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Computer Vision Syndrome in Eleven to Eighteen-Year-Old Students in Qazvin

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Background: Prolonged use of computers can lead to complications such as eye strain, eye and head aches, double and blurred vision, tired eyes, irritation, burning and itching eyes, eye redness, light sensitivity, dry eyes, muscle strains, and other problems.
Objectives: The aim of the present study was to evaluate visual problems and major symptoms, and their associations among computer users, aged between 11 and 18 years old, residing in the Qazvin city of Iran, during year 2010.
Patients and Methods: This cross-sectional study was done on 642 secondary to pre university students who had referred to the eye clinic of Buali hospital of Qazvin during year 2013. A questionnaire consisting of demographic information and 26 questions on visual effects of the computer was used to gather information. Participants answered all questions and then underwent complete eye examinations and in some cases cycloplegic refraction. Visual acuity (VA) was measured with a logMAR in six meters. Refraction errors were determined using an auto refractometer (Potece and Heine retinoscope). The collected data was then analyzed using the SPSS statistical software.
Results: The results of this study indicated that 63.86% of the subjects had refractive errors. Refractive errors were significantly different in children of different genders ($P < 0.05$). The most common complaints associated with the continuous use of computers were eyestrain, eye pain, eye redness, headache, and blurred vision. The most prevalent (81.8%) eye-related problem in computer users was eyestrain and the least prevalent was dry eyes (7.84%). In order to reduce computer related problems 54.2% of the participants suggested taking enough rest, 37.9% recommended use of computers only for necessary tasks, while 24.4% and 19.1% suggested the use of monitor shields and proper working distance, respectively.
Conclusions: Our findings revealed that using computers for prolonged periods of time can lead to eye-related problems such as eyestrain, headaches, weak and tired eyes, blurred and double vision, weak vision, burning itching and watery eyes, etc. To correct and reduce these problems the following precautions may be helpful, using computer shields (anti-reflex glasses), proper computer workplace illumination, enough rest after working with computers, appropriate viewing distances during computer work, placing computers far from bright objects and adjusting a line of vision with the top of the monitor.

Keywords: Computer; Eye; Students

1. Background

Computers are one of the most advanced technologies and have become a part of everyday life in many workplaces. It is believed that the majority of computer users experience some eye or vision symptoms as a result of computer use (1). It has been estimated that from 23% to 90% of computer users who work several hours on the computer have complaints of visual symptoms (2-4). The most common visual symptoms among people who use computers for prolonged periods and steadily are eyestrain, dry eyes, tired eyes, eye pain, redness, irritation, eye fatigue, color perception change, light sensitivity, decrease visual deficiency, and headaches (5-7). Uncorrected vision problems, such as farsightedness and astigmatism, can be major contributing factors to computer-related eyestrain (8). Headaches are caused by excessive adaptation of the lens and strain on the eye muscles while working on the computer for a long time and people usually refer to health centers because they can not tolerate the great pain in their temples, eyes, and eye sockets (9). Moreover many visual discomforts such as, burning eyes, eye stress, asthenopia, blurred distance and/or near vision, weak vision, slow refocusing and photophobia, are experienced by many individuals who work with computers (10, 11).

A national survey of optometrists found that more than 14% of their patients had eye-related problems resulting

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from computer work (12). Children who spend prolonged periods of times on computers, may have the same problems as adults, but the way they use computers can make them more susceptible to these problems (5). In the U.S, 54 million children are computer users, 25 to 30% of whom have developed eye-related problems and have to wear eye glasses for better vision and computer use (13). Work on computers can range from five minutes to eight hours or more than a day depending on the types of jobs people have (14). These problems can result from poor lighting, glare, an improper work place, vision problems or a combination of these factors (15-17). There are several types of contributing factors for Computer Vision Syndrome (CVS) i.e. computer screens, computer environments, human eyes, computer users, and computer tasks (18). Blinking plays an important role in maintaining the integrity of the ocular surface, and the occurrence of dry eye symptoms can be associated with decreased blink rate (19). A reduced blinking rate contributes to a poor tear film quality and temporarily stresses the cornea, and may lead in symptoms of dry eye that can be easily managed by applying lubricating eye drops or artificial tears (20, 21). The mean ± SD rate of blinking was 22 ± 9 per minute under relaxed conditions, while blink rate decreased to as low as 7 ± 7 blinks/minute for people working at a video display terminal (22).

