

## CALCULATION OF THE TIME PERIOD OF EXPOSURE TO ULTRAVIOLET RADIATION FOR THE OCCURRENCE OF BURNS FOR DIFFERENT SKIN TYPES FOR SPECIFIC CITIES IN IRAQ

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### Abstract

Solar ultraviolet radiation (UVR) from the sun is now understood to have both positive and detrimental impacts on people and other living things. Changes in human behavior, such as increased participation in outdoor activities, raise the risk of UV exposure. Some of skin diseases are caused by UVR exposure. In this paper, the time in minutes at which skin burns occur each day for the year 2021 was calculated based on the area of skin exposed to solar radiation for all skin types (according to the classification of Fitzpatrick) in the case of applying sunscreen or without it in the clear sky conditions of the cities of Mosul, Baghdad and Basra at Latitudes (37°N, 33°N, 31°N), respectively. UV index data was obtained by TEMIS platform. An increased risk of sunburn was observed with an increase in the UVI index during the summer for all regions, especially the city of Basra, which showed an increase in the number of extreme days of the UVI index over the course of a year, there are 111 days extreme compared to the rest of the regions, and from that we conclude that there is a short period of time for the onset of burns when the UVI index is high, and its effect on different skin types, especially on with light skin, and an increase in the time period for the onset of burns when using sunscreens

**Keywords:** Erythemal, Skin type, Sun protection factor, Ultraviolet radiation, UV Index.

### Introduction

The impacts of ultraviolet radiation (UVR) on people are well known today and based on a number of factors, involving atmospheric variables that effect on quantities of solar UVR, as altitude and cloud cover also skin phototype, which determines an individual's risk to excessive solar UV radiation (Kerr and Fioletov, 2010). The Fitzpatrick skin phototype classification is frequently used to categorize skin phototypes. Based on their properties and sensitivity to sunburn (Table 2) (Rofianingrum et al., 2020). While modest exposure to UV radiation can have positive benefits and

is necessary for the generation of vitamin D3, which is important for the health of the skeletal system (Rendell et al., 2022). Prolonged exposure may cause steep and chronically impacts on the skin, eyes, and immune system (McKenzie et al., 2009). UV radiation, in especially, has mainly impact on prematurely skin aging and the development of skin cancers such as cutaneous malignant melanoma (CMM), basal cell carcinoma (BCC), and squamous (Ainger et al., 2017). “Sunburn” is the occurrence of painful erythematous reaction following excessive UVR exposure, and is most noticeable in light-pigmented skin types, the term “erythema” is the medical name indicating sunburned skin that is red (Bernerd et al., 2022). The Ultra Violet Index (UVI), which ranges from 0 to 20, it’s a fundamental handle of the danger of exposure to solar radioactive. It is calculated by equation (2), which takes into account the spectrum of erythemal action as a function of solar UV irradiance (Cede et al., 2002). Over the past decades, because of the progressive increase in outdoor leisure activities, vacations in sunny regions and change in clothing habits (Erdmann et al., 2013). In general, individual UV exposure is typically correlated with the deployment of the three UV radiation components (direct, diffuse, and reflected), along with exposure time, skin tone, and sun protection practices (Religi et al., 2016). In the year 2013, a study was conducted in Spain on a group of adolescents, in which it focused on exposure to UV as a major risk factor. The results confirmed the high rates of sunburn that adolescents were exposed to, the need for awareness programs to protect from the harmful effects of sunlight (Wright et al., 2013). A study was carried out in the tropics of Reunion Island at three different locations to assess levels of UV exposure and compare the results with standard cumulative erythema (SED). UVI measurements display that Reunion Island is exposed to intense ultraviolet radiation (Cadet et al., 2020). The aim of this study is to study the duration of exposure to start burns resulting from ultraviolet radiation to reduce its negative effects.

