Study the effect of harmful radiation on patients' eyes from 15-25 years during using smart devices

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Abstract

The aim of this study was to assess the unsafe effects of harmful radiation, especially blue light and ultraviolet rays on patients' eyes aged (15-25) years during us exposure. It was carried out at the optics consulting clinic of the College of Health and Medical Technology in Baghdad/Iraq. In this research, (50) patients were enrolled, 28 males and 22 females, with their ages ranging from (15- 25) years. The smart devices are used by all patients for 2 to 5 hours daily. The majority of the patients were middle school and university students, accounting for 94 % of the patient study population, and these patients were using their mobile devices for more than (3-4) hours per day continuously due to internet browsing, gaming, and e-learning for all students. The majority of patients within the age range (15-20) years, who were not wearing multi-coated goggles, were shown to be a significant source of eye problems (80%). After giving the patients the required instructions to minimize radiation effects, it was found that the majority of them were wearing blue-cut spectacles. The results showed that (62%) of the patients in the age groups (21-25) years were wearing spectacles after following the prescribed instructions. The term "plastic" refers to patients who were wearing prescription spectacles without any protection from the radiations (Filter) emitted by these smart devices.

Keywords: *harmful radiation, ultraviolet rays, blue light, multi-coated spectacles, smart devices.*

دراسة تأثير الاشعة الضارة على عيون المرضى للأعمار من 15-25 اثناء استخدامهم للاجهزة الذكية

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الخلاصة

تهدف الدراسة الحالية الى تقييم التأثير غير الامن للاشعة الضارة خصوصا الاشعة الزرقاء والاشعة فوق البنفسجية على عيون المرضى البالغة اعمارهم (15 الى 25)سنة خلال فترة تعرضهم عند استخدامهم الاجهزة الذكية والتي اجريت في وحدة فحص البصر في كلية التقنيات الصحية والطبية- العراق /بغداد.لقد تضمنت الدراسة خمسون(50) مريضا، حيث كان عدد المرضى الذكور ثمانية وعشرون(28)، وعدد المرضى الاناث اثنان وعشرون (22) ممن كانوا يستخدمون الاجهزة الذكية لفترة لاتقل عن 2-5ساعات يوميا ولقد كانت اغلب اعمارهم من الدراسة المتوسطة والدراسة الجامعية (حيث تشكل نسبتهم 94%) وباستخام يومي ومستمر للاجهزة الذكية يقارب 3-4 ساعات (بمافيه من متطلبات الانترنت، الالعاب والتعليم الالكتروني)،حيث كان اغلب المرضى الذين تتراوح اعمارهم من 15-20 سنة لايرتدون النظارات وظهرت لديهم مشاكل ملحوظة بمايقارب ال80%

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،وبعد اعطاؤهم التعليمات والتوصيات بارتداء النظارات (ذات الطلاء المتعدد الطبقات) والتزامهم بذلك بمايقارب 62%، الامر الذي ادى الى تقليل الضرر على عيونهم.

الكلمات المفتاحية: *الاشعة الضارة، الاشعة فوق البنفسجية، الضوء لالازرق، النظارات ذات الطلاء المتعدد الطبقات ، الاجهزة الذكية.*

Introduction

Two pathways for light interact within the body: the primary optic tract governs visual perception and responses whereas the retinohypothalamic tract governs circadian, endocrine, and neurobehavioral functions [1]. Blue light has a wavelength ranging from (415 to 495) nm, and is a part of the visible light spectrum [2]. Exposure to blue light for an extended time can cause photochemical damage, resulting in the development of toxic reactive oxygen species, which can lead to retinal pathologies such as age-related macular degeneration [3]. Blue light is a part of the visible light spectrum, with a wave length (λ) of about (415 to 495) nm. Two bands of the blue light can be distributed into: a wave length of (415 to 455) nm as a blue-violet light and a wave length of (465 to 495) nm as a blue-turquoise light. Light of blue wavelengths is found all around us. The blue light shines brighter and longer than other types of shorter wavelengths. This flicker produces light that decreases visual contrast, impairing visual acuity and visibility. Eye pressure, headaches and redness will occur when you use your smart device [4]. The retina of the eye is damaged by wavelengths in the blue section of the spectrum. To block harmful rays, the front of the lens deflects UV light and about 20% blue-violet light. The posterior side shields the patient by allowing light from the back of the lens, primarily UV light, to pass through [5].

