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RESEARCH PAPER

# Smartphone overuse and vision problems among university students

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**A B S T R A C T:**

The impact of smartphone on human health are still being tested and studied. This study estimates the effect of tiny screens of smartphones on eye defects such as myopia, Hyperopia, Astigmatism, Eye dryness and regarding the way which students in the college of science-Salahaddin University-Erbil use cellphones in their daily lives. In the first part of this study, the auto-refractometer device (21- 36111) have been used to test the eye refractive errors of 350 students (94 male,256 female). The student's ages are about 18 (50 male,130 female) and 22 (44 male,126 female) years old and all the tests have been carried out at the medical physics laboratory in our department. Nearly, 46% and 40 % of the 18- and 22-years old students' eyes respectively have been suffered from vision defects. In the second part, Schirmer's check was used to test dry eye disease (DED). Among 112 students, 27%, 16%, 28.5%, and 28.5% of students have normal, mild, moderate, and severe eye dryness respectively. Overall, according to the above results and questionnaire survey, the eye problems caused by the smartphone tiny screens are related to the time duration which an individual spends in front of the smartphone's screen and also the operation mode of the smartphone. The way students use smart devices, as well as their exposure to blue light from mobile devices like smartphones and laptops, increases the risk of visual disorders including emmetropia, particularly astigmatism, and even permanent eye damage.

KEY WORDS: Smartphone, Radiation, Refractive errors, Dry eye, Questionnaire.
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## 1.INTRODUCTION :

In the last two decades, smartphone usage has grown dramatically. Ocular problems linked to smartphone use have become a significant concern as the number of people using them increases(Neto et al., 2017, Fook et al., 2021). Eye strain, ocular pain, dry eye, diplopia, and fuzzy vision have all been associated with excessive smartphone use. Increased intraocular pressure (IOP) is one of the most common ophthalmic problems following extended smartphone usage(Lee and Kim, 2019). Dry eye illness is more common in children and teenagers, according to the researchers, who also discovered that smartphone use is a significant risk factor for dry eye disease in children and teenagers.

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When it comes to video display terminals (VDT), especially smartphones, children should be supervised and exercise caution(Moon et al., 2014, Kim et al., 2016). A smartphone is a mobile device that combines the features of a phone and a computer into one device. Smartphones are distinguished from feature phones by their improved hardware and mobile operating systems. They allow for extra software, internet (including web surfing over mobile broadband), and multimedia functionality in addition to standard phone services like voice calls and text messaging (such as music, video, cameras, and games) (Wong, 2010). The first actual smartphone was introduced three years before in 1992, despite the fact that the term "smartphone" was not used until 1995. More than 15 years before Apple introduced the iPhone, IBM created the Simon Personal Communicator(Nuhel, 2021).

Smartphones now account for more than half of the worldwide mobile phone market, and more exact quantification of the difficulties they cause is necessary to improve knowledge in this sector. Some mobile phone users have been labeled as addicting due to their excessive usage of their phones. Overuse is often called "dependence syndrome," a phrase used by the World Health Organization (WHO Expert Committee, 1964) to define a disease distinct from addiction or habituation. This is classed as a behavioral disorder in the ICD-10 (mobile phone addiction)(Room, 2010, Sharma et al., 2021).

In India, it is estimated between 39% and 44% of teenagers use cellphones excessively and that smartphone addiction can hurt not only interpersonal skills but also lead to considerable negative health risks and severe psychological consequences for adolescents (Davey and Davey, 2014). Women prefer to use their phones more frequently than men. Males are less stressed by social situations than females, and only a limited minority of men use mobile phones for social purposes (Roberts et al., 2014). The goal of this study is to look at the effects of using cellphones on students' eyes by examining Myopia, Hyperopia, and Astigmatism. Also, the rate of tears, as well as conducting a questionnaire regarding how students use smartphones.