## Methodology

### Data acquisition and Study area

Throughout this study we used data from the TEMIS “(Tropospheric, Emission, Monitoring, Internet, and Ser-vice of European Space Agency)” platforms, (<https://www.temis.nl/>), UVI was calculated for selected cities of Iraq between latitudes (30.41 to 36.31) and they include Mosul in the north, Baghdad in the center and Basra in the south.

### Calculation Approaches

The best time to expose in order to determine how long it will be before you get a sunburn depending on the skin type, UVI, and the sun protective factor of the sunscreen (McKenzie and Liley, 2010). The time in minutes, it takes for a sunburn to appear on the skin (minimum erythemal dose) can be calculated by using:

$$T_{ery} = \frac{4000}{60} \cdot \frac{MED.SPF}{UVI} \quad (1)$$

Where the transform from UV ery to UVI are done by the ratio 4000/60; UVI is the UV Index:

$$UVI = 40 * UVEry \quad (2)$$

**Table 1 UV radiation exposure categories (Who, 2002)**

UVI Range	0-2	5-Mar	7-Jun	10-Aug	11
Exposure category	Low (green)	Moderate (yellow)	High (orange)	Very high (red)	Extreme (violet)

MED (Minimum Erythema Dose) is a factor that accounts for variations in skin color. Depending on the Fitzpatrick skin classification, it is represented as the number of SED (Standard Erythemal Dose) needed to cause erythema (see Table 2) and SPF is the sun protection factor of any sunscreen used (Gupta and Sharma, 2019). While Fitzpatrick skin typing (FST) is now used by dermatologists to evaluate sun sensitivity (Fitzpatrick, 1988), it was originally developed in 1975 to determine the safe initial dose of UVA. The Fitzpatrick scale depends based on sensitivity to sunburn and ability to tan (Eilers et al., 2013a). The skin of individuals was categorized into Types I-VI, (Table 2) (Eilers et al., 2013b).

**Table 2 Skin phototype classification according to Fitzpatrick scales**

FST	Properties	Minimum dose for erythema (SED)
I	white skin, extremely sensitive (always burns)	3-Feb
II	white skin, overly sensitive (burns easily)	2.5-2.3
III	light brown skin, moderately sensitive (may burn)	5-Mar
IV	light brown skin (burns rarely)	4.5-6
V	brown skin, Variable sensitivity (rarely burns)	10-Jun
VI	black skin (rarely burns)	20-Oct

## Results and Discussion

Figure 1. Display the yearly variation of the daily UVI values at noon for different cities of Iraq (Basra, Baghdad and Mosul), for the while the 1 January to 31 December 2021. where the UVI increases with decreasing the latitude for locations, this explain the difference between northern and southern Iraq.

