

# A cross-sectional study on the use of near-visual display devices in the Middle-Eastern children population

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<b>Access this article online</b>
Quick Response Code:

<b>Website:</b> www.saudijophthalmol.org
<b>DOI:</b> 10.4103/1319-4534.337850

## Abstract:

**PURPOSE:** The objective of the study is to highlight the demographics, awareness of hazards, ocular symptoms, and healthy practices associated with the use of near-visual display devices (NVDD) in the Middle-Eastern children population.

**METHODS:** Two hundred and sixty participants aged 4–16 years responded to a questionnaire on demographic aspects, symptoms, awareness of hazards, and healthy practices associated with the use of NVDD.

**RESULTS:** Daily use, prolonged viewing (for 3 h or more), and the use of multiple NVDD (2 or more) were seen in the majority (79.6%, 90%, and 71.5%, respectively). Smartphones, tablets, and iPads were the most used devices. Symptoms were present in 92.3%. The association between appearance of symptoms and duration of exposure to the digital screen was statistically significant ( $P < 0.00001$ ). Symptoms were itching (40.0%), watery eyes (31.0%), burning sensation (24.0%), headache (22.0%), excessive blinking (20.0%), dry eyes (20.0%), foreign body sensation (10.0%), redness (10.0%), eye or periorbital pain (8.0%), blurry vision (5.0%), and photophobia (3.0%). A low minority (9.2%) were aware of the harmful effects of prolonged use of NVDD and the protective measures against it; schools were not involved in educating students about the proper use of these devices. Sixty percent attended periodic eye checkup, 20.0% set time limit, 6.9% properly adjusted screen brightness, and 15.0% practiced outdoor play daily.

**CONCLUSION:** Majority of the children (90%) were symptomatic when used NVDD excessively. Children are generally uneducated about healthy practices to prevent these symptoms. Spreading awareness among children and parents is important.

## Keywords:

Children, Middle-Eastern children population, near-visual display devices, ocular symptoms

## INTRODUCTION

The worldwide increase in the use of near-visual display devices (NVDDs) by children is alarmingly bringing with it a multitude of health problems. These devices nowadays are an important tool of education, with many schools becoming increasingly high tech. While digitalization of education enhances learning, this is happening at the expense of the mental, psychological, and physical health of the students. Many children also spend hours on social media or digitalized entertainment. Computer vision syndrome (CVS) or digital

eye strain is a mantra of our time. It refers to a complex of eye and vision problems that are experienced during and are related to computer use which stresses the near-vision.<sup>[1]</sup>

Eye health is an important mainstay in the healthy development of children and is often neglected by a number of parents, caregivers, and educators. Measures that are important in protecting eye health are exhaustively discussed by eye care providers and researchers and the guidelines are suggested by many.<sup>[2-5]</sup> CVS affects a large number of young users because these protective measures and healthy ergonomic principles are not observed by children or their parents. This may stem from lack of knowledge

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**How to cite this article:** Maher TN, Khan MI, Azzam N. A cross-sectional study on the use of near-visual display devices in the Middle-Eastern children population. Saudi J Ophthalmol 2021;35:102-7.

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Submitted: 11-Oct-2018

Revised: 15-Jul-2020

Accepted: 07-Dec-2020

Published: 18-Feb-2022

about such measures. This study aimed at detecting the incidence of ocular symptoms resulting from the use of NVDD by children and assessing whether children were aware of the adverse effects of the digital screen on the eye and of ways to reduce them. We also investigated the extent to which protective measures were practiced. We believe that this is the first study that discusses the problem in the very young users through adolescence in the Middle-Eastern children population. We hope to motivate public health professionals and ophthalmologists to spread awareness of health hazards of the digital screen and ways to mitigate them starting from preschool level to help the community embrace a wise attitude toward the use of technology.