### 1-1- Emmetropic and Ametropic Eye

The eye is the primary sense organ. Several parts are involved in the eye's structure and function. The cornea (iris), the pupil (lens), retina (macula), optic nerve (choroid), and vitreous are only a few of the eye's components. The cornea is the front window that transmits and focuses light into the eye (Preethi and Koh, 2019). A point at an infinite distance from the eye is conjugated to the retina in a condition known as emmetropia, a type of refraction. One of the symptoms of ametropia is an incorrect focus on distant objects or a lack of proper focus (Gross et al., 2008). They are three types of Ametropic Eye Myopia (nearsightedness), Hyperopia (farsightedness), and Astigmatism.

Close-up objects appear clear to those with myopia, whereas far-away objects appear blurry. This is a very frequent visual problem. Light rays bend (refract) improperly in this situation, focusing pictures in front of your retina rather than on it. When you have hyperopia, a visual disease that makes far things distinct but close ones fuzzy, nearby items may look fuzzy in this case. Farsightedness has an impact on your ability to focus your attention (Gross et al., 2008, Upadhyay, 2015). An eye condition known as astigmatism can cause blurred vision. In this case, the cornea is shaped erratically, resulting in an eye's asymmetrical front cover. Because the eye's cornea and lens have distinct curvatures, the light has two focal points (Gross et al., 2008, Upadhyay, 2015). Since the cell phones are considered as a source of electromagnetic radiation including Non-ionizing and UV radiations,

the exposure of the eye to radiation from smartphones when used excessively, increases the exposure dose to the components of the eye, and it leads to biological damage to the eye cells or the appearance of the defects mentioned. As well as may cause some eye diseases such as your tears aren't able to adequately lubricate your eyes, you may develop dry eye disease (Clayton, 2018).

## 2- MATERIALS AND METHODS

A four-month cross-sectional study was conducted at Erbil Governorate, Salahaddin University-Erbil, College of Science on students age between 18 (50 male,130 female) years old and 22 (44 male,126 female) years old, 350 students (94 male,256 female) were recruited from both ages. First, a list of questions about how students use smartphones in their daily lives was given to the students as shown in table1.

**Table1: Sample of questionnaire on how to use smartphones by students.**

| Department: | | Stage: | | Age (years): | | Sex: | |
|---|---|---|---|---|---|---|---|
| Duration of Smartphones use, hours/day | Using glasses for Smartphones (Yes or No) | Using night-vision mode (Yes or No) | Using blue filter mode for smartphones, (Yes or No) | Using Smartphones in dark or light space | Use Smartphones for study (Yes or No) | Has refractive error (Yes or No) | |
| | | | | | | | |

Second, after enrolling in the study, each participant was thoroughly screened by the researcher. Four different eye tests were performed in our medical physics lab. on students to see if smartphones affected their vision in any way. Students' refractive errors, including myopia, hyperopia, and astigmatism, were tested as part of the evaluation process by using a portable auto-refractometer (spot vision screener), made by the American welch Allyn company with the serial number (21) 36111 was used. Testing for Dry eye disease (DED) with Schirmer's check, which measures the amount of tears a person's eyes produce. For the Schirmer's test, a person closes their eyes and places a filter paper in the lower eyelid of both eyes. After one minute, the filter paper is removed, and we examine the paper to see how far the tears have spread. The moisture rate depends on the amount of the tear, which means that the fewer tears produce less moisture on the paper. In most cases, this test is used to diagnose dry eye syndrome. The test is non-invasive and has been in use for about a century now (Senchyna and Wax, 2008). The following shows how the Schirmer test is interpreted:
Measurements of more than 15 mm suggest normal aqueous tear production.
Mild aqueous production reduction: 10-15mm.
The 5-10mm decrease in aqueous output is modest.
Severe dryness (< 5 mm) is caused by decreased tear production.

## 3- Results:

The results obtained are divided into two parts. The first relates to testing for vision defects or refractive errors and the results of the Schirmer test, for the students' eyes under study, and the second to show different ways of using smartphone devices by students.