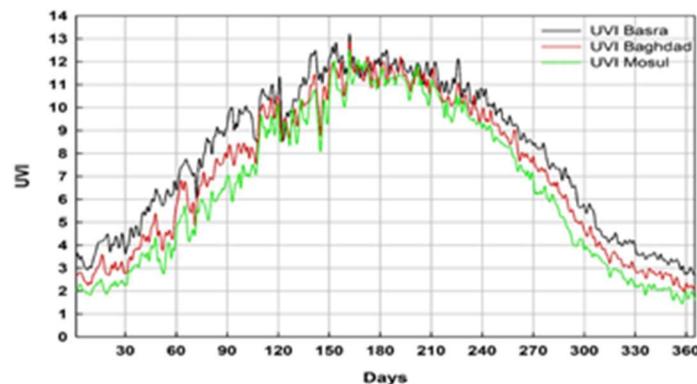


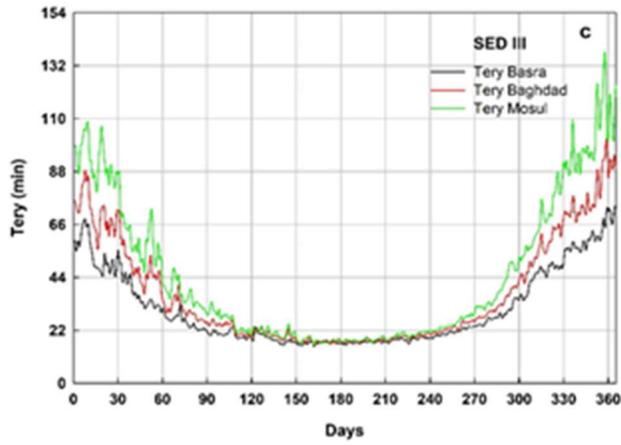
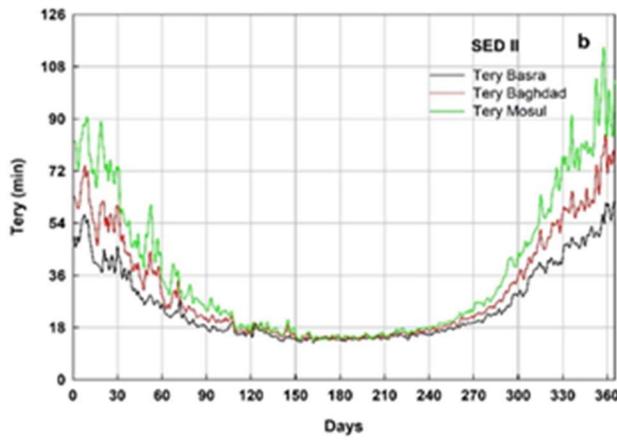
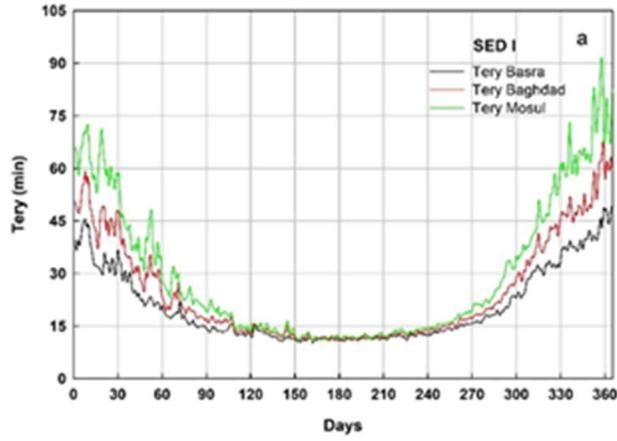
Figure 1 UV index at local noon in different cities of Iraq the year 2021.

In Figure 1, it provides information about the UVI contrast, as the conductor shows the weakest path in the year for UVI from December and January, and the UVI values are less than (3), and the maximum values of UVI values reach (11) the months of June and July. While Basra shows the lowest values of UVI in the month of December to February, approaching (3-5), and the maximum values are (11-13) in mid-May to September. The UVI at solar noon is shown to have a different maximum value on different cities of Iraq in the summer, while UVI levels are at their lowest in the winter (Figure 1). The number of days was calculated for each level of the UV Index “(low, moderate, high, very high, extreme)” during 2021 for the cities (Mosul, Baghdad and Basra). The pattern of UVI distribution is dominated by “High”, “Very-High”, and “Extreme” UVI values almost all-year-round especially Basra city, as shown in table 3.

**Table 3 Number of days of UV index levels for (Basra, Baghdad and Mosul) cities during the year 2021.**

UVI	Basra	Baghdad	Mosul	Collar band
0-2	0	17	70	
3-5	104	118	84	
6-7	53	43	57	
8-10	97	109	91	
+11	111	78	63	

Table 3. Tabulated values of ultraviolet radiation for each level for the year 2021, where the highest levels appear in the summer days and the lowest levels in the winter season as shown in Figure 1. Where we notice an increase in the number of days for the high level of the city of Basra compared to the cities of Baghdad and Mosul, and the absence of days with a low level due to the different latitudes. From this, Basra is more prone to redness of the skin due to sunburn than the rest of the regions, as well as the type of skin is affected mainly by the rise and fall of UVI, and as it is the opposite in the city Mosul. The curve shown in Figure 2, which show the time of start of erythema for different skin types in three Iraqi cities (Basra, Baghdad and Mosul), without use protection sun factor. Different skin types respond differently to sun exposure. An algorithm was calculated to calculate the time of onset of sunburn after determining the UVI value, skin type, and the value of the sun protection factor, as shown in equation (1).



