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RESEARCH ARTICLE

Ultraviolet Radiation and Its Health Risks to Humans

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Abstract

Ultraviolet radiation has many benefits; it is an important source for the formation of ozone, the basis of the ozone layer, This layer protects the Earth from harmful radiation and helps humans absorb vitamin D, which is essential for the absorption and storage of calcium in bones. However, this radiation also has significant harmful effects that can lead to human death. Due to the significant impact of these effects on humans, whether positive or negative, the researcher was motivated toconduct this research.

The study focused on six main areas. The first section examined the theoretical framework of the study, considering it the fundamental step in the research, while the second section covered the types of ultraviolet radiation. The third section focused on methods for measuring and calculating ultraviolet radiation, whereas the fourth section examined the factors affecting the amount of ultraviolet radiation reaching to the Earth's surface, while the fifth section focused on the diseases caused by ultraviolet radiation, and the fifth and final section addressed international indicators for ultraviolet radiation.

The study revealed that there are three wavelengths of ultraviolet radiation, and each wavelength affects human health differently. The wavelengths UVB and UVC have a lesser effect compared to the UVA wavelength. It also showed that the body parts most affected by ultraviolet radiation are the skin and the eyes; consequently, several diseases have emerged, some of which are mild and treatable, while others are incurable, such as cancers affecting the eyes and skin.

KEYWORDS

Ultraviolet Radiation (UV) , UV Index , Solar Radiation , Public Health Risk.

INTRODUCTION

Humans are exposed to various types of radiation during their daily lives, some of which are harmless and others harmful, with the degree of harm varying according to type and source. Among these are ultraviolet rays, which have a significant impact on human health, particularly given the depletion of the ozone layer due to environmental pollution. Consequently, the ozone layer's ability to block ultraviolet rays has diminished, leading to an increase in its harmful effects on all components of the ecosystem, particularly humans. For this reason, this study focused on identifying the types of ultraviolet radiation, determining which have the greatest impact on human health, and identifying the diseases caused by these rays.

Research Problem

What are the types of ultraviolet radiation?

Does ultraviolet radiation affect human health?

Research Hypothesis

There are three types of these rays, and their effects vary depending on the nature and amount of radiation.

The effects of ultraviolet rays on human health.

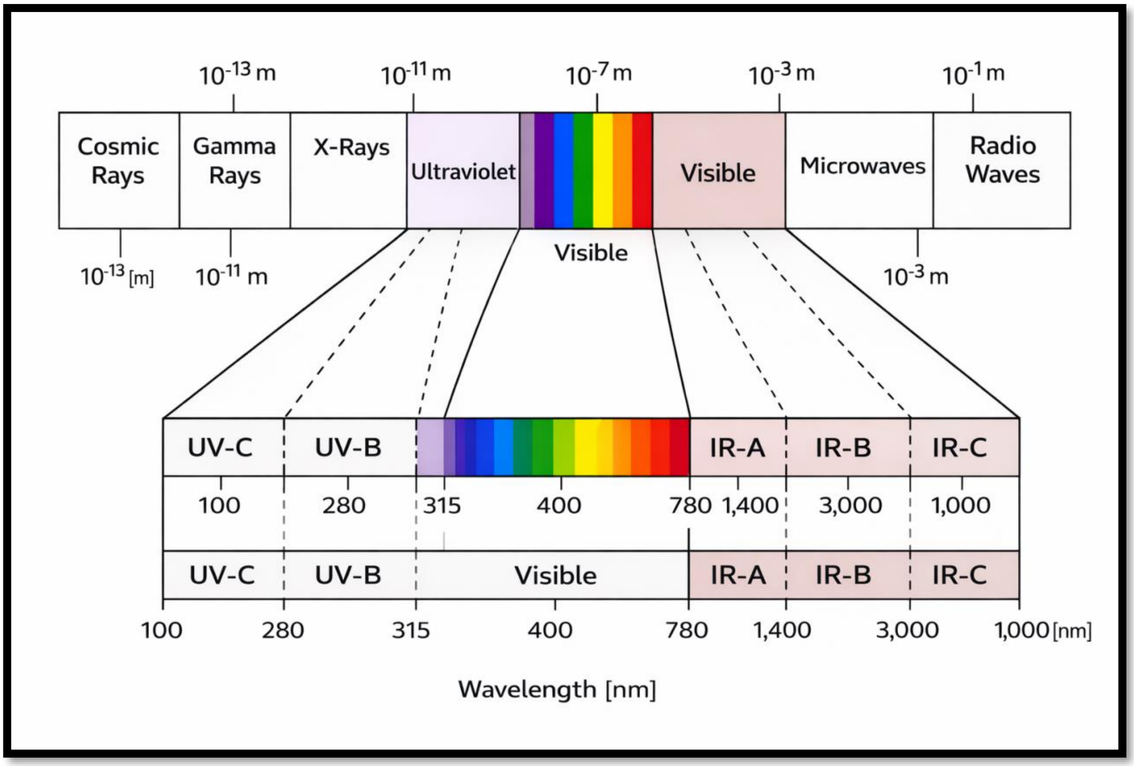
Importance of the Research

Ultraviolet radiation is an important source of energy that has many benefits and harms that significantly affect human health in the event of prolonged exposure or sudden exposure to radiation; for this reason, the researcher chose this study.