### 3-1- Vision Defects or Refractive errors

After taking the refractive error for the students of the total of 350 students, assume every eye represents an individual case for a person, which equals 700 eyes in total, the results are the following:

The students with age 18 years have a total of 360 eyes, 165 had vision defects, the defects like the following; 39 eyes with myopic defect, 12 eyes with hyperopic defect, and 114 eyes with astigmatism. The students with age 22 years have a total of 340 eyes, 135 had vision defects, 32 eyes with myopic defect, 12 eyes with hyperopic defects, 91 eyes with astigmatism, the results are shown in Table 2. Figure 1 shows that 46% and 40% of the total eyes of students for the 18 and 22 age years, respectively.

**Table2: The prevalence rate of different types of refractive error (myopia, hyperopia, and astigmatism) for the students according to ages.**

| Age/years | Total eye | Defected eyes | Myopic | Hyperopic | Astigmatism |
|---|---|---|---|---|---|
| 18 | 360 | 165 | 39 | 12 | 114 |
| 22 | 340 | 135 | 32 | 12 | 91 |

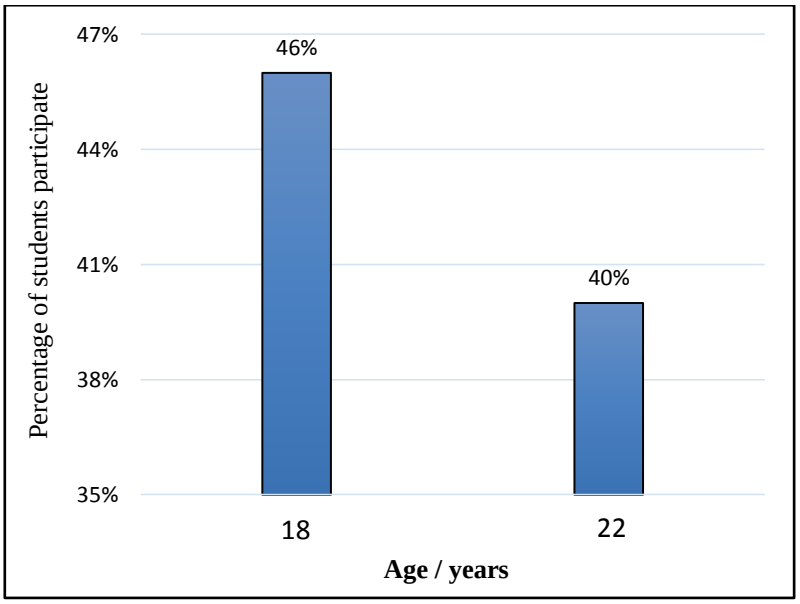


**Figure1: Compared the prevalence rate of vision defects for students according to ages.**

### 3-2- Schirmer test result

Our testing procedure was limited because of the social distancing due to (COVID-19), Therefore, some of the students were not ready to take this test. The number of students where we tested was 112 students. While the chances of getting dry eyes to go up with ages, those who spend more time on smartphones and other devices and less time outside have more symptoms of dryness. Due to less blinking while using smartphones the eyes will have a lower amount of mucus which is found in tears to moist the eyes while blinking. Table 3 show the measured value of Schirmer test for 112 students (46 male,66 female). Figure 2 shows the normal and abnormal students were having different rates of eye dryness.

**Table 3: Measured value of Schirmer test for 112 students.**

| Schirmer reading / mm | normal >15 | mild 10-15 | moderate 5-10 | severe <5 |
|---|---|---|---|---|
| Total students | 30 | 18 | 32 | 32 |
| Male | 14 | 12 | 14 | 6 |
| Female | 16 | 6 | 18 | 26 |