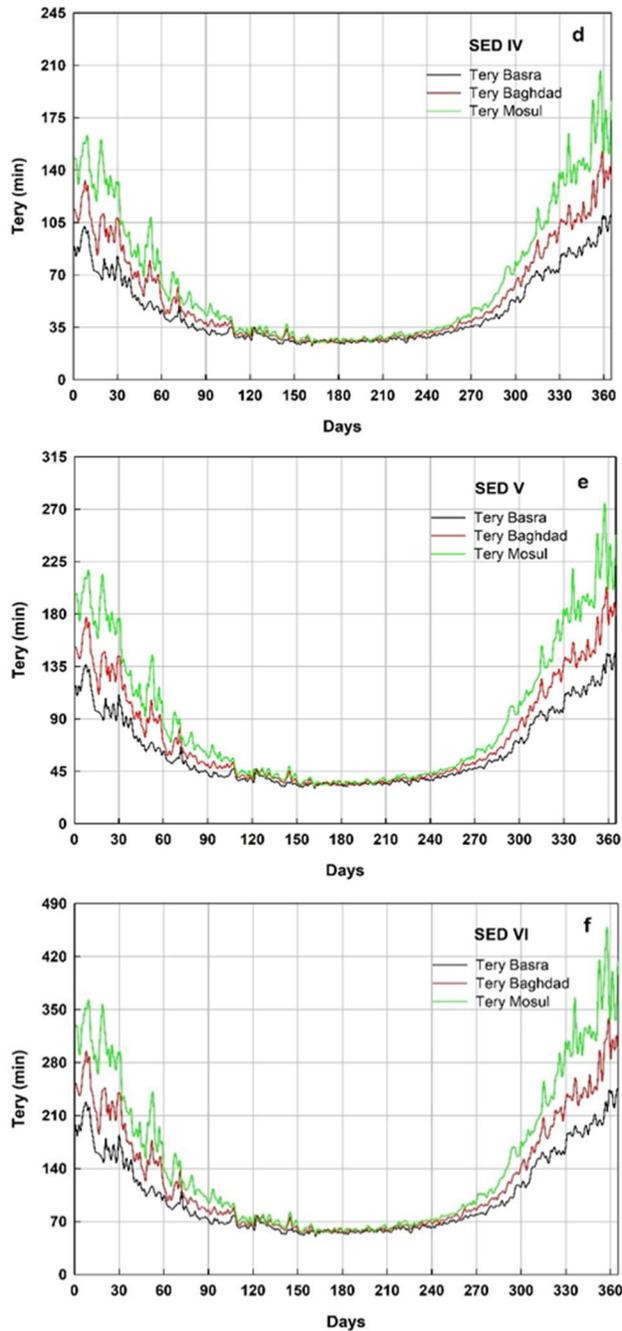
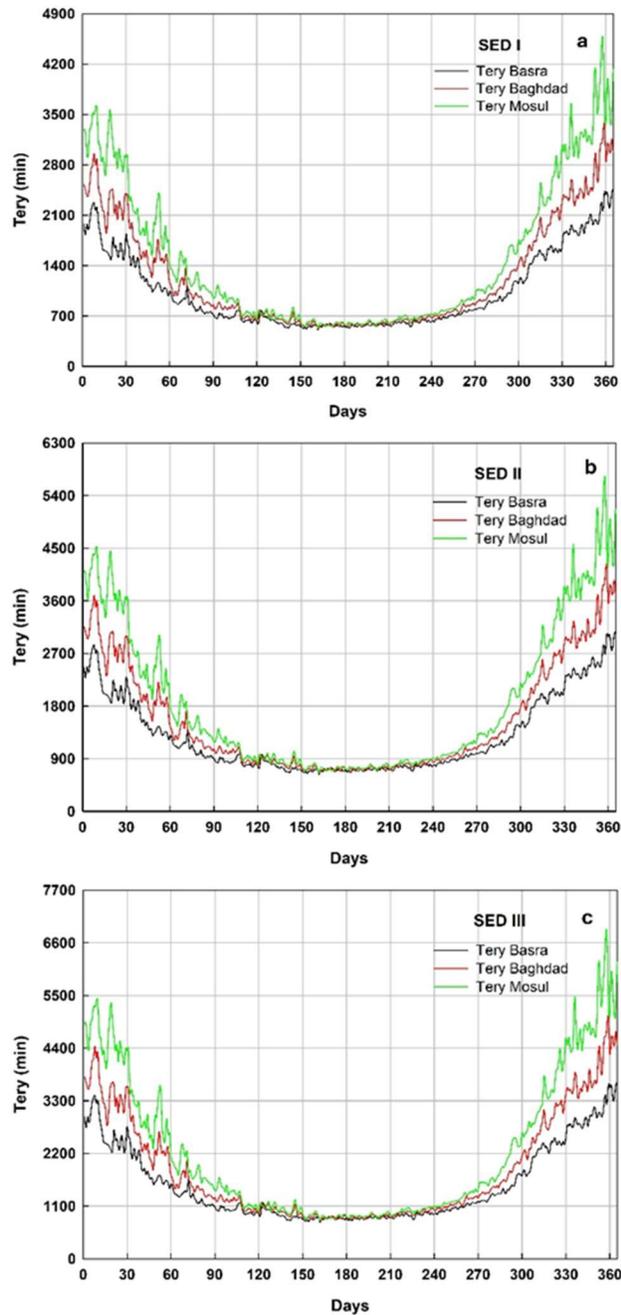