1- Types and wavelengths of ultraviolet radiation

UV radiation is a short-wavelength electromagnetic wave that includes all rays with a wavelength of less than 4 microns, and account for 6–7% of solar radiation. These rays are beneficial to human health when received in small amounts, as they help treat certain bone diseases, rickets, and other conditions. This is due to their ability to synthesize vitamin D in the skin and to weaken the effects of bacteria and certain germs. They also give fair skin the bronze color it takes on when exposed to sunlight for a long time. However, excessive exposure has a devastating effect not only on humans but on the entire ecosystem, and it also has serious effects on the climate. Fortunately, only a small amount reaches the Earth's surface, as the ozone layer absorbs the majority of it and prevents it from reaching the ground. Therefore, human pollution of this layer—caused by high-altitude aviation or certain human activities on the Earth's surface that use specific gases, such as those used in refrigerators, insecticide cans, hair styling products, and others—has serious environmental consequences.

Image (1) Wavelengths of solar radiation reaching the Earth's surface



Source: https://uomustansiriyah.edu.iq

Types of Ultraviolet Radiation

Ultraviolet radiation is divided into several overlapping wavelengths, as shown in the table based on the ISO-DIS-21348 draft standard for determining solar radiation:

1. Long-wave ultraviolet radiation (UVA) with a wavelength of 315 to 400 nanometers.

2. Medium-wave ultraviolet radiation (UVB) with a wavelength of 280 to 315 nanometers.

3. Short-wave ultraviolet (UVC) radiation with a wavelength of 180 to 280 nanometers.

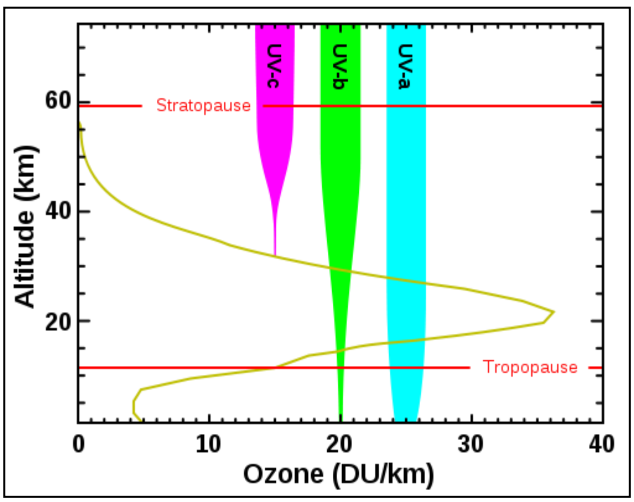
Ultraviolet rays from the sun are emitted in the form of long, medium, and short wavelength bands; however, because they are absorbed by the ozone in the upper atmosphere, 99% of the radiation that reaches the Earth's surface is in the long-wavelength UVA band. (For reference, the medium and short-wave UV bands are directly responsible for the formation of the ozone layer).

Table (1) Types and Wavelengths of Ultraviolet Radiation

Wavelength	Symbol	Wavelength in nanometers	Energy per photon
Long-wave ultraviolet radiation or black light	UVA	400 nm–320 nm	3.10–3.94 eV
Medium-wave or B-wave	UVB	320 nm–280 nm	3.94–4.43 eV
Short-wave or C-wave	UVC	280 nm–100 nm	4.43–12.4 eV

Source: https://uomustansiriyah.edu.iq

Figure (2): Ozone layer absorption rates for UV radiation in its three main wavelengths: UVA, UVB, and UVC



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2- Methods of measuring ultraviolet radiation

2-1- Direct method

The purpose of measurement varies for each device; accordingly, the most important devices will be mentioned.

3-1-1- The Epply pyranometer, which is used to measure direct and diffuse solar radiation.

3-1-2- Pyheliometers: The Angstrom pyheliometer, also known as the Angstrom sunmeter, is the most well-known type. It is used to measure direct and vertical solar radiation and is installed at a specific angle depending on the geographical location.

3-1-3- Kipp & Zonen UV Meter: This device is designed to measure solar radiation at wavelengths (0.295 – 0.385) microns (. This cylindrical device is hermetically sealed on all sides, and its outer surface contains a thick layer of selenium metal through which solar radiation passes but which acts as a barrier against external atmospheric influences. As the solar radiation passes through it, a thin layer acts as a filter. It allows only sunlight with a wavelength of 0.295–0.385 microns to pass through, after which these rays pass through a photovoltaic cell, generating an electric current. The data is recorded using a Kipp 8-zone device, and this voltage is converted into a radiation reading in units of watts per day per square meter ( ).

3-1-4. The Campbell-Stokes device: It consists of a glass sphere that focuses sunlight onto a strip of heat-sensitive cardboard attached to a clock, where the concentrated rays leave a burn mark on the strip depending on the sun's brightness. However, when the sun is obscured by clouds, this does not occur. The device contains a number of grooves carved into the bowl, into which strips of varying lengths are placed depending on the season, as the length of the day and the sun's angle vary with the seasons. The device must be placed on a base 2 m high so that the angle of the horizontal beams is greater than 3° relative to the horizon, because the sun does not leave a burn mark on the paper unless the angle is greater than 3° .