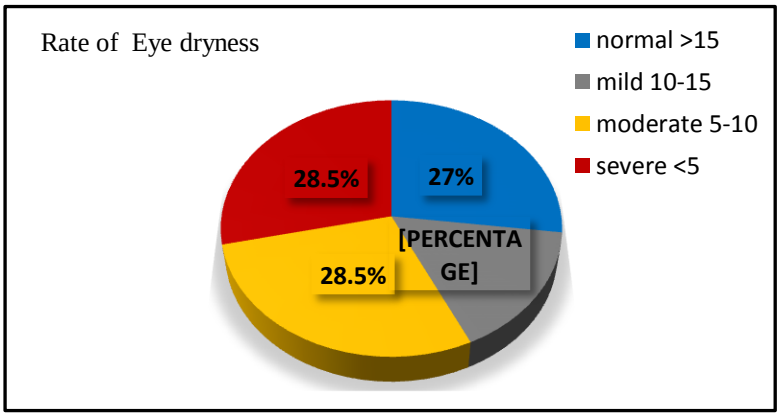


**Figure 2: Percentage graph of students with normal and abnormal eye dryness.**

**3-3- Different ways using smartphone devices: -**

Figures 3-5 illustrate the information taken from students about the different methods of using smartphones by the questionnaire form. Figure 3 shows that 82% of students use a smartphone in a light room and 18% of students use a smartphone in a dark room. Figure 4 shows that 74% of students use smartphones over 4 hours daily and 31% of students use smartphones for study. Figure 5 shows that 40% of students use glasses for smartphones, 12% of students use night-vision mode for smartphones and 11% of students use the blue filter on their smartphone.