## METHODS

A cross-sectional questionnaire-based study included 260 children between the age of 4 and 16 years attending an ophthalmology department in three different facilities; one governmental hospital and two independent ophthalmic healthcare providers in the United Arab Emirates between December 2016 and May 2018. The study was conducted in compliance with good clinical practices applicable to local regulations and the Declaration of Helsinki. Exclusion criteria were age below 4 years or above 16 years, current eye problems other than refractive errors, contact lens use, and current use of topical and/or systemic medications, especially for chronic allergic conjunctivitis.

The age when the child started to use the device was recorded, and the participants or parents of the very young participants were asked to answer four sets of questions:

1. The first set was about the type(s) of NVDDs used (other than television), whether the child owned a device, the pattern, and the duration of use per day
2. The second set of questions aimed at detecting the presence of ocular symptoms that were possibly related to the use of NVDDs. The participants were asked if they had any of the following symptoms: burning sensation, itching, foreign body sensation, watery eyes, dry eyes, red eyes, excessive blinking, tendency to avoid light, blurring of vision during or after the use of the device, double vision, eye/periorbital pain, and headache
3. The third part looked at whether the participants were aware of the possible harmful effects of the NVDD on the eye. If the response was positive, they were asked to name them. They were also asked if they have ever been educated at school about the hazards of electronic devices, ways of eye protection, and if they have browsed the Internet for the same
4. The fourth part asked if measures of reducing these harmful effects were implemented as a routine: the distance between the eye and the device, the distance between the eye and the air conditioner, adjusting the brightness of the device according to the level of ambient light, proper positioning of the screen, changing font size when needed, limiting exposure time to the digital

screen, applying the 20/20/20 rule or taking frequent breaks, voluntary blinking, body posture adjustment, use of appropriate wearable or screen filters, periodic eye checkup and spending time outdoor, or practicing physical activities as a daily routine.

## Statistical analysis

Microsoft Excel 2007 was used for statistical analysis. Chi-square test of independence was performed to examine the relationship between the presence of the symptoms and the duration of use of the devices.

## RESULTS

### Demographic aspects and pattern of use

Out of 260 participants, 175 (67.3%) were girls and 85 (32.7%) were boys. They were preschoolers ( $n = 70$ , 26.923%), elementary school students ( $n = 102$ , 39.230%), and secondary school students ( $n = 88$ , 33.846%). The mean age was  $10.492 \pm 2.996$  years. One hundred and forty children (53.8%) started using NVDD before the age of 3 years, of whom 95 (36.5% of total number) started around the age of 2 years. Figure 1 shows the percentage of users of one or more device(s).

Figure 2 shows the percentage of children who used electronic device(s) daily against those who used them only on the weekends.

The duration of use is shown in Figure 3 where the data were divided into three groups. All participants increased the duration of their use during the weekend or holidays.

Smartphones, tablets, and iPads were very popular, whereas desktop, laptop computers, game consoles, E-readers, or kindles were less popular. Figure 4 plots the percentage of the commonly used devices.

Ownership of the device was high for smartphones with 182 children (70.0%) possessing one, 141 (54.2%) owned an iPad or a tablet, 27 (10.4%) owned a laptop, and 20 (7.7%) owned an E-reader or a kindle.

### Symptoms

Ocular symptoms were reported by 234 (90%) children who used the devices for 3 h or more (considered excessive) as compared to 6 (2.3%) of those who used the devices for <3 h. Overall, a total of 240 (92.3%) were symptomatic. The

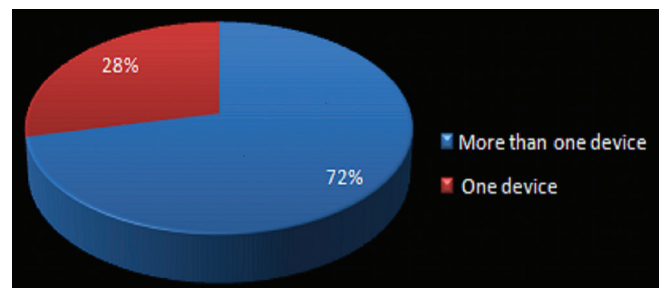


Figure 1: Percentage of users of one or more device(s)

frequency of symptoms encountered is shown in Figure 5. Itching was seen in the majority, while blurring of vision and photophobia occurred in a minority.

