulation of MED. The UPTP sunbed had a higher value for MED per unit irradiance than other beds using metal halide lamps owing to higher proportions of UVB and UVA2. There was a range of ± 20% in the rate of accumulation of MED per unit UV irradiance for the 82 sunbeds using type 1 fluorescent tubes arising from variations in the amounts of UVB.

The results were used to derive the proportion of the MED received in one session for each sunbed by multiplying by the session time. In council establishments, a token is purchased for a session of standard length, usually 20 min for sunbeds using type 1 tubes and 10 min for ones using type 2. The lengths of sessions for the majority of sunbeds surveyed followed this pattern, although seven sunbeds are operated for 15-min sessions, five for 25-min sessions and nine do not use a set length of session. In the calculation, 20 min is used for beds where there is not a standard session length. Figure 6 shows skin doses that would be received in one session for the various sunbeds in terms of the MED. The overall average MED for one session on a sunbed is 0·80. That for beds with fluorescent tubes is 0·84, while that for a session on a bed with metal halide lamps is 0·48. There are 22 beds on which the skin dose in a session is over one MED, of which the highest is 1·32.

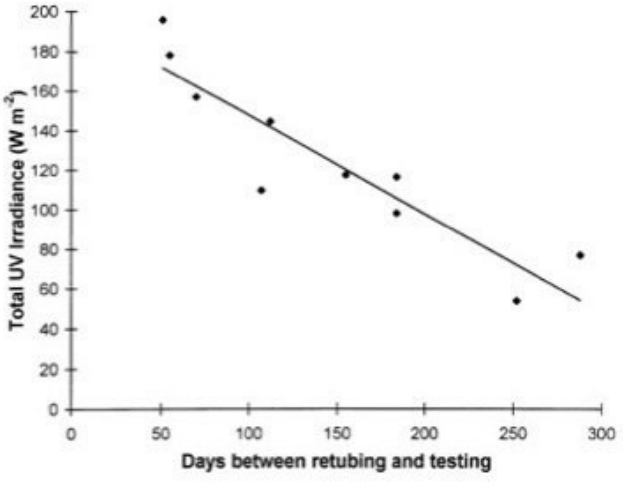


Figure 3. The UV irradiance of UP sunbeds against the time in days since the tubes were last replaced.

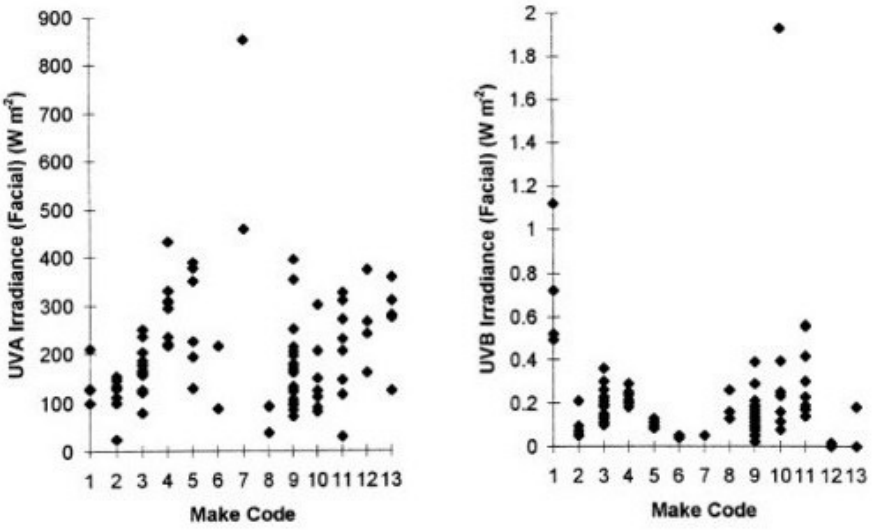


Figure 4. Irradiances for sunbeds with high-pressure filtered metal halide lamps in the UVA and UVB lamps (both in the facial units and as the only source of UV radiation). Numbers correspond to sunbed codes given in Table 1.