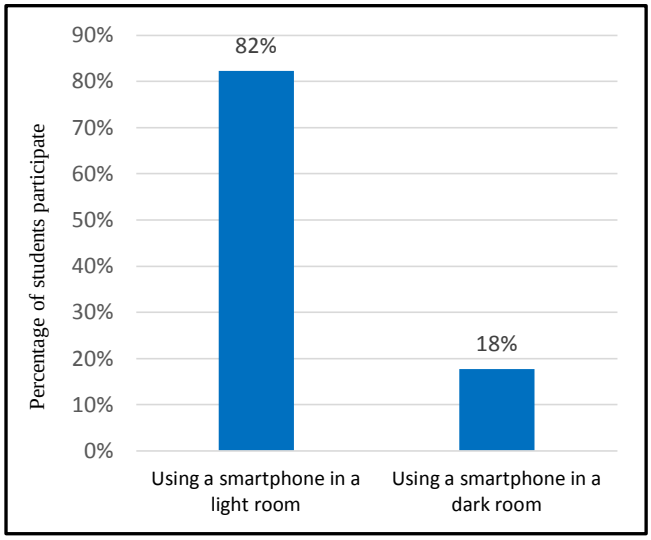


**Figure 3: Percentage of students using a smartphone in light and darkroom.**

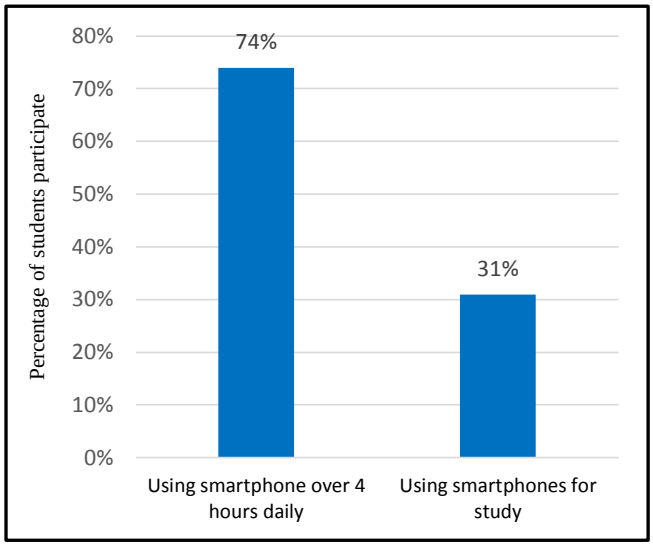


**Figure 4: Percentage time spent daily of students using a smartphone in general and especially for studying.**

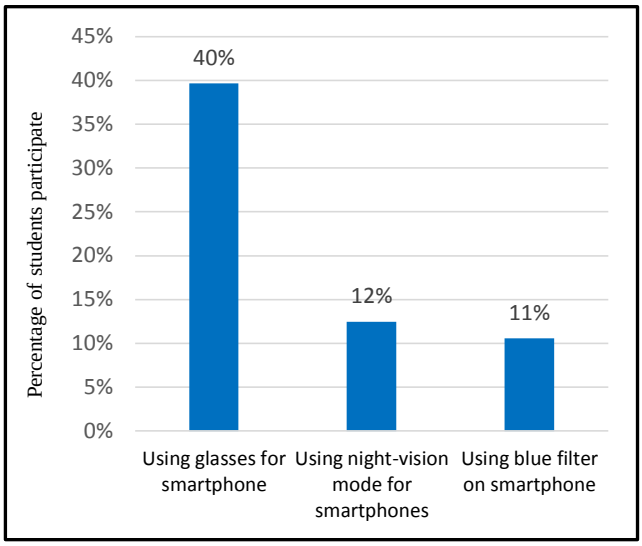


**Figure 5: Percentage of students who use glasses for smartphones, use night vision mode, and use the blue filter on the smartphone.**

**4- Discussion:**

In a recent study, smartphone use was connected to a variety of eye-related problems. Ocular health problems caused by smartphone use are becoming more prevalent as the devices become more commonplace in daily life(Moon et al., 2014, Kim et al., 2016, Nuhel, 2021). Using a smartphone can cause vision problems, eye dryness, and a variety of other side effects, which is why our research focused on these issues.

Figure 1 depicts that the 18 years old students have a higher number of eye defects than the 22 years old. This may be due to the growth of awareness and control over the use of smartphones and the organization of study matters and aspects of life.

As shown in figure 5 few percent of students use night mode, blue filter, and when they focus too much on smartphones thus increasing the possibility of retinal damage. Figure 3, noted that most students use a mobile phone in light room, which is good. However, a small percentage of them use it in dark rooms, and this is not good for the eye because the eye pupil (lens) expands in dark conditions, allowing more

light radiation to enter the eye and incident on the retina, which means an increase in the risk of eye damage. It's possible that excessive use of smartphones will permanently alter the lens of the eye and cause long-term vision problems like myopia, hyperopia, and astigmatism due to the lens' inability to adapt to changes in the eye's focus. Because blue light is so close to ultraviolet

rays in the solar spectrum that it is harmful to live cells, it is well-known that smartphone screens emit this light (Walsh, 2009, Zwinkels, 2015, Kozlowski, 2020). It's important to stress the importance of using a blue light filter, the night mode, and glasses when using smartphones for extended periods of time (more than two hours). Figure 4 notes that most students use smartphones for more than 4 hours daily. This negatively affects the health of their eyes. The majority of students spend more than two hours a day on their phones browsing the Internet, which has a negative impact on their academic performance(Atas and Çelik, 2019, Fook et al., 2021).

Ocular symptoms like blurry vision, redness, visual disturbance, inflammation, and lacrimation may have been exacerbated by exposure to smartphones, Biologically, the impacts of cellphones on ocular symptoms may be described by two types of electromagnetic fields (EMFs); extremely low-frequency EMFs and radiofrequency (RF) electromagnetic radiation (EMR) (Kim et al., 2016). With a specific absorption rate of 4 W/kg, cell phone radiation is quite modest in intensity(Hardell and Sage, 2008). However, it has been reported that adverse effects, such as DNA damage and thickening of the cornea, occur even at a specific absorption rate lower than 4 W/kg (Akar et al., 2013). Therefore, we see that most cases of students' vision problems appear as astigmatism and dry eyes, as shown in Table 1, and their impact is greater because the majority of students use smartphones for more than 4 hours per day.