One of the most significant environmental factors affecting computer work is lighting. The brightness of the computer screen and the surrounding room should be imbalanced. Screen brightness and contrast should be adjusted to provide a balance with room lighting and maximum visibility. Bright lights, windows and overhead fluorescent lights and desk lamps often contribute to a glare that provides discomfort. The lighting levels of a workplace are recommended to be between 200 and 700 lux. Light intensity should be different for different age groups; workers over 50 years of age tend to require twice the light levels of young adults to perform the same task (23).

The other significant environmental factor is the distance from the eyes to the computer screen. The viewing distance to the computer screen is generally about 20 to 28 inches and using special glasses can reduce computer vision syndromes (24). Working on computers can range in duration from five minutes to eight hours or more a day among users, depending on the type of job they hold (25). Many individuals experience eye discomfort and vision problems when viewing a computer screen for two or more continuous hours a day (26). It has been reported that computer screens can affect an estimated 90% of workers using computers for more than three hours a day (26).

2. Objectives

There is extensive research about computer vision syndromes among users of different age groups, including both office workers and those who work in other environments. Children and students have greater access to computers either at home or at school. It is believed that children are at risk of developing early vision syndromes when using computers for long periods. There are a few researches about children on CVS. The aim of the present study was to determine the prevalence of computer vision syndrome in adolescents and teenagers aged between 11 and 18 year, who spent extensive time on computers every day, residing in Qazvin city during year 2013.

3. Patients and Methods

This cross-sectional study was done on secondary to pre university students aged 11 to 18 years. All 642 participants who had referred to the eye clinic of Buali hospital were selected and those with visual defects were studied.

A questionnaire consisting of two sections was prepared based on previous studies. Section one included demographic questions on age, gender and education. Section two included 26 questions on the time and the duration of exposure to computers and eye-related problems. The participants were also asked to suggest ways to reduce vision problems. Face and content validity of the questionnaire was established by five faculty members of Qazvin University of Medical Sciences. As usual, eye examinations included visual acuity measurements, ocular motility evaluation, anterior segment and eyeball movements, fundus examinations, retinoscopy and in some cases cycloplegic retinoscopy with 1% cyclopentolate. Visual acuity measurements were used to assess the extent to which vision may be affected (2).

To measure the consistency of the instrument, the questionnaire was completed two times by the same students (20 pre university students) with an interval of two weeks. Spearman's correlation coefficient was used according to which a strong correlation was found among questions (0.7). Data extraction was done through the SPSS software and data analysis was done using descriptive analytical statistics.

4. Results

Overall, 642 patients including 387 males (60.3%) and 255 females (39.7%) were examined. The age range was between 11 and 18 years with a mean age of 15.83 ± 1.78 years. In total, 155 patients were pre university students (24.1%).

Amongst all subjects 63.86% had refractive errors. Of these, 53.17% had myopia, 9.76% hyperopia and 37.07% astigmatism (≥ ± 0.75). Figure 1 shows the prevalence of refractive errors in children of the two genders.

In total, 53.9% of subjects wore eyeglasses. Of these, 54.63% used white glasses and 45.37% used of photochromic or anti-reflex glasses. Furthermore, 41.95% reported that eyeglasses were not completely effective in alleviating symptoms and 39.5% believed eyeglasses were more effective in alleviating symptoms. Regarding period of computer use, 46% of the students had been using com-

puters for more than two years and 5.9% had become users for less than six months. Overall, 6.54% of the participants used computers for less than one hour per day, 23.36% used computers for one to two hours, 31.46% between two and four hours per day, and 38.63% more than four hours per day. Furthermore, 45.79% of users preferred using computers more at night, 40.19% in the evening and 24.92% in the morning. Regarding computer use at different times of the day, 61.37% believed that using computers in the morning is better than other times whereas 36.14% preferred use late at night. Moreover, 38.8% reported fewer problems in the morning and 38.5% mentioned minor behavioral changes caused by prolonged computer use.

Regarding rest after computer use, 9.66% after one hour of work had 15 minutes of rest, while 14.6% had rest after two hours, 11.2% after four hours and 64.49% used computers with no rest. Overall, 64.3% believed that lack of enough rest was the main reason for eye discomfort and headache. Finally, 87.2% did not use computer shields while 42.9% who used them claimed that shields could reduce symptoms to a great extend.

Table 1 shows the duration of exposure to computers and the time spent on them every day, based on the presence or absence of refractive errors. There was no significant difference between the two groups regarding duration of exposure to computers ($P > 0.05$) while there was a significant difference between the two groups regarding time spent per day ($P < 0.05$).