The blue light "safe and unsafe effects"

The dissemination of interpretative concepts is achieved through the periodic analysis of biological evidence by professionals in organizations. These thresholds reflect the lowest levels at which adverse health effects are impossible. When it comes to the retina's exposure to light, certain wavelengths are more powerful than others in causing harm. This is recognized by the working spectrum for blue light hazards [6, 7]. Looking at any digital screen for an extended time causes eyestrain because blue lights, which are of high energy and short wave, scatter more rapidly than other visible light and are difficult to focus [7,8]. Beside the visible light, the blue light is popularly transmitted through the cornea and crystalline lens to the retina. Perceiving artifacts of different colors plus the contrast in our environment is one of the diversity of visual roles of important blue light, and the non-visual functions including hormonal equilibrium, mood as well as memory preserved and controled by our circadian cycle that is aided by blue-turquoise light, with a wavelength similar to the "green light" [9, 10]. Pathological alterations due to photon energy absorption are taking place in

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ocular tissues. A photochemical reaction occurs due to photon energy may be absorbed and then dissipated as heat. Intense light of acute exposure can cause thermal injury (e.g. photokeratitis in skiers). The gradual accumulation of toxic photochemical waste products over time can result due to low intensities of exposure, eventually leading to cell death [11] as shown in (Fig1).

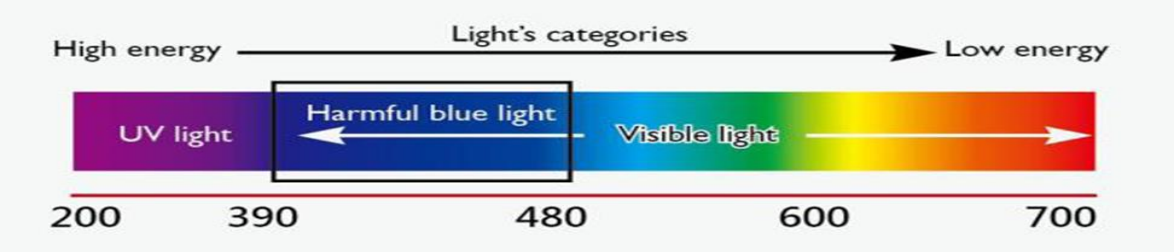

Fig. (1): Location of the blue light according to wavelength (λ) [2].

Effects of UV on the eyes

Cornea can absorb the UV radiation below 300 nm, and the wavelengths between 300 and 400 nm, particularly those up to 360 nm, are mostly attenuated by the crystalline lens. There is a comparatively enlarged degree of attenuation of blue light propagation with progressing age, and an associated physiologic yellowing of the crystalline lens. As a result, the aged crystalline lens exhibits blue-light filtering. The properties the so-called "blue-light threat" is caused by retinal exposure to a shorter-wavelength visible light (400 to 500 nm) [12]. The most risk factor for age-related macular degeneration is ultraviolet (UV) light. Only visible light can penetrate the eye and reach the retina since the ultraviolet light is mostly blocked by the cornea or lens [13].

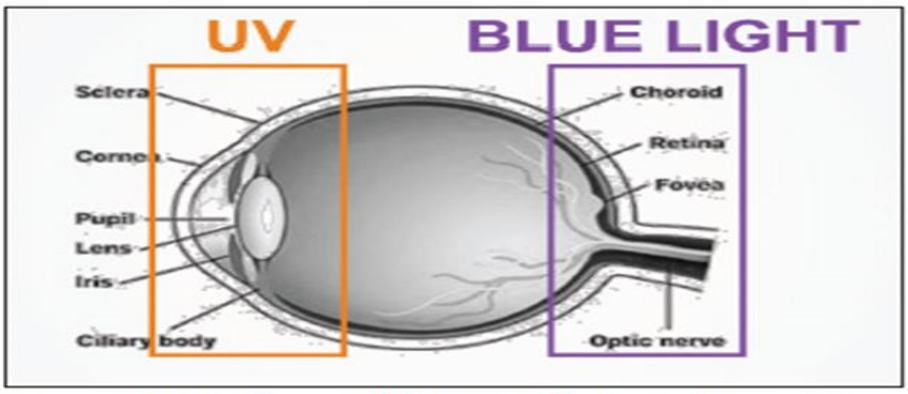

Fig. (2): Dangers of light to the eyes [14].

How does a blue light affect the eyes?