Double vision was not reported by any of the participants.

The relationship between the presence of symptoms and duration of exposure to the digital screen was statistically significant at  $P < 0.05$ ,  $\chi^2 (1, N = 260) = 181.75, P < 0.00001$ .

**Awareness of the hazards of near-visual display devices**

Ninety-three participants (35.8%) responded positively to being aware of NVDD hazards and the measures taken to reduce them, but only 24 (9.2%) could actually name some of these hazards. Two hundred and sixty (100%) got no education from school on the excessive use of NVDD, and no child or parent went online to search for the hazards.

**Healthy practices and ergonomics**

One hundred and fifty-six children (60.0%) attended periodic eye checkup. Wearable and/or screen filters were used by 99 (38.1%) children. Fifty-two users (20.0%) set a time limit (themselves or their parents), but only half of them were disciplined. Forty-five children (17.3%) adjusted the brightness of the screen according to the level of ambient light; the majority of whom were older children (14–16 years). Out of these 45 users, 27 (10.4% of total) increased (rather than decreased) the brightness of the screen when the room light was dim. Thus, only 18 children (6.9% of total) did the right thing about this point. As a daily routine, 39 children (15.0%) practiced physical activities or spent time outdoor without using NVDD. None considered the distance between the eye and the NVDD or between the eye and the air conditioner. Adjusting body posture, screen positioning, and changing font size were all ignored by our participants. None practiced

taking frequent breaks or voluntary blinking. None applied the 20/20/20 rule and all participants were unaware of it.

**DISCUSSION**

**Demographic aspects and pattern of use**

A growing pattern of early ownership and usage of electronic devices is seen in different countries all over the world. Studies from Australia, the UK, the USA, and EU countries confirm such pattern.<sup>[6-9]</sup>

The results of our study show that more than half of the children started using an electronic device before the age of 3 years. The use of smartphones was universal and ownership of a smartphone, tablet, or an iPad was high. Prolonged viewing for 3 h or more per day, daily use, and using more than one device were seen in the majority (90.0%, 79.6%, and 71.5%, respectively) [Figures 1-3]. The popular use of smartphones, tablets, and iPads greatly contributes to the high incidence of symptoms as these devices are usually held close to the eye.