User survey

A total of 205 questionnaires were collected from individuals using sunbeds at centres included in the survey. The main results are summarized in Table 3. The majority were female, and 73% of users were under 35 years old. The most common reasons given for use were to develop a 'base tan' before a holiday and to feel more relaxed. Some 38% of the respondents described their reaction to sun as compatible with skin of type I (always burns, never tans) or II (usually burns, tans with difficulty), and 38% also indicated that they had had some adverse reaction in the past when using sunbeds. Thirty-one per cent of responders had more than 10 courses of over five sunbed sessions in a year and, for 16%, this amounted to over 100 sessions per year. When asked about personal views on the relative safety of sunbeds and solar radiation, 56% thought that the risk from sunbeds was similar to that from solar radiation, and 26% thought that the UV from sunbeds was more harmful than natural sunlight.

Goggles are usually available either in the sunbed room or at the reception, but 35% of users stated that they either never or hardly ever used them. The following types of goggles supplied by sunbed manufacturers were tested: Sunbed Goggles (Jomi Ltd); SunGlobes, Sunbed Goggles, EZ Eyes (Australian Gold), Super Sunnies (Herts Sunbeds); Sunbed Goggles, Super Sunnies

Table 2. Irradiances for sunbeds and natural sunlight (W/m^2)

UV source	UVB	UVA2	UVA1	UVA
Sunbed exposure				
Fluorescent tube sunbed (mean)	0·75	20	110	130
Fluorescent tube sunbed (maximum)	2·3	40	200	240
Metal halide lamp sunbed (mean)	0·022	2·0	240	240
Metal halide lamp sunbed (maximum)	0·23	6·2	330	330
Facial position (mean)	0·17	6·2	160	160
Facial position (maximum)	1·6	23	700	700
Glasgow: summer				
Cloudless sky (13·00 BST)	0·89	8·5	34	42
Cloudless sky (average 10·00–16·00)	0·76	7·5	31	38
Average for 35 days with highest UV radiances (10·00–16·00)	0·57	5·6	23	28
Facial exposure (average daily irradiances, 09·00–17·00)	0·33	3·4	14	17
Mediterranean holiday				
Thessaloniki (cloudless sky, solar noon)	3·0	21	82	103
Cloudless sky (average 10·00–16·00)	2·6	19	76	95
Cloud cover (75%) average 10·00–16·00	2·0	14	57	71

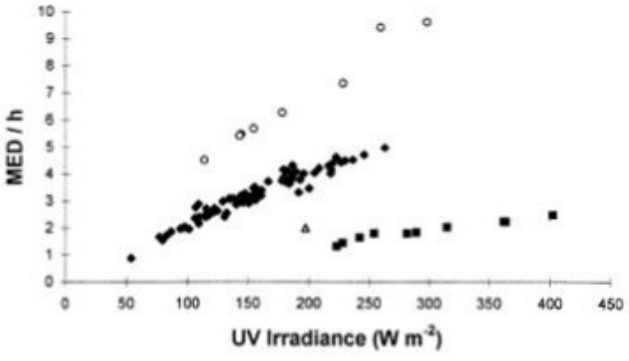


Figure 5. The rate of accumulation of minimum erythemal dose (MED) against total UV irradiance for sunbeds with four types of UV source: type 2 ( ) and type 1 ( ) fluorescent tubes, and filtered metal halide lamps in UB800 and UPHP sunbeds ( ) and in UPTP sunbeds (Δ).