Almost all visible" blue light" reaches the retina, after passing through the cornea and lens. This light can harm the eyes and obstruct vision prematurely. As vision is created, retina is the first site as

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well as the site of several blinding eye diseases. It is critical in the blindness prevention. The blue light can pass through the lens and cause photochemical damage to the retina as shown in (Fig 2) [14]. The blue light activates the retinal initiation, and the oxidation mechanism in aerobic conditions produces a large number of free radicals and kills messenger and protein. It causes necrosis of photoreceptor cells and pigment epithelial cells, and destruction of the body's normal redox state's dynamic balance [15]. At the same time, blue light-induced sleep disorders cause a reduction in the eye's closing time, and open eyes cause an increase in tear evaporation after a longer time, resulting in dry eye symptoms. Furthermore, some studies have shown that a lack of sleep can lower androgen levels in the body [16].

Exposure to blue-violet light causes retinal damage

UV light is more definitely absorbed by the structures of anterior lens than blue light, and consequently can penetrate the posterior part of the eye, potentially triggering damage of retina. The most serious type of retinal damage due to the cumulative impact of the blue light exposure is the macular degeneration, (Fig 3) [17&18]. The tissues of the lens, cornea, and retina contain specific chemical moieties that have been proven to exhibit light-mediated oxidative degradation. Proteins and lipids present in the cornea, lens, and retina, meet all of the physical requirements known to initiate the process of oxidative photodegradation upon exposure to solar radiation, the retinal damage is a photochemical process caused by acute exposure of blue light before exceptionally bright blue light is practiced [19].

The adverse effects of blue-violet light as a macular pigment, thins with age and the central retina becomes more susceptible to these effects. The blue light is emitted by backlit digital screens (computers, smartphones, laptops and LED displays). The combined effects of UV rays in the per orbital area are growing with increasing life expectancy and evolving lifestyle patterns (such as new artificial light sources) (i.e. malignancies). Note through (Fig 4), the extent to which the rays (UV and Blue cut) entered the eye using the eyeglasses CR-39 without coating [20]. The cornea and conjunctiva (i.e. apterygial, as shown in figure 5) as well as the lens are becoming more relevant in terms of public health. Given that eye protection is typically inadequate, and sun protection considerations for the skin differ from those needed for the eyes, it is necessary to take precautionary steps. As a result, prolonged exposure to these devices may potentially increase the risk of eye injury [21].

Ultraviolet (UV) radiation potentially damages the skin, the immune system, and structures of the eye. A useful UV sun protection for the skin has been established. Since a remarkable body of evidence shows an association between UV radiation and damage to structures of the eye, eye

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protection is important, but a reliable and practical tool to assess and compare the UV-protective properties of lenses has been lacking .Reflexes, fatigue, and dryness are all carried out in the eyes. Before the eyes can relax and heal, a new task is waiting for them inside the computer that they've grown tired of [22].

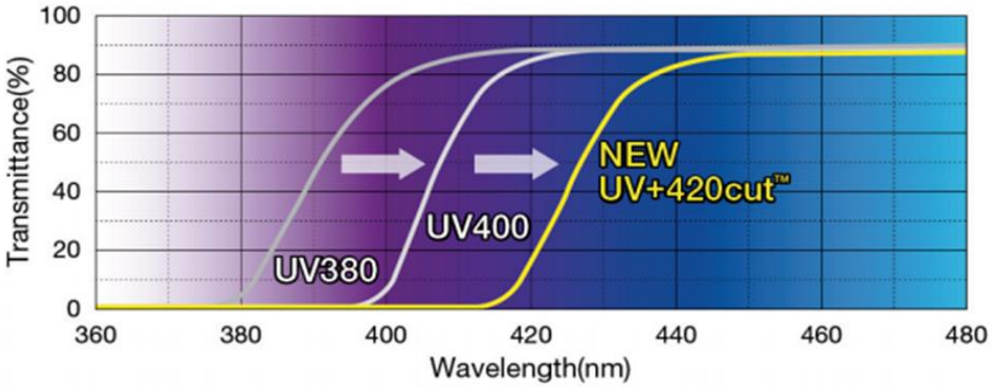

Fig. (3): UV+420 nm) cut lenses drive the absorption of harmful blue-violet radiation further into the visible range [22].

Fig. (4): Blue-cut eye glasses [22].