The most prevalent (81.9%) eye-related problem in computer users was eyestrain while the least prevalent was dry eyes (7.8%) (Figure 2).

Overall, 51.43% of the subjects reported feeling of tiredness between one and four hours, while 29.52% reported fatigue after four hours of steady work at computers.

The distance between the monitor and the eyes in 71% of users was 12 to 16 inches and in 22.74% this was between 16 and 24 inches while for the rest of the subjects this distance was 24 to 32 inches. Regarding activities on computers, 58.88% used computers for playing games, 38.63% for chatting, 15.58% for scientific activities and 10% for watching films. In 48.9% of cases computers were placed by the windows. In 79.75% of cases the symptoms were alleviated after taking some rest and in 2.49% no changes occurred while in 17.76% the symptoms decreased after resting for a whole day.

Regarding the position of the monitor, 63.24% sat directly opposite the monitors, 28% about 20 degrees above the monitor, and 1.57% were seated so that their face was below the monitor.

In order to reduce computer related problems, enough rest, use of computers for necessary tasks, use of monitor shields, and proper working distance were recommended by 54.2%, 37.9%, 24.4% and 19.1% of subjects, respectively.

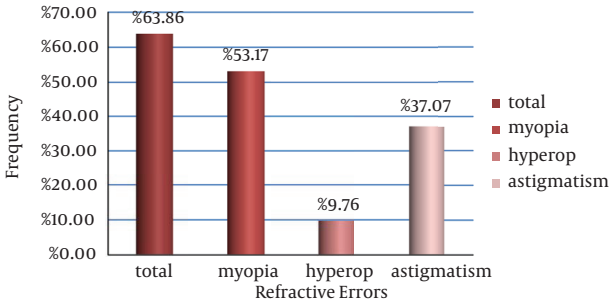

Figure 1. The Frequency of Refractive Errors Amongst Children of Different Genders

Table 1. Duration of Exposure to Computers and the Time Spent on Them Every Day Based on Refraction Errors [a]

Variable	The Presence of Refractive Errors	Lack of Refractive Errors	Significant
The duration of exposure to computers			$\chi^2 = 3.019$; df = 3; P = 0.389
Less than 6 mo	24 (5.7)	14 (6.03)	
6 - 12 mo	84 (20.5)	35 (15.1)	
1 - 2 y	122 (29.8)	68 (29.3)	
More than 2 y	180 (43.9)	115 (49.6)	
Total	410 (100.00)	232 (100.00)	
The time spent on computer every day			$\chi^2 = 8.818$; df = 3; P = 0.032
Less than 1 h	20 (4.9)	22 (9.5)	
1 - 2 h	100 (24.4)	50 (21.6)	
2 - 4 h	140 (34.1)	62 (26.7)	
More than 4 h	150 (36.6)	98 (42.2)	
Total	410 (100.00)	232 (100.00)	

[a] Data are presented as No. (%).

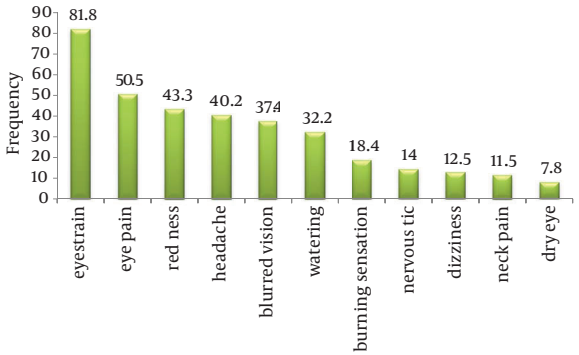

Figure 2. The Frequency of Eye-Related Problems in Computer Users

5. Discussion

Findings of the present study indicate that symptoms associated with increased use of computers in the workplace may be related to an increased number of ocular involve users. These symptoms may be caused by poor lighting, glare on the computer screen, improper viewing distances, poor seating posture, uncorrected or under-corrected vision problems and the combination of these factors.

As shown in this study, many of the visual symptoms experienced by computer users are only temporary and will decline after stopping computer use. In 81.8% the symptoms were alleviated after taking some rest and in 69.7% after resting for a whole day. In the current study computer users who worked prolonged periods at the computer had more complaints of visual symptoms, for examples, discontent of eyestrain among users who spent less than one hour at the computer was 19.05%, whereas, this increased to 29.52% for users who spent more than four hours on the computer per day.