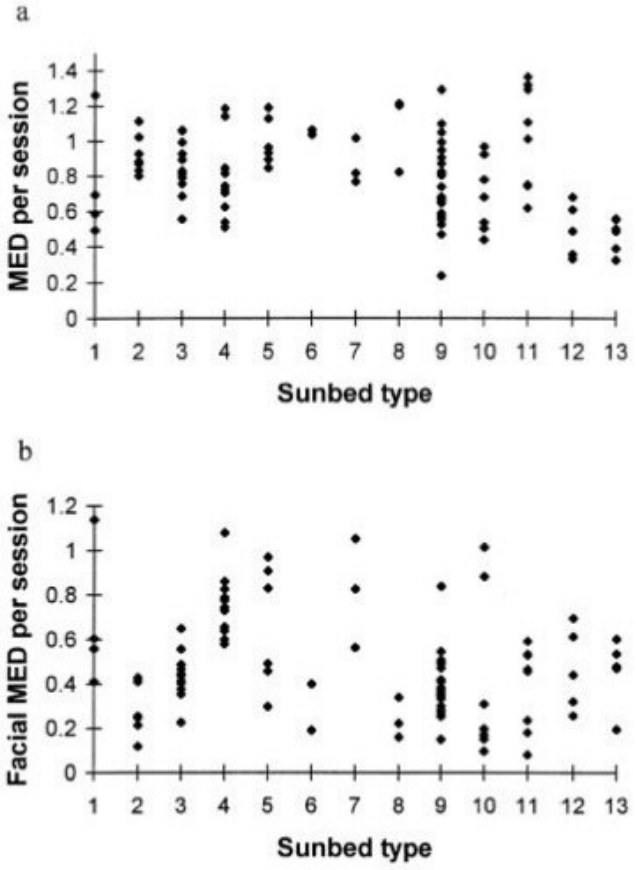


Figure 6. Doses for sessions on the sunbeds surveyed in terms of minimum erythemal dose (MED) for (a) the body and (b) the face. Numbers correspond to sunbed codes given in Table 1.

(JK Ergoline); UVAMED (Helionova). The British Standard BS EN 60335–2-27 (1992) states that the percentage transmission shall not exceed 0·1% transmission between 210 and 320 nm, 1% transmission between 320 and 400 nm and 5% transmission between 400 and 550 nm. All the goggles tested fulfilled these criteria.

Exposure levels to natural ultraviolet

In order to allow a comparison to be made between levels of exposure to natural sunlight and UV radiation from sunbeds, mean and maximum values for sunbed irradiances were calculated for different parts of the spectrum (Table 2). Solar irradiances that would be encountered on sunny days in Glasgow and on a Mediterranean holiday were calculated for comparison. As would be expected, irradiances in the UVA are higher for sunbeds than from natural sunlight. Average sunbed UVB irradiances are similar to those on a sunny day in Glasgow, while those for the highest power beds are similar to UVB levels in the Mediterranean. However, times of sunbed exposure are relatively short. Sunbeds using metal halide lamps give double the dose in the UVA1, but the dose from shorter wavelength UV radiation is much less. The irradiances were used to derive doses from UV exposures for a session on a sunbed and from periods of sunbathing. The average dose in the UVA received from a sunbed session is similar to that from sunbathing for 1 h on a sunny day in Glasgow or for 20–30 min in the Mediterranean, while the UVB doses from sunbeds are only 20–25% of those that might be received from natural sunlight in these times.

Doses from UV radiation that an individual might receive over a year from sunbathing are compared in Table 4. Twenty sunbed sessions each giving 1 MED is the recommended maximum number per year, and this would give a UVA dose similar to that received from a total of 20 h spent sunbathing in Glasgow or 1 week in the Mediterranean spending 1–2 h/day sunbathing. The UVB dose from the sunbed would, in this case, only be 20–30% of that from the sun. If sunbeds are used more frequently, the accumulated dose from UVA radiation could be much higher. That from 100 sessions per year will far exceed the dose from a 1-week Mediterranean holiday in which most of the days are spent sunbathing, although the UVB dose will be lower.

As metal halide lamps are used to irradiate the face in most sunbeds, facial exposure has been analysed separately (Table 4). The total UVA exposure from these lamps was higher than for fluorescent tubes, but the exposure in the UVA2 is only about 10% of that for fluorescent tubes. For comparison, the maximum UVA dose from working outside for 8 h/day, 5 days/week during the 4 summer months is higher than the dose from 20 sunbed sessions (Table 4), but the angle at which solar radiation is incident on the face may reduce this exposure by 50%, so the UVA1 exposure from 20 sunbed sessions would be similar to that from working outdoors, but the exposure to UVA2 and UVB radiation is much lower.

Discussion

We have found a wide range in UV irradiances in sunbeds in current commercial use in central Scotland. Irradiances from beds in which tubes have just been replaced are three times greater than those for similar beds in which the tubes had been in place for 1 year. The manufacturers of sunbeds recommend that fluorescent tubes should be changed every 500–600 h for this reason. The irradiances of filtered high-pressure metal

Table 3. Responses to questionnaires distributed to sunbed users

	No. of respondents in group (Male/female 35/170)	% of those responding (17/83)
Age group (years)		
Under 25	66	32
25–34	84	41
35–44	43	21
Over 45	11	5
Reason for sunbed use		
To develop a base tan before a holiday	103	50
To make a holiday tan last longer	66	32
To feel more relaxed	94	46
Other	23	11
Skin type defined by user		
(I) Never tan, always burn	18	9
(II) Usually burn, then tan	59	29
(III) Tan, but occasionally burn	94	46
(IV) Never burn, usually tan	33	16
Adverse reaction to sunbed use in past		
Redness/sunburn and prickly sensation	6	3
Redness and sunburn	28	14
Prickly and uncomfortable	44	21
Pattern of sunbed use		
(figures in brackets represent courses of more than five sessions)		
1–4 courses per year	41 (40)	32 (31)
5–10 courses per year	35 (15)	28 (12)
>10 courses per year	51 (39)	40 (31)
Wearing of eye protection		
Never	45	24
Not very often	22	11
Usually	34	18
Always	89	47