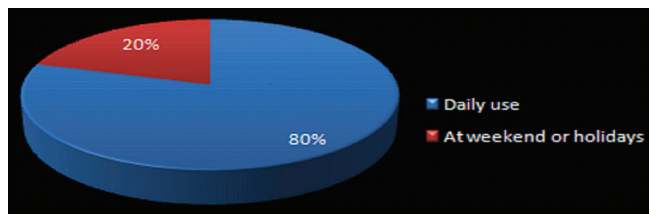


Figure 2: Percentage of the frequency of the use of electronic devices

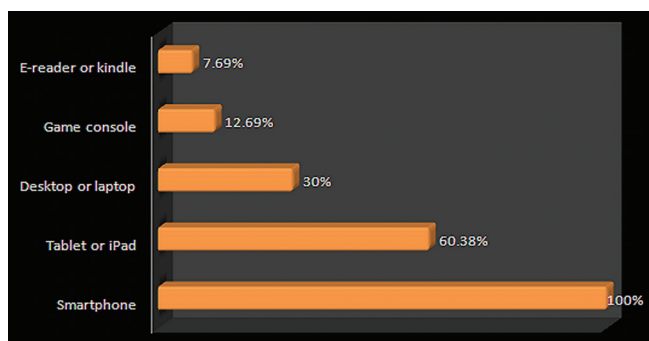


Figure 4: Percentage of commonly used devices by participants of the study

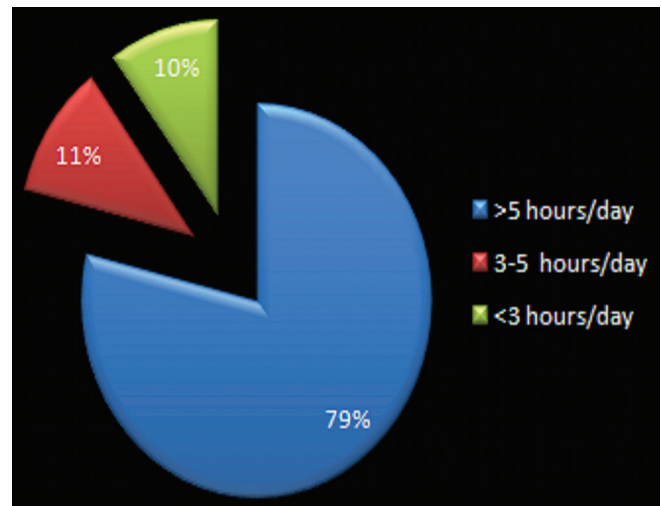


Figure 3: The duration of exposure to the digital screen per day

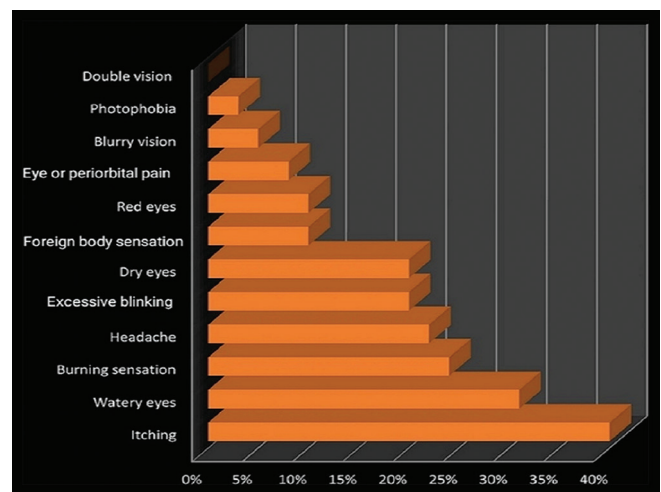


Figure 5: Type and frequency of symptoms encountered in the study sample

This, in turn, results in increased accommodation and vergence. In addition, the angle of gaze may be uncomfortable to the eye and spine. These devices may also be a source of significant screen glare and blue light.<sup>[10,11]</sup>

### Symptoms

The occurrence of ocular symptoms was high in our study; overall, 92.3% were symptomatic. The majority of the children who were exposed to the digital screen for 3 h or more (90%) suffered ocular symptoms, and the association between the two variables was statistically significant. Our results agree with the findings of Kim *et al.*, who studied ocular health in adolescents using smartphones and found higher odds of multiple ocular symptoms when smartphones were used excessively regardless of whether this was intermittent or persistent.<sup>[12]</sup> Our study population showed a higher incidence of subjective complaints (92.3%) compared to the results of Bogdănici *et al.*, who reported that 43.3% of their population did not have symptoms of CVS. They diagnosed blurred vision in 33.3% of their study sample by clinical examination, while only 5.0% of ours reported it.<sup>[13]</sup>

Symptoms reflecting eye strain were major encounters in our population. Itching, watery eyes, burning, excessive blinking, feeling of dryness in the eyes, foreign body sensation, red eyes, ocular or periorbital pain, blurry vision while watching the digital screen, and photophobia or tendency to avoid light were all seen in our participants. This finding is consistent with what was reported in digital screen users of different age groups studied by different researchers.<sup>[10-18]</sup>

Headache, excessive blinking, and ocular or periorbital pain were present in 22.0%, 20.0%, and 8.0% of our participants, respectively. These symptoms may be caused by uncorrected eye problems, especially undetected or improperly corrected refractive errors in addition to the possibility of a musculoskeletal origin of headache. These symptoms are commonly seen in adult computer users; some researchers report an incidence as high as 82.1%.<sup>[19-23]</sup>