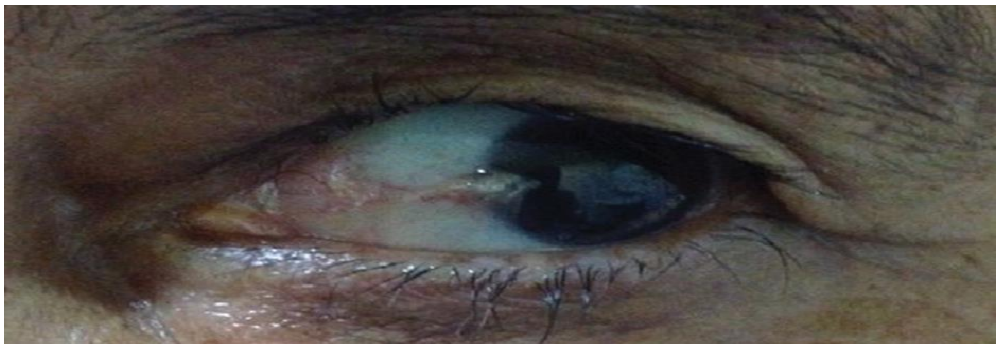

Fig. (5): Patients with Pterygium* photokeratitis, a painful eye condition [17].

Many studies have found evidence of potential health effects such as brain tumors, sleep disorders, cognitive function, DNA damage, immune system function and stress reaction [23, 24].

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Any complication in the eye due to misuse of smart devices makes it necessary to use MC-lenses to prevent harmful radiation from smart devices) (Table 1) [25].

Table (1): Comparison between the UV radiation and blue light.

Items	Ultraviolet radiation	Blue light
Sources	Due to ozone depletion, UV exposure is growing [6]	General white illumination, such as that used in computers, smartphones, and other electronic devices, emits about 50 to 70 lux, while sunlight emits around 100,000 lux of blue light [7].
Wavelength λ Absorption	The cornea absorbs wavelengths of less than 300 nm between 100 to 400 nm, while the crystalline lens absorbs wavelengths of less than 400 nm [3] .	380-500 nm, the cornea can penetrate λ = 300 to 400 nm. The most dangerous of these is HE short wave blue light between 415 to 455 nm. Easy crystal penetration into the retina [8].
Effect on conjunctiva and cornea	A pterygium is thought to be caused by UV exposure [9]. Corneal invasion has a driving force by the pterygium was thought to induces UV ray-changes in cells of corneal epithelial stem [10, 11].	Corneal epithelial cells have a mitotic phase can be influenced by blue light in the near-ultraviolet field, resulting in dry eyes.
Effect on Lens	One of the most common risk factors for cataracts is exposure to UV from the sun [13].	Structural proteins and protein metabolites in the lens are absorb short-wave radiation, addition of these substances and compounds to the lens protein, resulting in yellow pigments in the lens protein and cataract [14].
Effect on retina	Because the lens absorbs almost all UV-B and only very small quantities of this waveband can reach the retina, the lack of a consistent link between UV ray exposure and AMD is not surprising [15].	Blue light can pass through the lens and cause photochemical damage to the retinal system, as well as damage to the blood-retinal barrier function and retinal oxidative stress injury [16]. After cataract surgery, accelerate the onset and progression of AMD [17].

Materials and methods

The study was conducted in the Optometry Consultation Clinic at the College of Health and Medical Technology - Baghdad. The current study included (50) patients, of whom (28) were males and (22) were females, whose ages ranged from 15 to 25 years (understudy). The information was taken based on (age, gender, time of using smart devices in hours, family history, symptoms), and all patients were using smart devices for a period of up to three (3) hours. All patients were exposed to

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ultraviolet and blue rays from smart devices. One group of patients did not wear glasses because they had an acceptable visual acuity value (VA) = (6/12, 6/18) and the second group included patients with (cataract, retinal problems and patients without complications). It has an unacceptable value of (VA).

Results and discussion

The blue light with a certain extent can support refractive development and regulate circadian rhythm in human's eye, and blue light can also produce different degrees of damage to the cornea, and crystal lens as well as retina can also be produced by blue light exposure. Therefore, appropriate protective measures are necessary when using blue light-related products, especially at night [14]. The blue light emitted by the smart phones screen harms the human eyes, especially in epithelial cells of cornea, tear film deterioration, and stimulates levels of inflammatory markers as the results of the blue light overexposure was indicated by one of the studies [21].

Table (2): Demographic descriptions of study for age groups (years) and gender of patients.

Age groups (years)	No. of males	No. of females	Total (%)
15-17	11	7	36
18-20	10	7	34
21-23	7	5	24
Up to 25	2	1	6

The majority of the studied patients (94%) were within the middle school and universities, who used smart devices for more than three hours per day continuously for the purpose of surfing the internet, playing games and e-learning for all students in Iraq, causing strains that affect the eyes as a result of exposure to harmful rays, (Table 2).

