Solar ultraviolet-B radiation monitoring in Khorram Abad city in Iran

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Background: The increasing evidences show that global depletion of stratospheric ozone layer is caused by pollutant and growing incidence of the skin cancer and cataract is related to the amounts of solar UV radiation reaching the earth's surface. Therefore, the main driving force behind such efforts has been the lack of an appropriate network in scope monitoring of the terrestrial UV radiation. ***Materials and Methods:*** The present work was performed at Khorram Abad province, Lorestan, Iran. Khorram Abad (48˚, 21´ E and 30˚, 23´ N) is approximately 1171m above the mean sea level. UV radiation was measured using a UV-Biometer Model 501, from November 2005 till November 2006. ***Results:*** Hourly average UV- index, the effective power and other parameters such as effective UV dose have been "moderate" from April until the end of August 2006 and very low from November till January 2006. However, in some days, the maximum UVI was in the range of "High" , especially in May. ***Conclusion:*** It was observed that the monthly average hourly UV index values in Khorram Abad were never at the extreme range. Chronic UVB exposure could be the major cause of eye's and skin disease in months from April to August, during which most people's activities were performed outdoor in the province of Lorestan. **Iran. J. Radiat. Res., 2009; 7 (3): 171-175**

Keywords: *UV- index, Khorram Abad, Iran, UVB biometer, solar radiation intensity.*

INTRODUCTION

The increasing evidence of global depletion of stratospheric ozone leads to a growing interest in the monitoring of terrestrial ultraviolet radiation. Reduction in the thickness of the stratospheric ozone results in an increase in the amounts of Solar UV radiation intensity reaching the lower atmosphere of the earth [1]. The extraterrestrial solar radiation spectrum contains (I) UVC, with a spectral range from 100-280 nm, which is completely absorbed by the stratospheric ozone layer, (II) UVB, with a spectral range from 280-320nm, which is mostly absorbed by the stratospheric ozone layer and virtually no solar radiation below 290 nm is incident on the earth's surface, and (III) UVA, with a spectral range from 320 - 400 nm, where stratospheric ozone layer absorption is minimal. Although at UV wavelengths greater than 320 nm, the ozone absorption is small but Raleigh scattering and line absorption are the main extinction processes. So, any reduction in stratospheric ozone layer depth increases the intensity level of UV radiation at wavelengths 295-320 nm, i.e. within the UVB ranges [2]. UVB is the solar radiation which is most biologically effective in causing sunburn, skin cancer and eye disease in human and general destruction of plant tissue and living cells [3-5].These harmful effects of exposure to UVB are partially compensated by some beneficial factors, including its germicidal action, the vitamin D production and the photoclimatotherapy of various skin diseases. These efforts result in atmospheric and medical scientists' interest in generating public awareness to the dangers of excessive exposure to UVB radiation [6]. Developing of an UV index for informing the mass of the UV radiation levels helps general public to plan their outdoor activities to prevent overexposure. This index is referred to as UV index (UVI), and it is determined by the integrated erythmally weighted radiation to all wavelengths up to 400 nm in unit of Wm^{-2} [7]. The UVB doses of Khorram Abad

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residents were never measured, so the goal of the present study had been to provide both an ultraviolet database and on-line radiation intensity values at Khorram Abad where most people's activities are performed outdoor.

MATERIALS AND METHODS

The equipments used in this study were a calibrated (NIST traceable standards) UV Biometer, Model 501 (Solar Light Co. Inc; USA), comprising a Robertson - Berger pattern UV detector, and a digital recorder and a control unit. The UV Biometer model 501 is a meteorological grade instrument which measures biologically effective ultraviolet radiation outdoors. The UV Biometer was located on the roof of a building of the Lorestan University of Medical Sciences, to monitor and store the data at one hour intervals from the sun rise till the sun set. The registered data were calculated, and continuously downloaded to a computer via modem while the Dom of the detector was monthly cleaned in order to prevent any inconvenience caused by local air dust and pollution during data registration. The radiation intensity was measured in minimum erythma dose per hour (MED/H). One MED/H is defined as a dose which causes minimal redness of skin type II (i.e. skin color between fair and dark) after 1h of irradiation and is equivalent to 2.4 UV-index. The effective power of 1 MED/H is equivalent to 58.3mWm^{-2} for a MED of 210Jm^{-2}. Consequently, its normalized spectral response degrades linearly with wavelengths ~ 0.01 at 320 nm and ~ 0.01 at 330 nm. The accuracy of the measurement was ±5% for the whole day. Generally, the displayed value SUV_{disp} of the intensity is calculated

according to the formula:

$$SUV_{disp} = \frac{SUV_{meas} \times SCALE - OFFSET}{TCORR}$$

Where the SUV_{meas} is the measured value, SCALE and OFFSET are system variables that can be altered by the user, and TCORR is the temperature correction factor. Also spectral response of UV-Biometer is displayed in figure 1.