As compared to other studies in the young population, our children had a lower incidence of headache. Bogdănici *et al.* reported it in 30% of their study sample.<sup>[13]</sup> Eye pain was present in 40.2% and headache in 50.5% of 11–18-year-old computer users, which is studied by Khalaj *et al.*, and there was an association between the duration of use and the frequency of occurrence of eye strain.<sup>[20]</sup>

Excessive blinking in our participants was also lower (20.0%) than what is reported by Bogdănici *et al.* (30.0%).<sup>[13]</sup> However, when we reviewed the literature, we did not come across scholarly articles that described CVS in children as young as those included in our study.

Double vision as a manifestation of CVS was reported by some researchers, but we did not encounter it in our participants.<sup>[5,21-23]</sup>

In our study, using NVDD for 3 h or more was associated with a 90% occurrence of symptoms. A high incidence of symptoms

in children and adolescents was linked to the duration of exposure to the digital screen.<sup>[13,19,24]</sup> Horgen *et al.* reported that digital screens affect about 90% of those who use them for >3 h a day.<sup>[25]</sup>

Evidence-based recommendations regarding the safe duration of exposure to NVDD to prevent CVS in children are still awaited. In October 2016, the American Academy of Pediatrics introduced new evidence-based guidelines for screen time for children. For those aged 2–5 years, parents are advised to limit screen use to 1 h/day of high-quality programming each day monitoring the content and context.<sup>[26]</sup> However, these recommendations are based mostly on research about obesity from sedentary media and thus may not be relevant to eye health.

### Awareness of hazards of near visual display devices

A very low minority of this study sample (9.2%) knew about NVDD hazards and measures of reducing them and schools had no role in educating students about this issue. Our study also showed that none of participating parents was concerned enough to educate themselves about the problem. In this, we agree with the results of a survey conducted by the Vision Council in 2012 which concluded that eye consequences of children exposure to the digital screen were not a big worry for the majority of parents.<sup>[27]</sup> When parents are unconcerned, the young users will likely be negligent.

### Healthy practices and ergonomics

Proper ergonomics for digital screen use were not widely practiced by our study sample as were other healthy lifestyle measures that help the healthy development of vision in children. CVS may originate from improper lighting, glare on the digital screen, improper viewing distances and angles, poor seating posture, uncorrected vision problems, or a combination of these factors.<sup>[2-5]</sup>

Other factors contributing to CVS are text size, accommodation and convergence, blink rate, and the blue light emitted by the device.<sup>[12,28-30]</sup> Working together, these factors put an increased burden on the visual system. Measures to reduce this burden are, therefore, essential for the well-being of the eye and the visual system.

In our study, 156 children (60.0%) attended periodic eye checkup. Eighty-five percent of them were from those who consulted in the governmental hospital or those who had health insurance coverage. The presence of uncorrected or undercorrected vision problems, especially refractive errors and phorias, may heavily weigh on the comfort of the screen user. If a regular checkup within a comprehensive eye examination is not freely available to all children, many eye problems will be missed and their presence will add to the magnitude of the problem of digital eye strain. Since children usually fail to report symptoms, regular checkup becomes essential to detect hidden problems.

Measures toward glare reduction were not practiced by the majority of users. Only 18 children (6.9%) reduced the device

brightness when the ambient light was dim and vice versa. Filters were used by 38.1% of the participants in the form of screen filters or wearable ones. We did not ask them to specify if it was an antireflective or a blue light filter. Glare can be a source of discomfort in the absence of adjustment of room lighting, screen positioning, and user positioning. In addition to glare, modern electronic devices emit substantial amount of blue light which ranges in wavelength between 400 and 490 nm.<sup>[31]</sup> We now have accumulating experimental evidence that prolonged blue light exposure negatively impacts the retina, leading to toxic apoptosis of the RPE cells which may end up in macular degeneration.<sup>[31-33]</sup> The loss of cell viability was found by Arnault *et al.* to be maximal for wavelengths from 415 to 455 nm.<sup>[34]</sup>