3-1-4- Photometer and Spectrophotometer: These devices differ from one another in design and application. In photometers, which are primarily used for the quantitative analysis of compounds using a specific wavelength, optical filters (Absorption filters) that allow only a narrow range of wavelengths to pass through for measurement, while blocking the rest of the light. There are several filters, each allowing light to pass through within a specific wavelength range .

2-2- The indirect (statistical) method

1- The atmospheric transparency to ultraviolet radiation is calculated using the following equation

KUV = 0.712 Kt 0.771 m - 0.254.

Where: (KIUV) = atmospheric transparency to ultraviolet radiation,

(m) = relative optical air mass.

(Kt) = atmospheric transparency or attenuation of solar radiation, calculated using the following equation:

Kt = Rs / Ra

(Kt) = atmospheric transparency to solar radiation

(Rs) = total solar radiation

(Ra) = outgoing solar radiation, calculated using the following equation

Ra = 24(60)/3.14 Gsc dr(Ws sin(Φ) sin(δ) + cos(Φ) cos(δ) sin(Ws

where: (Ra) = the value of incident solar radiation reaching the outer atmosphere, measured in mW/cm^2

(Gsc) = the solar constant, with a value of 0.0820 $MJ/m^2 \cdot min^{-1}$

dr is the distance between the Earth and the Sun.

(Ws) = the angle of elevation of the sun

(Φ) = degree of latitude

(δ) = the angle of the Earth's axis relative to the Sun

Rs is derived from the following equation

Rs = (as + bs n/N) Ra

where

Rs is the total solar radiation (mW/cm^2)

as = a constant value depending on the geographical location

bs = a constant value depending on the geographical location

N = hours of sunshine

n = actual sunshine hours

n/N = Ratio of actual to theoretical sunshine hours

Ra: External solar radiation, measured in milliwatts per square centimeter

The value of (N) is calculated using the following equation

N = 24 / 3.14 * Ws

Where: (N) = theoretical sunshine hours (hours per day)

Ws , the hour angle

The value of (m), the optical air mass, is calculated using the following formula

$$m_r = \frac{1}{\cos \theta_z},$$

Mr= Relative optical air mass

Φ = Sun elevation angle in degrees

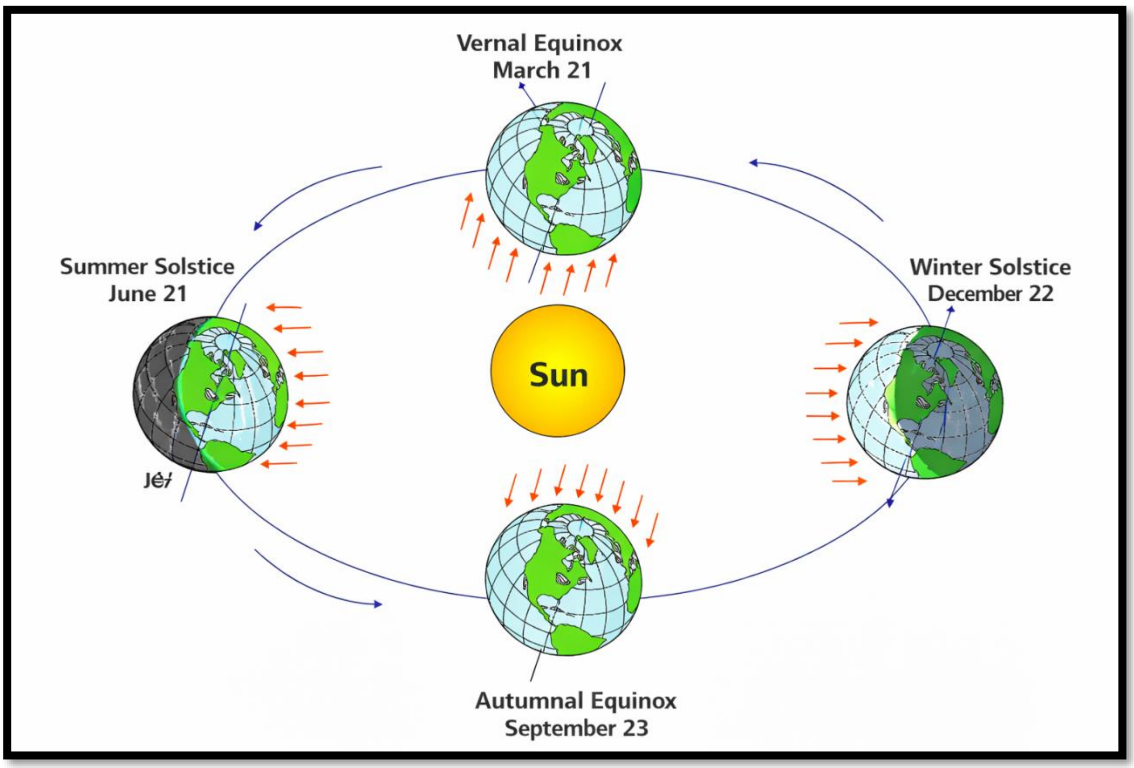
3- Factors affecting ultraviolet radiation levels.