However, some individuals may experience continued reduced visual abilities, such as blurred distance vision, even after stopping work at a computer. Prevention or reduction of vision problems associated with computer vision syndrome involves taking steps to control lighting and glare on the computer screen, establishing proper working distances and posture for computer viewing, and assuring that even minor vision problems are properly corrected (2). According to the findings, eye strain and blurred vision were the most and dry eyes the least prevalent symptoms reported by computer users, while Blehm et al. found dry eyes as the leading problem in computer vision syndrome (2). Of course the severity of symptoms depend on the type of job and age of the person. For example typists, due to prolonged use of computers, experience more eye-related symptoms (27). These problems are prevalent in developed countries such as the US where more than 100 million people use computers on a daily basis and 50% of them experience eye-related problems (28). These problems include, eye strain, headaches, eye redness, dry eyes, burning eyes, weak vision, blurred vision, eye irritation, nervous tic, double vision, photophobia, nearsightedness, eye fatigue, light or glare sensitivity, watery eyes, contact lens discomfort, changes in color perception, etc. (8, 29, 30).

Eye strain, eye stress and headaches are more prevalent in people with astigmatism (31). According to Bali et al., eye strain was the common vision complication (97.8%) (17). A study showed that monitor glare was the major problem stated by 75% of computer users that was reduced to one-third after using computer shields; the percentage of people experiencing tired eyes decreased from 86% to 40%, itching and watery eyes from 50% to 28%, dry eyes from 52% to 24% and headaches from 53% to 32% (33).

The present study indicated a prevalence of 50.5% for eye pain and 40.2% for headache among computer user. These complaints could be a result of uncorrected or under-corrected/overcorrected refractive errors or some other environment factors. A high percentage of computer users reported visual discomfort because of uncorrected or under-corrected farsightedness, astigmatism, and presbyopia or binocular vision (4, 30).

The main vision syndromes in this study were eyestrain (81.8%), eye pain (50.5%), headache (40.2%), blurred vision, (37.4%) watering (32.2%) and redness (43.3%), burning sensation (18.4%), nervous tic (14%), dizziness (12.5%) and neck pain (11.5%). These findings were different from those of Bali et al. who reported that the chief symptoms among Indiana ophthalmologists who were using computers at their hospitals/offices were eyestrain (97.8%), headache (82.1%), tiredness and burning sensation (79.1%), watering (66.4%), and redness (61.2%), shoulder pain (44.0%) and neck pain (35.8%) (17). The CVS reported by different studies might be as a result of different age groups under study. In the youngest workers such as students, the rate of eye problems was lower than older individuals, especially in people older than 40 years.

Most students did not use computer shields; 52.78% of those who used shields reported a reduction in vision problems. In contrast to this, 16.67% reported no changes in visual problems when using computer shields. Although 50% of problems were eliminated by computer shields, other methods are still needed to minimize the vision complications. A study on the effect of computer shields showed that 81% of subjects could easily read the screen, while the prevalence of tired eyes reduced from 86% to 45%, itching and watery eyes from 50% to 28%, dry eyes from 52% to 24% and headaches from 53% to 32% (34).

Headaches may still continue even after using computer shields because they are caused by prolonged focusing of eyes on monitors, excessive visual adaptation and strain on the eye muscles (35). Our study showed that 164 of cases (40.2%) experienced pain in their eyes and 324 (50.5%) had headaches. It was also found that 37.4% of computer users had blurred vision. The findings were consistent with a study done on 20,000 computer users

in Italy, in which it was found that 30% of the participants complained from blurred vision as well (36). In this study, computer users had blurred vision after one to two hours of working at the computer. Blurred vision occurs when the eyes do not focus on an image accurately due to a lack of visual acuity (37).