Clearly, this emission is within the range of blue light coming from the digital screens, especially smartphones and tablets. Because of the transparency of their crystalline lens, children may be particularly susceptible to blue light damage.<sup>[31]</sup>

The use of filters to block blue light is recommended by many researchers.<sup>[19,35,36]</sup> Cheng *et al.* found that these filters improve the comfort of computer users suffering from dry eye.<sup>[36]</sup> However, in his detailed review of CVS, Rosenfield asks for more supportive evidence of the real efficacy of these filters.<sup>[11]</sup> The majority of children studied by Khalaj *et al.* (87.2%) did not use computer shields and 42.9% of those who used them did not find them of great help in reducing symptoms. In the same study, 41.9% of those who wore protective glasses reported that eyeglasses were not completely effective in alleviating eye strain symptoms.<sup>[20]</sup>

Only 10.0% of our participants (or their parents) strictly monitored the time of use of the device. Children generally have limited self-awareness which makes it hard for them to stick to a defined duration on the screen. If parents themselves do not monitor their children's exposure to the digital screen, the latter is very unlikely to be disciplined.

Thirty-nine of our participants (15.0%) spent time outdoor without using NVDD as a daily routine. In general, our population is not much involved in outdoor sport activities, and this is especially true for females. This reflects an unhealthy attitude toward protecting the eye from myopia. Daily outdoor activity was found to halt the development and progression of myopia in primary school and teenage children.<sup>[37-39]</sup>

All the other protective measures were neglected by our young users reflecting failure to implement healthy practices.

None of our participants considered the distance between the eye and the device. Asthenopia is likely to occur if this distance is much shortened which is the case with all small digital devices such as smartphones and tablets, the use of which tops the list in younger users. The ideal viewing distance from the screen in adults has been suggested to be about 50–70 cm where accommodation and vergence are at physiological resting state.<sup>[5]</sup> However, in their Joint Position Statement, the Canadian Association of Optometrists and

the Canadian Ophthalmological Society advised against automatically conferring adult guidelines for safe use of electronics to children because children's visual and physical systems are different and are still developing and because children use screens differently and for different tasks.<sup>[40]</sup> Shantakumari *et al.* found high incidence of dry/tired/sore eyes in students who viewed the screen at a distance < 50 cm, not using screen filters, and working for longer duration on computer and the complaints decreased as the viewing distance increased.<sup>[24]</sup>

The distance between the eye and the air conditioner is also important to adjust since dryness is associated with shorter distance between the two. This point was also neglected by all of our users although air conditioners are widely used over a long hot season in this part of the world. None of our participants practiced taking frequent breaks or voluntary blinking. None applied the 20/20/20 rule, and all respondent children and parents were unaware of it. No adjustment of any of the following was practiced by our participants: Font size, body posture, and screen positioning which affect the angle of gaze and the glare from the screen. Comparing our findings to what was reported by other researchers, our participants showed lower compliance with and less awareness of healthy ergonomics than older children participating in other studies.<sup>[14,18,20,24]</sup>

## CONCLUSION

Children and adolescents in the UAE have easy access to electronic devices since early childhood and spend hours watching the digital screen which leads to a high occurrence of symptoms of CVS. Although today's learning largely incorporates digital technology, education about proper measures to reduce the strain on the eye does not parallel the extensive use of this technology and schools fail to educate students about healthy use of technology.

## Recommendation

Awareness campaigns of the harmful effects of electronic devices on the eyes and body and ways to prevent them should be instituted in school; media and concerned scientific organizations should step in. Schools bear the responsibility to ensure that students stay active and have access to outdoor play. Parents should make sure that their children do not overuse NVDD and that technology is not unnecessarily harmful. A comprehensive eye examination should be freely available to children before starting school and whenever is required.

## Acknowledgment

The authors are grateful to Mrs. Asmaa Mahir for providing technical support, statistical help, and preparing the manuscript.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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