There are a number of factors that affect the wavelengths of ultraviolet radiation reaching the Earth's surface. These factors are as follows

3-1- The Earth's rotation around the Sun

Since the Earth orbits the Sun in an elliptical rather than a circular orbit, it moves closer to the Sun at certain times and farther away at others. Consequently, the distance between the Sun and the Earth varies from 15 million km on July 4 to 147 million km on January 3. This means that in its elliptical orbit, the Earth is closest to the Sun on February 23. In this case, it is said that the Earth is at its perigee (i.e., close to the Sun), whereas on July 4, the Earth is farthest from the Sun, and in this case, it is said that the Earth is at its apogee. Studies have shown that the differences in the distance between the Earth and the Sun during perihelion and aphelion have no significant effect on the amount of solar radiation received by the Earth's surface during the day or year, whereas this difference is of great importance in terms of the amount of solar heat reaching the outer surface of the atmosphere.

Figure (3) The Sun's position relative to Earth



https://images.app.goo.gl/R9p5kLsZrgwk4BGB7

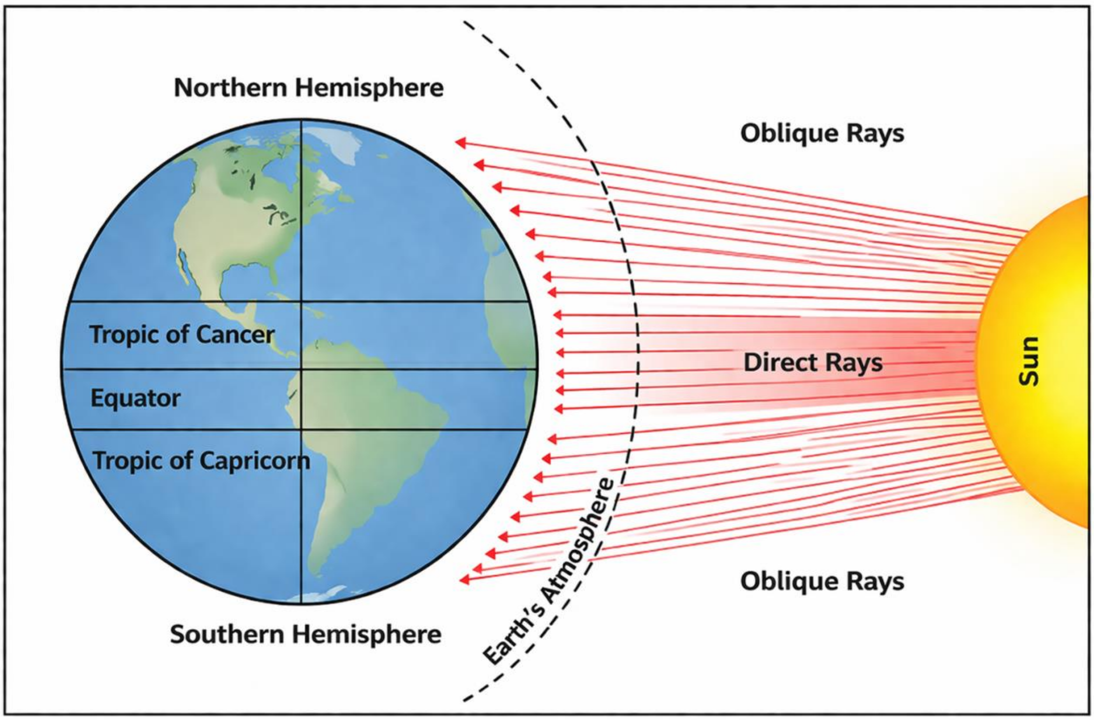
3-2- Angle of incidence of sunlight

The angle of incidence of sunlight refers to the angle formed by the sun's rays and the Earth's surface. and since the Earth is elliptical in shape and orbits the Sun from west to east, the angle at which the Sun strikes the Earth's surface is either vertical or nearly vertical or oblique. When the Sun is directly overhead in a given region, that region receives the maximum amount of solar radiation, whereas when the Sun is at an angle of (33.0) from the sun, the region receives a smaller portion of solar radiation energy. The intensity of solar radiation depends on the angle of the sun's elevation, where solar radiation is intense when the sun's rays are perpendicular, and the amount of solar radiation decreases as the angle of the sun's rays increases, and generally, an angle that is perpendicular or close to perpendicular travels a shorter distance than oblique rays. If the angle of incidence is perpendicular or close to it, as is the case in the region between the two tropics, temperatures are high . This is because perpendicular radiation is concentrated over a limited area, while oblique radiation is spread over a wide area. Thus, the amount of energy per unit area in vertical radiation is greater. Furthermore, vertical radiation travels a shorter distance through the atmosphere than oblique radiation; consequently, oblique radiation is subject to more scattering, absorption, and reflection compared to vertical radiation. This can be observed by comparing the intensity of radiation at noon and sunset: at noon, the intensity ofis greater because it is less oblique; thus, the rays are concentrated over a smaller area and travel through a shorter gas layer. whereas at sunset, the oblique rays spread over a wider area and pass through a gas layer more than three times thicker than the one they pass through at noon. Thus, the intensity of radiation at noon is greater than that at sunrise and sunset

3-3- Sunshine Hours

The variation in solar radiation values is reflected in the variation in the number of theoretical and actual hours of sunshine in the study area. Theoretical sunshine hours refer to the average number of hours of sunshine, which is determined by the duration during which the Earth receives solar radiation and depends entirely on the Earth's rotation around its axis. Actual sunshine hours, on the other hand, are the average number of actual hours of sunshine, which are measured using instruments such as the Campbell ball ( ) .

