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# The measurement of solar ultraviolet radiation in Kermanshah city over a one-year period from 2015 to 2016

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► ***Short Report***

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## ABSTRACT

***Background***: Ultraviolet radiation is present in sunlight. If ultraviolet radiation exceeds the limit, it can cause detrimental effects on human health such as skin cancer and cataract. ***Materials and Methods***: In this descriptive cross-sectional study, the level of solar ultraviolet radiation type A (UVA) were measured using UV LOG HAND HELD in Kermanshah city. The intensity of ultraviolet radiation was measured three times a day including two hours before noon, noon and two o'clock in the afternoon. The results were analyzed using ANOVA statistical tests with a confidence interval of 95%. ***Results:*** The lowest and highest average intensity levels of solar UVA in Kermanshah were in December (14.21± 0.94 w/m2) and August (32.87 ±2.3 w/m2), respectively. Also, winter and summer seasons (with average intensities of 16.37± 1.12 w/m2 and 30.12±1.7 w/m2) had the lowest and highest intensity of this radiation, respectively. ***Conclusion:*** Regarding that UVA radiation exceeds the safe exposure level, even in the winter in Kermanshah, it is recommended for people to avoid from long-term staying in open spaces at noon and use proper protective wears especially in summer.

***Keywords:*** *Solar radiation, ultraviolet radiation, Kermanshah.*

## INTRODUCTION

Ultraviolet (UV) radiation is an electromagnetic radiation and is present in sunlight. If UV irradiation exceeds the limit, it can endanger human health. Due to its relatively high energy, this radiation can lead to biological responses (1). Solar ultraviolet radiation intensity is so high that if it is not absorbed in the different layers of the atmosphere, the especially ozone layer, it can lead to the loss of life on Earth (2). The sun's ultraviolet spectrum is divided into the three ranges of $UV_A$ (320 - 400 nm), $UV_B$ (280 - 320 nm) and $UV_C$ (100 – 280 nm) (3). Type C radiation, which is the most energetic and harmful, is absorbed by the gases in the upper atmosphere and thus plays no role in ultraviolet radiation received by the Earth. $UV_B$ is spread close to the Earth's surface, such as high mountains or aircraft in flight, but $UV_A$ reaches the surface so that approximately 6 percent of the sun's ultraviolet received by the Earth is $UV_B$ and 94 percent is $UV_A$ (4). Compared to $UV_B$, $UV_A$ has a longer wavelength and lower energy and can penetrate the skin to the epidermis and the dermis layers. This type of radiation plays an important role in the induction of wrinkles and aging of the skin (5, 6). In a number of studies, ultraviolet radiation of the sun has been reported as the only environmental risk factor in the induction of malignant skin cancer (7-9). The incidence of skin cancer has increased significantly in the last two decades, and a number of studies have claimed that it is because of reduction in the thickness of the ozone layer and thus an increase in the intensity of solar ultraviolet radiation at the earth's surface. The most important factors affecting the intensity of solar UV radiation are solar zenith angle, months, seasons, time, the thickness of the ozone layer, the amount of the Earth's reflection, clouds, dust, altitude, geographic location and environmental conditions [3, 10]. It is essential to measure the level of solar UV radiation in residential areas because of potential harmful effects of this radiation. Regarding the high incidence rate of skin cancer in Iran especially in Kermanshah city, in recent years [11] understanding of ultraviolet radiation level is very important. Due to the lack of an adequate information about the amount of this radiation in Kermanshah despite other big cites in Iran [12, 13], in the present study, we measured the level of solar $UV_A$ radiation in Kermanshah over a one-year.

## MATERIALS AND METHODS

In this descriptive cross-sectional study, the amount of $UV_A$ radiation from the sun in Kermanshah were measured using UV LOG HAND HELD manufactured by *sglux* in Germany. The device was calibrated by the company before measurements. This portable device with dimensions of 130 × 53 × 55 mm and measurement accuracy of ± % 4 has some sensors and each sensor measures one of the ranges of ultraviolet radiation of the types A, B and C. In the range of measuring $UV_A$, its highest sensitivity is at the wavelength of 360 nm. To measure the ultraviolet radiation, a suitable location was selected, away from tall buildings. Before measurements, the suitable sensor was connected via cable to the device and after turning it on, the device was allowed to detect the sensor, and then desired option in measurement was choosed. Then, the intensity of $UV_A$ radiation was measured three times a day (two hours before noon, noon and two o'clock in the afternoon) and to improve accuracy, measurements were repeated five times at each stage.