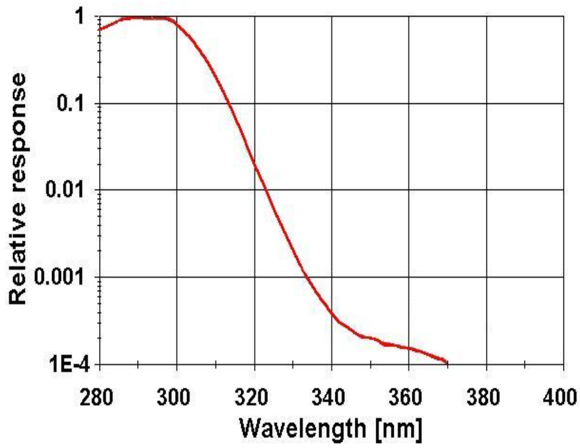

Figure 1. Spectral response of UV-Biometer Model 501.

RESULTS

All available hourly values for UVB radiation from November, 2005 to November, 2006 were included in the database used in this analysis. Table 1 shows the total mean hourly UVI values (TMHUVI) throughout the day. As it is shown the total mean values in May (maximum value) and June (minimum value) were respectively 233.08 and 46.69 UVI. Maximum average values from May till end of June were about 6 in UV- index scales, and the minimum was 1.5 from December to January at midday (figure 2). Figure 3 shows the monthly average hourly MED/H values. The maximum average MED/H registered in May was 2.5 and the minimum average was 0.7 in December. In figure 4 maximum and minimum amounts of the average of effective UVB dose are shown. As are seen, the maximum and minimum average doses are respectively 530Jm^{-2} and 150Jm^{-2} in May 2006 and December 2005.Also maximum and minimum the average effective UVB intensity are shown in figure 5. As

Table 1. Mean hourly values in 2005-2006 years.

Month	Frequency	Mean UV index	Mean total UV index
October	149	0.58±0.63	50.08±58.30
November	750	0.68±0.76	62.88±69.80
December	742	0.51±0.59	46.70±54.40
January	674	0.72±0.88	65.90±80.86
February	514	1.33±1.4	121.10±128.20
Mars	802	1.94±1.96	177.40±179.40
April	808	2.3±2.19	209.22±199.97
May	800	2.55±2.12	233.10±194.47
June	719	2.5±2.06	228.05±188.65
July	800	2.2±1.87	200.40±170.76
August	777	1.83±1.51	167.10±138.40
September	730	1.36±1.22	124.40±111.67
Total	8265	1.55±1.73	140.65±44.06

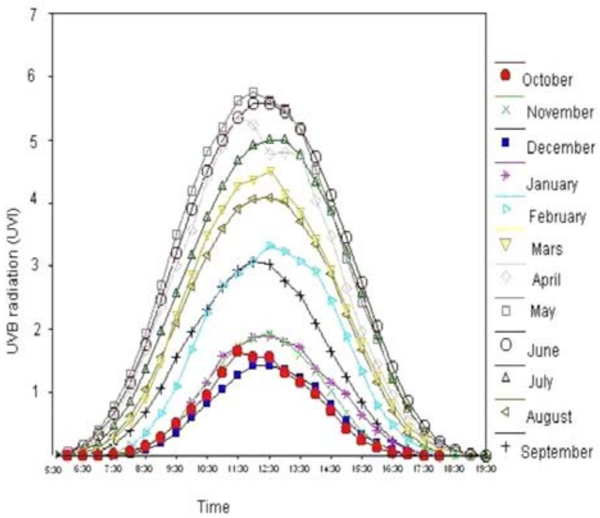

Figure 2. Monthly average hourly UV index values in Khorram Abad city.

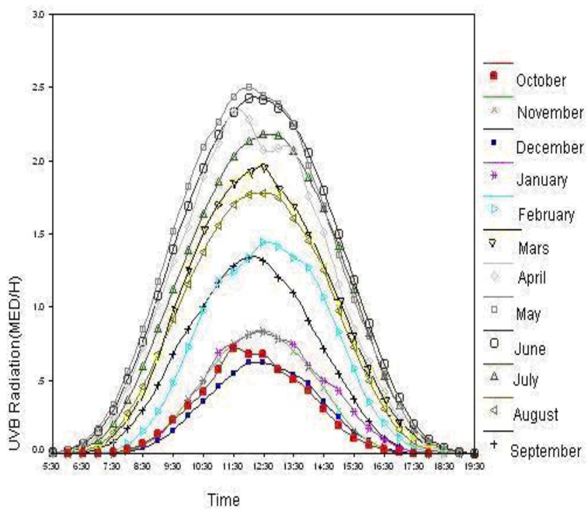

Figure 3. Monthly average hourly MED/H values in Khorram Abad city.

seen, maximum intensity has been 150mWm^{-2} in May, 2006 and 35mWm^{-2} in December, 2005.