Figure (4) Angle of incidence of sunlight



Source: https://fadwaoma-n47254.blogspot.com/2018/09

3-4- Atmospheric transparency

The transparency of the atmosphere affects the intensity of solar radiation reaching the Earth's surface, as dust, ash, smoke, and water vapor play a significant role in the reflection, scattering, and absorption of sunlight. These impurities also cause terrestrial radiation to be lost outside the Earth's atmosphere. Consequently, areas with heavy cloud cover and air polluted with dust receive significantly less solar radiation compared to areas with clear skies. For this reason, areas with heavy smog, such as major industrial cities like London, New York, and Paris, receive very little solar radiation, especially since the frequent cloud cover in tropical regions has caused the amount of sunlightreaching them less than the amount reaching tropical regions with clear skies or bright sunshine

3-5- Al-Bido

This factor affects the amount of solar radiation to a small extent when measured from the Earth's surface, and to a large extent when considered in the broader context; the concept of reflectivity is based on the fact that all objects in nature reflect and scatter a portion of the radiation falling on them and absorb the remainder. Since nature does not contain black or white objects, there is always a portion of radiation that is absorbed or scattered, and the rest is absorbed. The amount of radiation absorbed or reflected by an object depends entirely on the roughness of the object's surface and its color; colors closer to white reflect more than they absorb. Meanwhile, objects close to black absorb more than they reflect . For example, the reflectivity of modern snow is 90%, compared to 50% for old snow, due to the increased proportion of water and impurities in it. Conversely, reflection is lower from dark-colored and rough surfaces; reflection is negligible from black surfaces, reflecting only 8% of the rays. Soil moisture plays a significant role in reducing reflectance, reaching 15% for dry soil and 10% for moist soil, noting that the reflectance coefficient for water (4–8%) is lower than that of vegetation cover compared to bare land. The reflectance coefficient of vegetation varies depending on the type of trees and field crops, as well as their seasonal growth stage (, Table 2).

3-1- Topography

Solar radiation decreases with altitude above sea level, and cloud cover increases at high elevations, blocking part of the solar radiation. The orientation of mountain slopes affects the duration of sunshine, and the difference in solar radiation is clearly evident in rugged mountainous regions at mid- and high altitudes. Southern mountain slopes in the Northern Hemisphere receive the greatest amount of radiation because they face the sun throughout the day, while the northern slopes remain in the shade. The sun shines on the eastern slopes from sunrise until midday and on the western slopes from midday until sunset. The steepness of mountain slopes has an impact on the angle of incidence of the rays, particularly in the mid- and high-altitude ranges such as the Alps and the Himalayas, especially when the slope is steep enough to increase the angle of incidence of the rays on the mountain slopes. This leads to an increase in radiation due to reduced reflection and its concentration over a smaller area. Therefore, temperatures on mountain slopes vary depending on the slope's orientation and the angle of incidence of the rays

Table (2) Surface Reflection of Solar Radiation

Albedo	Surface	Albedo	Surface
٪15	Grass	90%	Fresh Snow
٪20	Crops	50%	Old Snow
٪15	Green Forests	50%	Average (mixed) Clouds
٪25	Cement	25%	Light Sand
٪25	Asphalt	5%	Light Soil
٪ 5	Water	8%	Dry Soil
٪ 30	Desert	30%	Wet Soil
٪ 30			

Source: Hassan Abu Samoura and Ali Ghan, Introduction to Physical Geography, Dar Safa for Publishing and Distribution, Amman, 1997, p. 28.

3-2- Vegetation

Vegetation, whether natural or cultivated, has a specific effect on the climate of the area it covers. This effect is particularly pronounced when the air is still, due to vegetation's role in absorbing and reflecting solar radiation and its impact on the soil. Consequently, it affects the process of air heating, as plants lower the temperature by converting most of the energy they absorb into latent energy used for transpiration. In barren, vegetation-free areas, however, sunlight falls directly onto the ground, where some of these rays are absorbed while others are reflected as ground radiation, which heats the air in contact with the ground ( ). Accordingly, trees act as barriers to reduce solar radiation, allowing only a portion of it to reach the Earth's surface. Trees with sparse canopies