Table (3): The relation between the group of patients who do not wear the spectacles (multi-coated (MC) and the patients who wear the spectacles that have impairing vision with (MC).

Age groups(years)	Patients without spectacles	Patients wearing (MC)spectacles	Total (%)
15-17	20	5	50
18-20	13	2	30
21-23	6	1	14
Up to 25	0	3	6

In table (3); most of the patients under investigation (80%) who did not wear protective glasses (MC) within the ages (15-20) years had a major cause of eye problems due to negligence and lack of knowledge about the harms of radiation to the eye due to their constant use of smart devices.

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Table (4): Effect of radiations on patients' eyes using smartphones

Age groups (years)	Cataract	Glaucoma	Others
15-17	8	5	9
18-20	5	1	2
21-23	2	2	5
Up to 25	8	-	3

It was shown that 23 patients were affected by Glaucoma due to the effect of the rays on the eyes and non-wearing protective glasses during the use of these smart devices. Others: The patient suffered from eye pain or sensitivity, redness in the eye, and dry eyes as a result of stress or lack of medication by ophthalmologists. After providing the necessary directions to the patients during their review at the educational clinic for optic techniques to reduce the radiation effects, it was observed that most of the patients were wearing blue glasses, as revealed in (Table 4**).**

Table (5): The relationship between the age groups of patients were the blue cut, multicoated or hard multicoated and CR-39 spectacles.

Age groups/years	Blue cut	Multicoated (MC)or Hard multicoated(HMC)	CR-39	Total (%)
15-17	4	5	2	22
18-20	5	2	1	16
21-23	16	4	-	40
Up to 25	9	2	-	22

It was revealed in (Table 5), that (62%) of the patients who were wearing the spectacles after the requisite directions were in the age group (21-25) years and were undergraduate students. The (CR-39) refers to the patients who were wearing the spectacles according to the prescription without any protection against the radiations produced from these smart devices.

Table (6): The relationship between the study age groups and the number of hours using smart devices.

Age groups /years	No. of hours using smart devices (straight)
15-17	More than 2 hrs.
18-20	More than 4 hrs.
21-23	More than 5 hrs.
Up to 25	Less than 3 hrs.

*College students more than 4 hours.

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In (Table 6), the results revealed that there is a relationship between the patient's age groups and the number of hours of using the smart devices. The age group of (18 to 20) years was shown to be the most group who used the smart devices as compared with other age groups.

Table (7): The relationship between the using smart devices with types of spectacles (MC, blue cut light, and without spectacles) and the number of hours using the smart devices (straight).

Types of spectacles(CR-39)	No. of hours using smart devices (straight)
Multi-coated (MC)	4hr
Blue cut light	5hr
Without using spectacles	6hr

The relationship between the different types of spectacles (multi-coated, blue cut light, without spectacles) and the number of hours using smart devices was shown in (Table 7).

Mobile phones or smartphones have many negative effects. Several systemic researches have been performed on the harmful effects on human health by smartphones or mobile phones. Chronic dry eye syndrome has main effects through causing rapid change in graphics, brightness as well as its effects on the eyes while gaming. The eyes bear tremendous amounts of reflexes, stress and dryness [22]. Many studies provided evidence on the possible health effects such as damage of DNA, immune system function, brain tumors, cognitive function, sleep difficulties and stress reaction in the humans [23, 24]. Any complication in the eye due to misuse of smart devices makes it necessary to use MC-lenses to prevent harmful radiation [25]. The relationship between the use of smart devices with different types of spectacles (multi-coated, blue cut light, without spectacles) and the number of hours using smart devices, these showed in (Table 5).

Conclusion and recommendation

The best and safest solution to solve the problems of the effects of electromagnetic radiation on the eyes (lens and retina) due to smart devices that are specially used (ultraviolet and blue rays) is the use of blue light glasses with a wavelength (UV+420 Cut) nm, as well as the classification of the use of smart devices. It is recommended to use the principle of (20 × 20 × 20) due to the absence of refractive defects of the eye and giving complete comfort to the eye as well as reducing pressure on the eye muscles to prevent the effects of the retina. The cut-off blue light helps prevent the effects of the blue light emitted by smart devices that cause pain, redness, dry eyes and sleep disturbances that cause the weakness of the human body as well as not to use these devices in complete darkness.

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