Figure 2 Sun exposure times (in minutes) for the occurrence of erythema at solar noon as a function of latitude, date and skin type without use sun protection factor.

As shown in figure 2(a, b, c and d) most sunburns occur in people with the skin type (I-IV) quickly, not exceeding 30 minutes during the summer. As for people with dark skin (V-VI) figure 2(e and f), it occurs slowly due to the increase in melanin pigment, which reduces the risk of solar radiation. They can have harmful consequences, others such as eye burns and retinopathy.

On the other hand, in figure 3(a, b, c, d, e and f) increasing sun protection factors delays the speed of sunburn, as it is considered one of the ways to prevent sunburn, especially for those with light skin.



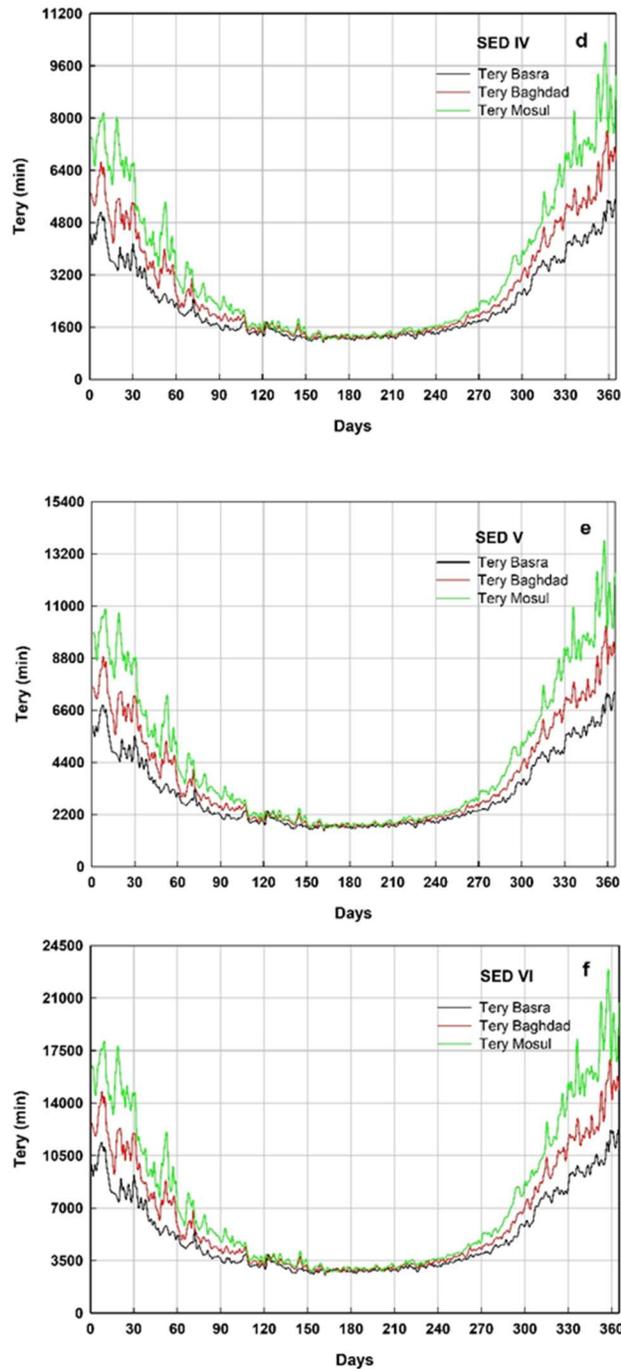


Figure 3 Sun exposure times (in minutes) for the occurrence of erythema at solar noon as a function of latitude, date and skin type with use sun protection factor 50.

For illustration, when an individual of skin type III is exposed to UVI of 8 without using spf, the exposure time until caused sunburn, as shown in equation 1, will be (25 min). However, if he applied SPF 50 sunscreen, the time to sunburn caused will be increased and become 1250 minutes (20 hour and 1 min).

Sunburn time can range from 12 minutes to 11 hours, as shown in Table 4. UVI can change during this time, and the person may apply sunscreen with a different SPF, that will impact the Tery calculation.

**Table 4 Sunburn time in minutes for six types of skin without sun protection at various UVI levels.**

Type skin/UVI	1	2	3	4	5	6	7	8	9	10	+11
I	133	67	44	33	27	22	19	17	15	13	12
II	167	83	56	42	33	28	24	21	19	17	15
III	200	100	67	50	40	33	29	25	22	20	18
IV	300	150	100	75	60	50	43	38	33	30	27
V	400	200	133	100	80	67	57	50	44	40	36
VI	667	333	222	167	133	111	95	83	74	67	61