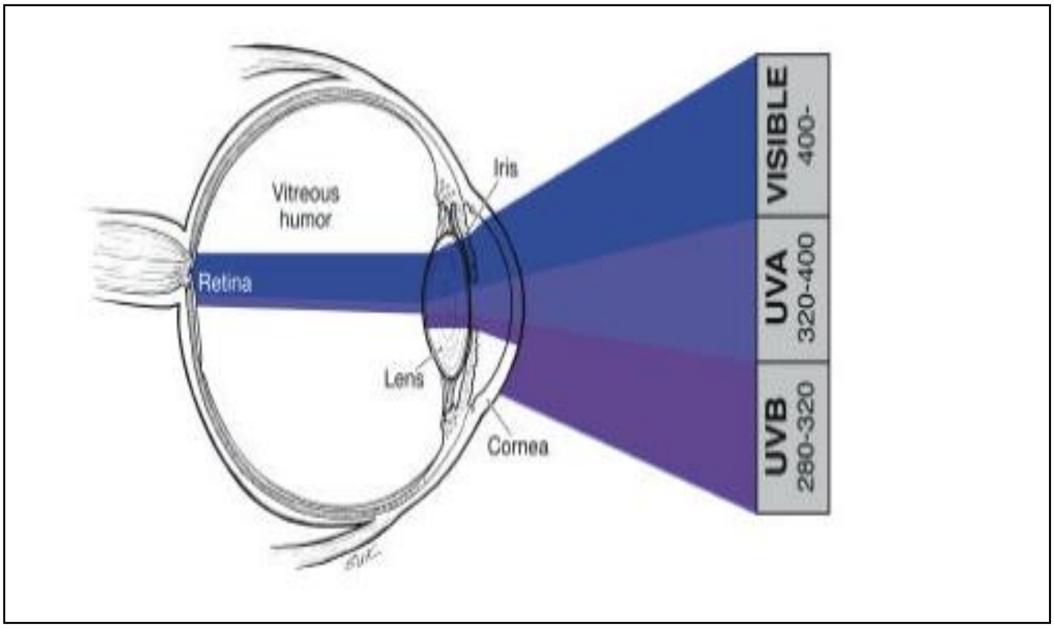
4- The Harmful Effects of Ultraviolet Radiation on Human Health.

The amount of ultraviolet radiation reaching the Earth's surface depends on several factors, including the amount of ozone in the atmosphere, the presence of clouds, and air pollution. The expansion of the ozone hole leads to an increase in the amount of ultraviolet radiation reaching the Earth's surface because ozone is an effective absorber of ultraviolet radiation. Ultraviolet radiation causes harm to various living organisms in general and to human health in particular. This is considered an indirect effect of ultraviolet radiation, while the direct effects are as follows.

4-1- Eye Diseases

The eyes are the organ most exposed to ultraviolet radiation, which causes many eye diseases. The cornea absorbs these rays first, followed by the lens, the vitreous humor, and the retina.Studies indicate that because these rays are absorbed by the cornea and lens before reaching the retina, they never actually reach the retina in the normal adult eye. Removing the lens, however, exposes the retina to the risk of damage caused by ultraviolet radiation (Figure 5). For this reason, many artificial replacement lenses are manufactured from materials that absorb ultraviolet rays.

Figure (5) Absorption of ultraviolet radiation by the eye



Ultraviolet radiation. An authoritative scientific review of environmental and health effects of UV, with reference to global ozone layer depletion. Geneva, World Health Organization, 1994, p. 32.

The eye is susceptible to photokeratitis upon direct exposure to ultraviolet radiation, which causes redness of the eye, severe pain, tearing, photophobia (aversion to light), and eyelid spasm. Photokeratitis is often diagnosed in skiers as "snow blindness," and this condition also occurs in beachgoers

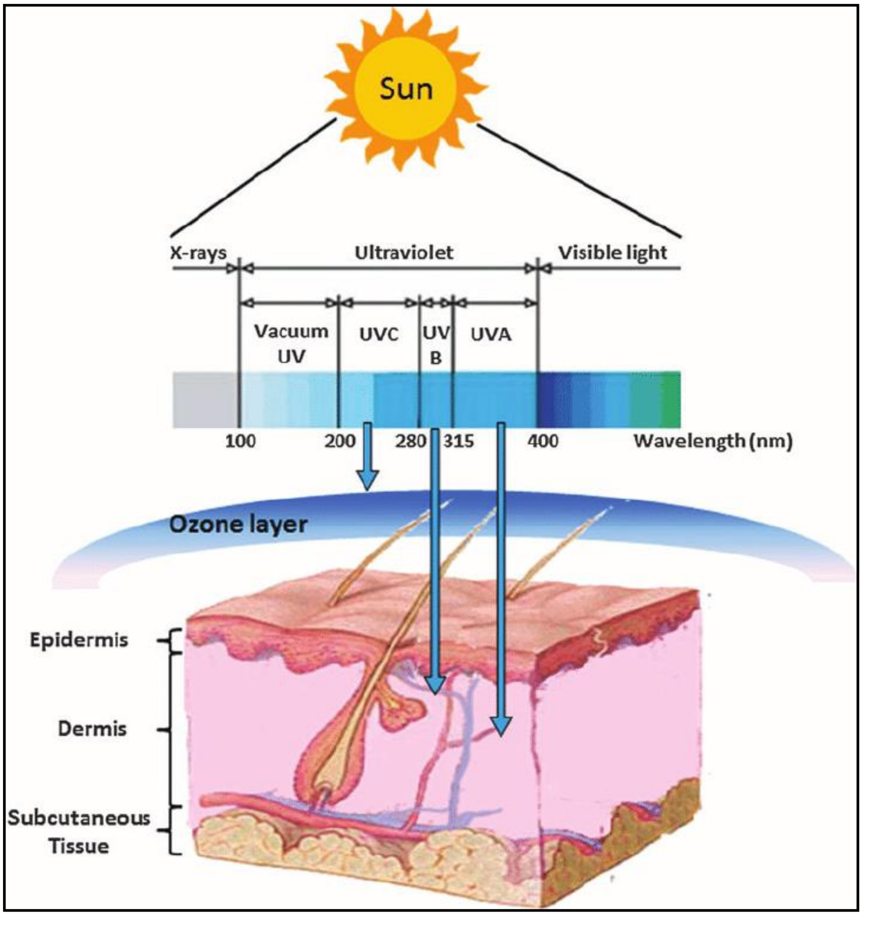
4-2- Damage to the Skin from Ultraviolet Rays