Table 4. Exposure to the body over 1 year from various activities for different parts of the UV spectrum (kJ/m^2)

UV source	UVB	UVA2	UVA1	UVA
Sunbed exposure: 20 sessions				
Fluorescent tube sunbed (mean)	15	440	2300	2800
Fluorescent tube sunbed (maximum)	27	760	4400	5200
Metal halide lamp sunbed (mean)	0·33	42	5400	5400
Metal halide lamp sunbed (maximum)	3·3	89	7900	8000
Facial position (mean)	3·7	140	3500	3600
Sunbed exposure: 100 sessions				
Fluorescent tube sunbed (mean)	80	2200	12,000	14,000
Metal halide lamp sunbed (mean)	1·6	210	27,000	27,000
Facial position (mean)	18	680	17,000	18,000
Glasgow: sunny, summer days				
Sunbathing for 2 h between 12·00 and 14·00 on 10 days	47	450	1800	2200
Sunbathing for 6 h per day on 10 days	120	1200	4900	6200
Outdoor worker, 8 h per day, 5 days per week (May–August)	113	1170	4800	6000
Mediterranean holiday				
Sunbathing for 2 h per day, 12·00–14·00 on 7 days	115	810	3100	3900
Sunbathing for 6 h per day, 10·00–16·00 on 7 days	290	2200	8600	10,800

halide lamps used for facial units and for whole-body irradiation in a small proportion of beds vary by factors of 2–5 for the same model of bed. A number of variables may contribute to this, including the age of the lamps, the stability of the lamp power supply and differences in the material used for the filter. Differences in the rate of accumulation of MEDs with UV irradiance for different lamps can be clearly seen in Figure 5. The higher rate and higher proportions of UVB and UVA2 for the UPTP sunbed are likely to be caused by a lower level of filtration than in other metal halide lamp beds. The scatter in the results for beds with tube type 1 results from variations in the proportions of UVB that are likely to be caused by differences in the filtration of the plastic covers used in different models. Variations in the proportion of UVB of 20–40% for a few individual beds of similar type could be caused by the use of a different filter, alterations in the properties of the filters with time or inadequate cleaning.

Irradiances from sunbeds have been compared with those from solar radiation in Glasgow and in the Mediterranean. The major difference is that the majority of the exposure from sunbeds is in the UVA, in particular the UVA1, part of the spectrum. Relative risk from exposure to radiation from sunbeds and natural sunlight therefore depends on the relative risks from UVA and UVB. Comparing exposures from UVA, the mean irradiance for sunbeds using fluorescent tubes is three to four times that from natural sunlight on a sunny day in Glasgow and one to two times that in the Mediterranean (Table 3). The UVB irradiance from a sunbed fitted with fluorescent tubes is similar to that on a sunny summer day in Glasgow and 30–50% of that from the Mediterranean sun, so the rate of accumulation of MEDs on a sunbed is significantly less than that for solar radiation (Fig. 6). The use of filtered high-pressure metal halide lamps for irradiating the face means that the rate of accumulation of MED for the face is much lower than that for the body, but the UVA1 exposure may be higher.

The UVA exposure from 20 sessions on a sunbed using fluorescent tubes is similar to the dose that might be received from a few hours sunbathing in Glasgow on 10 days during the summer, but it is likely to be less than that received during a 1-week holiday in the Mediterranean devoted to sunbathing (Table 4). The UVB exposure from sunbeds would be much less in both cases. Sunbed use would be likely to make up the largest component of the UVA dose to the body and face for those in the survey who had over 100 sessions per year. It should be noted, however, that our calculations do not take into account protection provided by the use of sun screens during exposure to natural sunlight.