Although it is necessary to use a sun protection factor, especially for light skin, to protect from sunburn, it may prevent the benefit from the amount of ultraviolet radiation necessary to produce vitamin D, in addition to the lack of the need to use a high protection factor for people with dark skin because of the characteristics of this type of skin and at a low UVI. The results of this study highlight the importance of public awareness campaigns on the dangers of exposure to ultraviolet radiation resulting from excessive exposure to sunlight, especially during the summer.

### Conclusions

A comparison of the ultraviolet climate of the selected regions (Basra, Baghdad, and Mosul) appeared that these regions are situated at a brief geographical distance from each other. Nevertheless, the behavior of ultraviolet radiation differs due to the different weather conditions of these regions. The Measurements showed very high UVI levels for the city of Basra in particular because of the latitude, altitude and environment and in general for the rest of the cities, these high levels of UVA may lead to sunburn in people with light skin in the case of exposure without adequate protection from the sun's rays. The highest value of UVI was 13 during the summer season for the city of Basra and the lowest value was almost 1 for the city of Mosul. UVI values for the year 2021 were detected and the results showed that the period between Aprils to October is high and very high. Among them over the course of a year are 11 extreme days for the city of Basra, 78 days for the city of Baghdad, and 63 for the city of Mosul. The mathematical relationship also showed the relationship of UVI with sunscreen the increase in the time of onset of burns when using sunscreen for different skin types. The lowest time for burn occurrence was at UVI (11) for the skin type I (12 min) and the highest time for burn occurrence was at UVI (1) for the skin type VI (667 min) without used sunscreen.

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