Ultraviolet rays penetrate all layers of the skin—the epidermis, dermis, and subcutaneous tissue—as well as basal cells (Figure 6) and affect them to varying degrees, with the extent of this effect depending on the wavelength and intensity of the light. The greatest danger arises from this interaction when it occurs in the layers that generate melanocytes and epidermal cells, because mutations in these basal cells are difficult to repair and may lead to random cell divisions that have a serious impact on the skin (skin cancers

Sun exposure contributes to the development of skin cancer due to the growth of abnormal cells capable of invading or spreading to other parts of the body. It primarily appears in areas of the skin exposed to the sun, including the scalp, face, lips, ears, neck, chest, arms, hands, and legs in women. It also appears in some areas not exposed to sunlight Studies indicate that increased UV radiation reaching the Earth's surface due to declining ozone levels leads to a rise in cancer cases, with estimates suggesting that a 10% decrease in ozone levels would result in 300,000 cases of non-melanoma skin cancer and 4,500 cases of melanoma .

Ultraviolet radiation also causes liver spots, actinic keratosis, and actinic elastosis. Skin burns, which are damage to skin cells caused by exposure to ultraviolet radiation, result in excess blood flowing to the damaged skin in an attempt to repair it; this is why the skin turns red when sunburned. A number of degenerative changes in the skin's cells, connective tissue, and blood vessels, as well as pigmented spots on the skin, such as freckles, moles, and pigmentation. Accelerated skin aging, as UV rays destroy collagen and connective tissue beneath the skin's top layer, leading to wrinkles, brown spots, and loss of skin elasticity . When fair skin is exposed to sunlight for 15 to 30 minutes during the midday hours of a hot summer day, signs of damage appear immediately, whereas it takes several hours for these effects to appear on darker skin under the same conditions of exposure, and the skin can become more tolerant when pre-conditioned through intermittent exposure to solar ultraviolet rays, as it becomes darker and thicker.

Figure (6) Penetration of ultraviolet rays through skin layers by wavelength



Asheesh Gupta, Opportunities and Challenges of Fluorescent Carbon Dots in Translational Optical Imaging, Volume 2, Number 8, Copyright 2013, 424.

4-3- Other health concerns: Light radiation generally affects the body's immune system; however, excessive exposure may negatively impact cellular homeostasis. Ultraviolet radiation is characterized by its harmful effects on health through its impact on the immune system; excessive exposure to these rays leads to the degradation of organic compounds, turning them into substances foreign to the body, which strains the immune system as it attempts to eliminate them. This effect may manifest as a skin rash or an allergic reaction. Consequently, exposure to ultraviolet radiation has a negative impact on the immune system that protects the body, making the body susceptible to various diseases. On the other hand, it is important to mention a vital effect that is of great benefit to the body ( ), namely the role of ultraviolet radiation in activating the production of vitamin D in the blood and ensuring the body's need for this vitamin ( ).

6- Solar Ultraviolet Index (SUVI)

The UV Index is an international standard defined by the World Health Organization, used to describe the level of solar ultraviolet radiation at the Earth's surface. It serves as a guide for prevention, as it indicates the level of risk associated with UV exposure, which may expose the body to numerous dangers. This index can be calculated using the following mathematical equation

$$I_{UV} = k_{er} \cdot \int_{250\text{ nm}}^{400\text{ nm}} E_{\lambda} \cdot s_{er}(\lambda) d\lambda$$

where ker is a constant equal to 40 m/s.

E is the spectral solar irradiance, expressed in units of (W/m·nm) at the wavelength

S(er) isthe reference spectral radiation for the sun

di is the wavelength interval used in the compilation

Classification of the radiation index into five risk categories by the World Health Organization, as follows: Table (3):

Low: This level ranges from 0–2 and is green, meaning that the risk of UV exposure for the average person is low, but people should wear sunglasses on sunny days and use sunscreen.

Moderate: This level ranges from 3 to 5 and is colored yellow, meaning the risk of UV exposure is moderate. but care should be taken to stay in the shade at midday when the sun is strong, and to wear long-sleeved clothing that protects the body from the sun when going outside, as well as sunglasses and a wide-brimmed hat, and to apply sunscreen every two hours even after swimming or sweating, and on cloudy days.

High: This level ranges from 6 to 7 and is indicated by the color orange, meaning the risk of UV exposure is high. In this case, you must protect your skin and eyes by minimizing time in the sun between 10 a.m. and 4 p.m., staying in the shade, and wearing protective clothing and sunglasses.