The relative risks to health of UVA and UVB exposure are not yet well established. Most studies relating to this have been carried out on albino hairless mice.[9–12] Action spectra relating to damage to the elastin and collagen in the dermis of the skin, which leads to photoageing, peaks in the UVB, declining sharply in the UVA.[10] However, UVA radiation penetrates deeper into the dermis than UVB.[12,13]

There is current concern about the carcinogenic potential of UVA. An action spectrum for the induction of basal and squamous cell carcinoma, derived from a study of albino hairless mice,[11] indicates that the relative effectiveness for the induction of non-melanoma skin cancer by UVA1 is a factor of a thousand less than for UVB.[12] A person having 100 sunbed sessions per year, each giving a dose of 1 MED, between the ages of 20 and 40, is likely to have a significantly increased risk of developing basal cell carcinoma and squamous cell carcinoma at the age of 70 years,[12] although exposure in childhood and adolescence may be the most critical factor.[14] The risk of malignant melanoma is of greater concern, and recent studies have suggested that UVA exposure may be a risk factor. UVA radiation induces melanoma in fish with unexpectedly high efficacy[15,16] and is only slightly less effective than UVB in the induction of melanocyte hyperplasia, considered to be the precursor lesion for melanoma in shaved opossums.[17]

The Health and Safety Executive[18] advise that 'people who have fair sensitive skin that burns easily or tans slowly or poorly' (skin types 1 and 2) should not use sunbeds for cosmetic tanning. This group comprised 38% of sunbed users who completed questionnaires, and a similar percentage reported some adverse reaction after sunbed use in the past. More effort should be made to discourage these individuals and anyone exposed to photosensitizing agents from using sunbeds. The fact that 50% of respondents use sunbeds to develop a so-called 'base tan' before a holiday indicates that further public education is needed. The protection derived from natural UV radiation results from a combination of increased melanin content and thickening of the epidermis not produced by UVA.[19–21]

Our survey of sunbed users indicated that 16% admitted to over 100 sessions per year, confirming the results of other surveys.[22] The British Photodermatology Group recommend that exposures for any skin type should not exceed 20 sunbed sessions in a year.[23] This

recommendation keeps sunbed exposure to UVA at a similar level to recreational exposure from natural sources (Table 4). Until more evidence is available about the degree of risk from exposure to the UVA, this recommendation seems prudent.

Guidance for those using sunbeds recommends the use of goggles for eye protection throughout all sunbed sessions.[18,24] Some 35% of our responders did not use the goggles. It is thought that the majority of users would have closed their eyes during the sessions. The skin in the eyelid is less than 1 mm thick, but the penetration of UV radiation is poor,[25,26] and so little UV will pass through a closed eyelid. However, the eyes could be exposed unprotected for up to 1 min, if the user was required to set a time switch or turn on the machine before lying on the sunbed. For the most powerful facial unit in the survey, the maximum permissible ocular exposure for UVA[27] would be exceeded in 12 s.

Photodamage to the eye varies with wavelength. The cornea is primarily affected by exposure to UVB radiation and becomes more sensitive with repeated exposures.[12] The lens contains chromophores that absorb UV light between 295 and 400 nm. The lack of protein turnover in the central part of the lens means that any damage caused by absorption in the lens will tend to accumulate over time.[28] UV radiation has been linked to the development of certain types of cataracts.[29] Concern has been expressed about the possibility of injury through the accumulation of damage from subthreshold exposures.[30] Although UVB is thought to have a greater effect, the possibility of a link to UVA has also been suggested.[31] It would be prudent to exercise caution until it has been established whether there is a link between UVA and cataracts.[32] In two case–control studies, the use of sunlamps has been associated with subsequent development of intraocular melanoma.[33,34]

In conclusion, this survey has shown that sunbeds are widely used by individuals with fair skin, that many individuals use them more frequently than is wise and that over one-third do not use protective goggles. These facts, together with advances in UV cabinet design to reduce exposure times necessary to obtain a tan and the increased availability of sunbeds for purchase by members of the public, must stimulate more research into the hazards of high doses of UVA to human health in terms of skin ageing, of skin cancer risk and possibly also of immunological effects. Only when this is available will it be possible to offer evidence-based advice and information to potential sunbed users.

Acknowledgments

The authors acknowledge the Department of Health for their support of this project and the many operators of sunbeds for access to their equipment. They would also like to thank Dr Colin Driscoll and Mrs Irene Clark from NRPB for the provision of natural sunlight spectral data collected in Glasgow, and Dr Ann Webb of UMIST for the supply of solar spectral data collected in Thessaloniki, Greece.

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