Measurements were made every day and in different weather conditions. The UV sensors were stored in a dry place when not in use. The Kolmogorov-Smirnov test was used to assess the normality of the obtained data and data were analyzed using ANOVA and Tukey's post hoc tests. The significance level in this study was considered 0.05.

## RESULTS

The average intensity of solar $UV_A$ radiation in Kermanshah which measured in various weather conditions, in different months over a one year period, can be found in table 1 and figure 1.

**Table 1.** Average of UVA intensity of Kermanshah in different months over a one year period.

| Month | $UV_A$ intensity (Average ± SD) ($w/m^2$) | Seasons | $UV_A$ intensity* (Average ± SD) ($w/m^2$) |
|---|---|---|---|
| January | 16.41±1.16 | Winter | 16.37±1.12 |
| February | 18.5±1.26 | | |
| March | 20.15±2.01 | | |
| April | 23.38±1.37 | Spring | 23.35±1.72 |
| May | 26.53±1.96 | | |
| June | 27.28±1.47 | | |
| July | 30.23±1.35 | Summer | 30.12±1.7 |
| August | 32.87±2.3 | | |
| September | 28.59±1.91 | | |
| October | 22.27±1.06 | Autumn | 30.12±1.26 |
| November | 15.72±0.81 | | |
| December | 14.21±0.94 | | |
| **Total (year)** | | **23.01±1.47** | |

*The standard level of UV radiation intensity is 10 $w/m^2$





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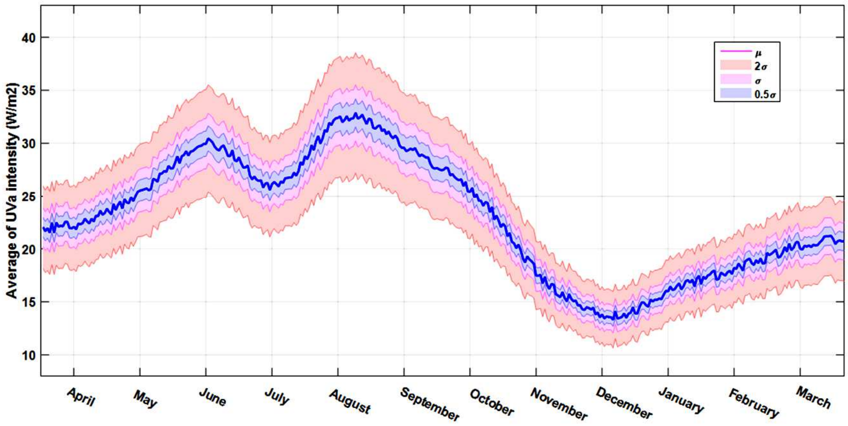


**Figure 1.** The average intensity of UVA in Kermanshah during a year.

Also, the results of measurements of solar UVA intensity in Kermanshah in various weather conditions, in different seasons are presented in table 1.

According to the results, the lowest average intensity of solar UVA radiation in Kermanshah was in December (14.21± 0.94 w/m2) and highest average intensity of solar UVA radiation was in August (32.87 ±2.3 w/m2). As expected, the lowest and highest levels of solar UVA intensity in different seasons corresponded with winter and summer with values of 16.37±1.12 and 30.12±1.7 w/m2, respectively. The intensity of UVA in the summer is about twice more than it in the winter.

Also, statistical results showed no significant difference (p>0.05) between the average intensity of UVA in spring and autumn.