Very High: This level ranges from 8 to 10 and is colored red, indicating a very high risk of UV exposure. Additional precautions must be taken to protect the skin and eyes from UV rays.

Extreme: This level is 11 or higher, indicating the highest level of UV radiation and the most dangerous exposure. All necessary precautions must be taken, as unprotected skin and eyes can burn within minutes.

Table (3) Ultraviolet Radiation Index (SUVI) According to the World Health Organization (WHO) Standard

Protection		UV Index (SUVI)	
Protection		Exposure Category	
----		≤ 2	Low
----	Sunglasses, Hat	3 – 5	Moderate
----	Sunglasses, Hat, Sunscreen	6 – 7	High
----	Sunglasses, Hat, Sunscreen, Protective Clothing	8 – 10	Very High
≥ 11	Sunglasses, Hat, Sunscreen, Protective Clothing, Stay in Shade	≥ 11	Extreme
≥ 11	Sunglasses, Hat, Sunscreen, Protective Clothing, Stay in Shade		

ICNIRP, WHO, WMO, UNEP, "Global Solar UV Index, A Practical Guide," World Health Organization, 2002, p. 6.

Conclusions

1- There are three wavelengths of ultraviolet radiation; the negative effects of these rays are concentrated in the short wavelengths.

2- A number of factors influence ultraviolet radiation levels, including the angle of incidence, the number of hours of sunshine, the nature of surfaces that reflect UV radiation, the terrain, and the natural vegetation.

3- Ultraviolet radiation causes many skin diseases, including skin cancer, burns, and skin infections.

4- The eyes are significantly affected by ultraviolet radiation when exposed to it directly, leading to damage to the iris and inflammation.

Recommendations

1) Encourage researchers to study ultraviolet radiation to uncover its effects on humans.

2) Establish laws and regulations to limit the spread of pollutants that deplete the ozone layer, which acts as a barrier against ultraviolet rays.

3) Raise public awareness about the importance of wearing sunglasses that reduce UV exposure to the eyes, as well as using medical-grade sunscreen to act as a shield for the skin and prevent harmful rays from reaching it.

4) The responsible authorities should establish special stations to monitor the levels of ultraviolet radiation reaching the Earth's surface in order to take the necessary measures.

References

1. Abu Samoura, Hassan, and Ali Ghan, Introduction to Physical Geography, Dar Safa for Publishing and Distribution, Amman, 1997.
2. Abu Qasim, Issam et al., Non-Ionizing Radiation: Its Nature and Prevention of Its Risks, Arab Atomic Energy Agency, Tunis, 2011.
3. Al-Samarai, Qusay, Principles of Weather and Climate, Dar Al-Yazouri, Amman, 2007.
4. Al-Sha'ir, Hadeel Abdul-Majid Abbas, The Relationship Between Solar Radiation and Terrestrial Radiation and Temperature in Iraq for the Period (1970–2007), Master's Thesis (unpublished), College of Education, University of Kufa, 2009.
5. Shahadah, Numan, Climatology, 1st ed., Dar Al-Safa for Publishing and Distribution, Amman, 2009.
6. Ali, Marwa Khudair Abbas, Spatial and Temporal Analysis of Ultraviolet Radiation Values in Iraq, Master's Thesis (unpublished), College of Education, University of Kufa, 2016.
7. Mohammed, Alaa Rahim, Calculation of the Amount of Electrical Energy Generated by Solar Radiation, Master's Thesis, College of Education, University of Kufa, 2011
8. Al-Mousawi, Ali Sahib Talib and Abdul Abhin Madfoun, The Climate of Iraq, 1st ed., Al-Mizan Press, Najaf, 2013
9. Al-Mousawi, Ali Sahib Talib, An Analytical Study of Climatic Characteristics and Extreme Weather Phenomena in Najaf Governorate, Journal of Geographical Research, Issue (2), College of Education for Girls, University of Kufa, 2001.
10. Al-Mousawi, Ali Sahib Talib and Abdul Abhin Madfoun, The Climate of Iraq, 1st ed., Al-Mizan Press, Najaf, 2013.
11. Al-Waeli, Ali Abdul Zahra, Principles and Foundations of Meteorology and Climatology, Arab Geographers, 2005.
12. Barbero, G. Lopez, Batlles, "Determination of Daily Solar Ultraviolet Radiation Using Statistical Models and Artificial Neural Networks," Geophys,
13. Asheesh Gupta, Opportunities and Challenges of Fluorescent Carbon Dots in Translational Optical Imaging, Volume 2, Number 8, Copyright 2013
14. ICNIRP, WHO, WMO, UNEP, "Global Solar UV Index: A Practical Guide," World Health Organization, 2002.
15. Ultraviolet radiation. An authoritative scientific review of environmental and health effects of UV, with reference to global ozone layer depletion. Geneva, World Health Organization, 1994.
16. https://sotor.com
17. https://www.mayoclinic.org
18. https://uomustansiriyah.edu.iq
19. https://images.app.goo.gl/R9p5kLsZrgwk4BGB7
20. https://fadwaoma-n47254.blogspot.com/2018/09