Moreover, it has been shown that the local specific absorption rate is higher in tissues at a younger age, which could explain the higher susceptibility of adolescents to smartphones(Leitgeb, 2008). In addition, studies confirm that viewing computer and smartphone screens at close distances less than 40 cm from the eye, leads to distance visual acuity and refractive error changes (Ciuffreda and Vasudevan, 2008, Kim et al., 2012) and thus increases the impact of the intensity of emitted light and blue light on the components of the eye and retina, which leads to vision defects(Ivanov et al., 2018). This is one of the reasons for the spread of vision defects among students, as we see from Figure 5 a few percent of them use the night mode and blue light filter, with their use of smartphones for long periods of time to browse the net and other programs, as well as study and review, which require more focus of the eye on the screen of smartphones.

Schirmer test result: The result shows that 27% of students have normal eye dryness 16% of students have mild eye dryness and 28.5% have moderate eye dryness and student have severe eye dryness which is 28.5% as shown in figure 2. The reason for eye dryness and even vision problems may return to excessive time spent staring at mobile devices reduces the amount of blinking that occurs, which in turn reduces the amount of moisture that the eyes are able to absorb from tears. A person blinks about 900 to 1200 times per hour on average, which is why blinking is so crucial(Argilés et al., 2015). If you don't blink for a long period of time, you'll be more susceptible to eye infections, dry eyes, and blurry vision. Most importantly, blinking helps to remove any debris from your eyeball and flush out the fresh tears that have been produced. Your retina receives a clearer and brighter image thanks to the coating of tears on your eyeballs. Blinking also provides oxygen and nutrients to the eye, ensuring that it remains healthy and comfortable for as long as possible(Balci et al., 2007).

Irritation, burning, and dryness are common dry eye symptoms in a person who is dealing with visual display terminal (VDT) screens (Rosenfield, 2011). Despite normal lacrimal function, VDT workers had a short tear break-up time and increased corneal fluorescence staining, according to Uchino and colleagues (Uchino et al., 2013). Therefore, the excessive tear evaporation generated by extended blinking intervals when staring is thought to be a reason for a dry eye(Tsubota and Nakamori, 1995, Cardona et al., 2011). Cohi and his colleagues noticed weariness, burning, and dryness symptoms after spending more than 4 hours in front of a computer screen, whereas those who used cellphones had

much greater exhaustion, burning, and dryness (Choi et al., 2018). Blink intervals vary from person to person, but healthy people blink roughly 20 times per minute on average. In general, during VDT (smartphones) operation and various reading settings, the blink rate is greatly lower(Hirota et al., 2013, Argilés et al., 2015).

The watching distance has a key role to reduce the eyes problems, The preferred distance for watching the smartphone is 36.2 cm (Bababekova et al., 2011). So, the eye makes an effort to continuously adapt without blinking for a long time when focusing on the smartphone screen (Kim et al., 2017). Therefore, we must avoid smartphone overuse at a close reading distance because it may lead to abnormalities in accommodation and can lead to esotropia in adolescents(Lee et al., 2016b).

The radiation from LCD and LED screens contains a big amount of blue light that is harmful to the retina, it causes an increase in reactive oxygen species (ROS) production and damages photoreceptors and retinal pigment epithelial cells(Lee et al., 2016a). Therefore, conclusion that the overuse of smartphones reduces the lifespan of cells and increases the appearance of ROS (Lee et al., 2014).

Finally: from figures 3-5, it is noted that the health conditions for using the smartphone are not observed, especially since some of the students use it for study and review. Therefore, it is recommended to pay attention to the culture of health for the use of the smartphone by taking advantage of the operation of the night mode and blue light filters, as well as the use of glasses assigned to the smartphone, taking into account the use of smartphones in bright rooms and not looking at the smartphone screens continuously for long periods of time, but rather giving them time to rest.

## 5- Conclusions

This study shows that exposure to radiation emitted from screens of mobile devices such as smartphones and laptops increases the risk of eye dryness, emmetropia, particularly astigmatism, and even permanent eye damage. To put it simply, this study provides yet another reason to limit our time spent staring at screens, even if the user is not at risk of developing degenerative eye conditions. For this reason, long-term smartphone users should wear blue-light or UV filtering eyewear. Finally, I'm aiming to promote awareness of the health culture of using smartphones among students.

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