Eye problems were eliminated after taking a rest in most cases and in 69.7% of cases after a whole day of rest. Excessive use of computers without enough rest can lead to computer vision syndrome symptoms, and eye stresses, such as eye and headaches, eye fatigue, burning and itching eyes, watery eyes, double vision, light sensitivity, and blurred and weak vision, which are common in 50% - 88% of computer users (38). In the present study refractive errors were diagnosed in 410 (63.86%) students, 218 (53.17%) of who were nearsighted (the study focused on refractive errors not the causes). Vision problems can be caused by prolonged use of computers, improper working distance, no rest, etc. The recommended distance between the monitor and the eyes is about 16 - 24 inches, which varies according to the types of refractive errors and the types of jobs people have. More than half of the students (57%) in our study used computers at a distance of 12 - 16 inches or sat in front of the monitors. It should be noted that in some professions people have no or little rest, such as bankers, thus the authorities must take measures to reduce problems. Proper working distance and posture, and blocking unwanted light sources, such as room light or unshaded windows, contribute to the reduction of vision problems. Staring at the computer without blinking can lead to watery eyes. On the other hand tired eyes, fatigue and headaches are caused by excessive computer use (8). Half of the students in this study had placed their computers by the window whose reflected light on the monitor caused eye-related problems. Burning, itching and watery eyes were reported by these children. Weak vision as well as visual stress can lead to body fatigue and reduced efficiency (5). A few studies have been done on dizziness and nervous tic. Some computer workers in this study complained from dizziness, which was rarely reported by other studies.

Another vision complication is dry eyes, which may be caused by infrequent blinking during computer use, yet it is not as high as the other symptoms. Wearing eye glasses especially photo chromic glasses can reduce problems. Although, in many cases these glasses or monitor shields are of no use, they decrease eye sensitivity and irritation caused by unwanted light sources on the monitors. In this study, 42% of students believed that eyeglasses were not effective in reducing their problems. This claim was consistent with other studies. Some developed countries have made monitors with glare-reducing features, which can reduce burning and watery eyes. Furthermore, color display tube (CDT) and cathode ray tube (CRT) monitors were somehow effective in this respect. In 2002, about 20 million people with burning eyes used these types of monitors and there was no complaint thereafter (5). According to most computer users and the findings of this study, proper rest can reduce eye-related problems; therefore, it is suggested to have a 10-15 minute-break every 45 minutes on computers and massage eyes for a few minutes. This study recommends the time of rest among younger users should be different in comparison to users of old age. It is suggested to have 15-minute-breaks every 30 minutes on computers for older aged users.

Computer vision syndrome is a new problem that was reported during this century because of the increased use of computers at home, school, and or at offices (20). The findings of this study indicate the association between computer usage and ocular symptoms such as tiredness, eye pain, redness, dryness, blurred vision, burning sensation, nervous tic, dry eye, watering, head, and neck pain. These problems differed with the duration of exposure to computers and the time spent on the computer every day. Eye-strain syndrome with 81.8% prevalence was recognized as an eye problem affected by computer use and increased with prolonged visual tasks. Moreover, about 12.5% of the individuals in our study were found to have dizziness (12.5%). This symptom was not reported by some previous studies.

5.1. Prevention

Several types of contributing factors, such as lighting conditions, computer screens, computer environments, human eyes, posture of computer users, position of the monitor, computer tasks, and the use of rest breaks can play an important roles in CVS. These symptoms are usually temporary and disappear at the end of the working day even though a minority of workers may experience continuity of symptoms after work (20). To prevent or reduce many of the recognized symptoms in computer vision syndrome, the following recommendations are suggested by the researchers:

- Special computer glasses are useful to reduce eye-related symptoms and to minimize glare from light sources, using a screen glare filter (10).
- Illumination for general office areas should be in the range of 200 and 700 lux (approximately 20 to 70 foot candles).
- Generally, bright lights, windows, and overhead fluorescent lights need to be controlled with proper blinds, filters or adjustment of the room arrangement so that an acceptable level of lighting is obtained to minimize visual fatigue.
- Work with fonts of darker shades on light background is preferential.
- The light between the computer screen and the surrounding should be balanced.
- When using a computer, make an effort to blink normally.
- To prevent eyestrain, try to rest your eyes when using the computer for long periods. Rest eyes for 15 minutes after one hour for younger and 15 minutes per 45 minutes for older users of continuous computer use.

- Every 20 minutes, look away from the screen for 15 seconds to allow your eyes a chance to refocus and blink slightly more than normal.

- Taking a short break, stretching muscles, massaging the palpebral muscles, change of scenery and a quick walk around the workstation could all reduce CVS symptoms (10). The computer screen should be 15 to 20 degrees below eye level (about 4 or 5 inches) as measured from the center of the screen and 20 to 28 inches from the eyes (32). As a result, the top of the screen should be below the horizontal eye level of the user and tilted back slightly (10° - 20°) away from the user.

- Regular eye examinations, using eyeglasses and proper viewing habits can help prevent or reduce the development of symptoms associated with computer vision syndrome (12).

- The best time for using computers to minimize the incidence of problems and complaints is in the morning and in the evening.

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