## DISCUSSION

We measured the intensity of solar $UV_A$ radiation in Kermanshah over a one-year period. The intensity of the $UV_A$ radiation varies during a day and also in different days, months and seasons over a year at a given point on the Earth's surface. The minimum intensity of $UV_A$ radiation in Kermanshah, which occurs in December (14.21 ± 0.94 w/m$^2$) is even more than recommended safe exposure level (10 w/m$^2$) for unprotected skin by the American Conference of Governmental Industrial Hygienists(an organization with the mission and ultimate goal of promoting the health of the environment and working places) [14]. Also, the average intensity of $UV_A$ in August (32.87 ± 1.4 w/m$^2$) was approximately three times more than the standard level. In a study done in the city of Manado (Indonesia, 124° 50′ 42″ E and 1° 29′ 13″ N), the highest and lowest intensity of UV radiation were reported in July and December respectively [15]. In another study by Hu et al in Beijing (China, 116° 23′ 17″ E and 39° 54′ 13″ N), the highest intensity was reported in March and the lowest intensity in December [16]. These studies demonstrate that the highest intensity of ultraviolet radiation occurs in a month when the sun is in the closest distance to the measurement location. Based on results there is a significant difference between $UV_A$ radiation intensity reaching the earth in different seasons and months ($p< 0.05$); as expected the maximum amount of $UV_A$ was recorded in the summer, when it was sunny and at noon; these results are in agreement with the results of Behrooz *et al.*, Hokmabadi *et al.* and Dahlback *et al.* studies [2, 12, 17]. The reason of this fact can be the clear sky with no clouds, as well as the vertical shining of the sun to the ground which leads to a reduction in attenuation and or scattering UV radiation in the atmosphere. In winter, because of the diagonal glint of sunlight on earth, less ultraviolet radiation reaches the earth, so the lowest average intensity was recorded in the winter. Rostampour *et al.* in Hamadan (Iran, 48° 40′ E and 34° 52′ N) reported the highest





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intensity in the period of 23rd of August to 22nd of September (corresponding to the Iranian month of Shahrivar) and the lowest intensity for 22nd of November 21st of December (corresponding to the Iranian month of Azar), with the amounts of 27.3 w/m$^2$ and 11.8 w/m$^2$ respectively [3]. In contrast, the highest and the lowest intensity of ultraviolet radiation in Kermanshah (Iran, 47° 00′ E and 34° 23′ N) are respectively 18 and 24 percent more than these values in Hamadan which is located relatively close to Kermanshah (190 km). In a study, Behrooz *et al.* measured the maximum and minimum of UV intensity in Ahvaz (Iran, 48° 40′ E and 31° 20′ N) respectively in the period of 23rd of July to 22nd of August (corresponding to the Iranian month of Khordad) and 22nd of November to 21st of December (corresponding to the Iranian month of Azar) with the average of 43.28 w/m$^2$ and 20.0 w/m$^2$. Measurement results in Ahvaz which is located at a distance of 485 kilometers south of Kermanshah were respectively 34 and 36 percent greater than the highest and lowest values of average intensity which were recorded in our study. Some other studies have reported lower level of UV radiation than Kermanshah in which measurement were done in Isfahan (Iran, 32° 39′N and 51° 43′E) [7] and other cities such as Cairo (Egypt, 30° 3′N and 31° 15′E) [18], Kathmandu valley (Nepal, 27.7° N and 85.5° E) [19] and in Hamedan [3]. These differences between cities are due to their geographical location including latitude and altitude as well as other weather situations.

Regarding the increase in skin cancer [20] in Kermanshah especially in women, it is recommended for the national organizations which are responsible for public health to provide continuous and accurate monitoring for UV radiation. So it seems that the installation of ultraviolet radiation measuring stations in densely populated areas of the cities as well as announcement the UV radiation level is essential. Also, proper education of people through the public access facilities like television and radio is important to make them aware of the possible dangers of UV radiation. It seems to be necessary for governments (mainly the ministry of health and medical education in Iran) to establish the education programs for health care professionals, teachers, outdoor workers as well as the public in protection against exposure the UV radiation.

## CONCLUSION

We measured and reported the ultraviolet radiation intensity level in Kermanshah over a one-year period. Regarding to the exceeding of the safe exposure level of $UV_A$ radiation, even in the winter, in Kermanshah, it is recommended for people to avoid from long-term staying and working in open spaces at noon, especially in summer. Those whose working conditions require being in open spaces should make sure to use proper protective wears, such as long sleeves, suitable sunglasses, wide cap to protect the eyes, face and neck; and in the case of very high intensity of ultraviolet radiation they'd better to use umbrella.

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***Conflicts of interest*: *Declared none.***

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