DISCUSSION

An important factor in UV radiation level is sun elevation. The higher the sun in the sky, the higher will be the UV radiation level. Thus, radiation levels vary with day time and year, even residential locations (Urban and suburban peoples) (8-11). Daily totals of erythemal effective irradiance were 18%±2% per 1000 m during the summer (12). The increase in UVB radiation during months is shown in table 1. The maximum mean value index was in May, with a value of 2.55±2.12, and the lowest value was in

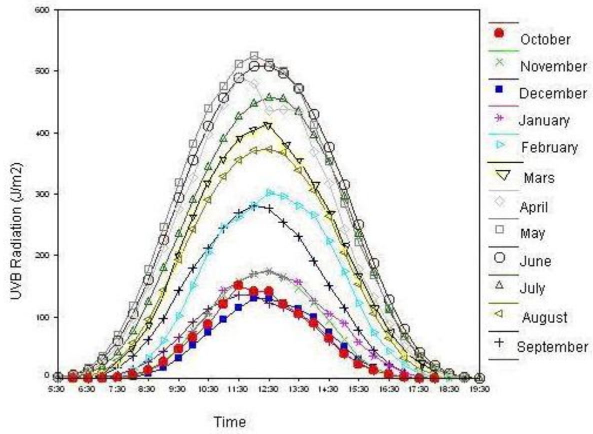

Figure 4. Monthly average hourly effective dose values in Khorram Abad city.

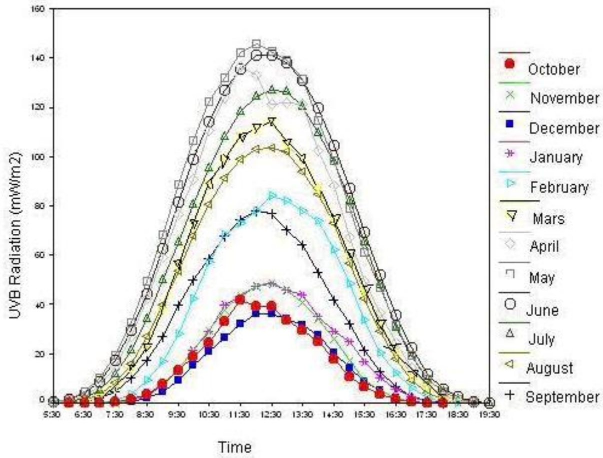

Figure 5. Monthly average hourly effective intensity values in Khorram Abad city.

December, with 0.51±0.59. Also, mean total value indices in May and December were 233.10±194.47, and 46.70±54.40, respectively. This was mostly due to relatively less attenuation and scattering. As the sun rises above the horizon, the amount of absorption in the stratosphere and scattering in the troposphere is reduced. It is also clear that more than 70% of the integrated UVB in the each day results between 10am to 15pm o'clock (figures 1, 2, 3). These finding are consistent with the results reported by Martinez-Lazano JA in Spain [13]. It is an important point for human health as it has been reported by WHO [14]. The highest monthly integral UVB radiation appeared in May 2006 with intensity value of 530 Jm^{-2} while the lowest intensity value was in December 2005, with a value of 150Jm^{-2} (figure 4). The maximum and the minimum average of effective UVB intensity were in May, 2006, with a value of 150 mWm^{-2} and 35mWm^{-2} in December 2005 (figure 5). It means that the amount of UVB radiation to the body has been about ≈5 times higher in May than December. Nearly the same conclusion has been obtained by Cui *et al.* in Qinghai-Tibetan Plateau [15]. Overall, outdoor-working adults get about 10% of the total available annual UV (on a horizontal plane), while indoor-working adults and children get about 3%(2- 4%). People's UV doses increase with increasing altitude and decreasing latitude; for examples most indoor-working European adults get 10^4 -$2\times10^4 Jm^{-2}y^{-1}$, Americans 2×10^4 - 3×10^4 $Jm^{-2}y^{-1}$ and, Australians about 2×10^4 - $5\times10^4 Jm^{-2}y^{-1}$ excluding vacation, which can increase the dose by 30% or more [16, 17]. Consequently, in spite of advantageous effects of UVB radiation, public awareness about the hazard of excessive exposure related to biologically active UVB radiation must be highly considered.

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