Probable effects of exposure to electromagnetic waves radiated from video display terminals on some visual functions

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Because of the extensive use of computers, many studies have been conducted in an attempt to address questions concerning safety and health for Video Display Terminal (VDT) users. To improve the understanding and awareness of VDT users regarding the effects of exposure to electromagnetic waves radiated from VDT’s on some visual functions, a hundred and fifty computer operators working in different institutes were randomly selected. They were asked to fill a pre-tested questionnaire (written in Arabic), after obtaining their verbal consent. The selected exposed subjects were subjected to clinical assessment. A control group includes a hundred fifty participants; they are working in a field does not necessitate exposure to video display terminals. Among the exposed subjects studied and the control group, a statistically high significant occurrence of dryness was found and a high significant association between occurrence of asthenopia in exposed group and background variables (working hours) using computers. Exposed subjects showed that 92% complained of tired eyes, 37.33% complained of dry sore eyes, 68% complained of headaches, 68% complained of blurred distant vision and 45.33% complained of asthenopia. Meantime control group complain was 18% of tired eyes and 21.33% of dry eyes. Prevalence of Computer Vision Syndrome (CVS) was noted to be quite high among computer operators.

Key words: Computer vision syndrome, computer operators, epidemiologic factors.

INTRODUCTION

Computer has become an integral part of office equipments. However, working at a computer terminal is not free from health hazards and computer users are experiencing a variety of vision-related complaints collectively referred to as Computer Vision Syndrome (CVS) (Tamez–Gonzalez et al., 2003).

The term CVS is an umbrella that covers numerous conditions which are eye and environmental related condition that occurs when the viewing demands of the task exceeds the visual abilities of the user leading to inability to focus properly on computer images. The eyes cannot remain focused on the pixel-generated images on a computer screen (Belisario et al., 1988) and as such, the eyes must focus and refocus thousands of times per day while viewing the screen. The visual symptoms experienced by computer included tired eyes, burning tearing eyes, dry sore eyes blurred near vision and asthenopia (Table 1).

Complains may be severe enough to cause productivity problems, job dissatisfaction, absenteeism, and disability issues. If nothing is done to address the cause of the problem, the symptoms will continue to reoccur and perhaps worsen with future computer use (Collins et al., 1990) and (Hanne et al., 1994).

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A study of the magnitude of the problem stated that visual complains occur in more than 50% of VDT workers, and nearly 88% of all computer users will develop CVS at some time in their lives (Anshel, 2005). At greatest risk for developing CVS are those persons who spend two or more continuous hours at a computer every day, that is, people who use computers intensively, such as: AutoCAD designers, software designers, graphic designers, design engineers, researchers and customer service representatives (Francis, 2005).

The following are some epidemiological problems that contribute to CVS:

2. Display quality and refresh rates, monitor resolution and poor contrast are important factors in the development of CVS and are known to cause asthenopia (Best et al., 1996; Culhane and Winn, 1999).
3. Glare from lighting, especially, from bright light sources is well known to cause symptoms of asthenopia (Sheedy and McCarthy, 1994).
4. The role of lighting: Improper lighting can account for up to 30% of the visual symptoms the computer operator report. A significant correlation between the lighting conditions, luminance, contrast, and design of the workplace in VDT work stations and eye discomfort, ocular asthenopia, and temporary myopia (myopization) as these symptoms were not observed when all of these conditions were adequate (Gobba, 1988). This blue light is difficult for the human eye to focus due to its scattering characteristics (Berman, 1994).
5. Improper workstation design: If the ergonomic design of the workplace and the viewing distance are adequate, musculoskeletal symptoms are usually fewer (Luberto et al., 1989). If the computer display is at a less than optimal gaze angle, then, it can result in asthenopia (Burgess et al., 2000).
6. Dry environment: The cornea is very sensitive to drying and chemical imbalances from environmental factors. The office includes hazards such as dry air, airborne paper dust, laser and photocopy toner, and building contaminants (Toda et al., 1993; Carter and Banister, 1994; Sotoyama, 1996) (Table 2).
7. Reading new, unfamiliar material at work: When the person strains to catch hold of unfamiliar information and have to do it on a tight deadline, the mind can become stressed and agitated resulting in Asthenopia (Grisharn, 1988; Sheedy, 1992).
8. Other factors: Flickering stimuli, even at rates higher than our ability to perceive are known to cause asthenopia. Flicker rates beyond 80 to 90 Hz are unlikely to cause discomfort (Patel, 1991).
Table 3. Comparative statistics of asthenopia among exposed and control.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Exposed</th>
<th>Controls</th>
<th>Total</th>
<th>Chi-square</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Asthenopia</td>
<td>68</td>
<td>45.33</td>
<td>2</td>
<td>1.33</td>
</tr>
</tbody>
</table>

Table 4. Prevalence of Asthenopia among exposed in relation to background variables (working hours).

<table>
<thead>
<tr>
<th>Asthenopia (Working hours)</th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>36</td>
<td>48</td>
<td>84</td>
</tr>
<tr>
<td>9</td>
<td>6</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>20</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>68</td>
<td>82</td>
<td>150</td>
</tr>
</tbody>
</table>

Mean ± SD: 9.441 ± 1.765, 8.585 ± 1.490

Wiggins and Daum (1991) evaluated the effects of small amounts of uncorrected astigmatism on the visual comfort of VDT users. The analysis of their data suggests careful consideration to be given to the correction of small amounts of astigmatic errors for VDT users.

MATERIALS AND METHODS

A cross sectional study that included good matched control personnel. It included hundred fifty computer professionals' namely: software developers (24); call center workers (77), and data entry workers (49) and another hundred fifty control subjects. The groups were randomly selected and asked to fill a pre-tested questionnaire (written in Arabic), after obtaining their verbal consent.

The computer operators were working in the following institutes: Atomic energy authority (center of designing circuits and systems) (Madinet Nasr area) and RAYA.net Company (Abbasia area). Then, they were subjected to the following clinical assessment: 1) Visual acuity measurements; 2) Refraction (using autorefractometer); 3) Measurements of the ocular dryness defects using the following different diagnostic tests: Schirmer test-Fluorescein staining, Rose Bengal staining, Tear Break Up Time (TBUT) and LIPCOF test (lid parallel conjunctival fold).

A control group included hundred fifty participants and their working in a field does not necessitate exposure to video display terminals. Inclusion criteria of the subjects were as follows: minimum of three symptoms of Computer Vision Syndrome (CVS), minimum one year exposure to (VDT's) and minimum 6 h/day in 5 working days/week (Table 3 and 4). Exclusion criteria included candidates having ocular pathology like: glaucoma, optic atrophy, diabetic retinopathy, papilledema. Subjects with refractive error were not included in this study.

RESULTS AND DISCUSSION

The electromagnetic field of the VDT used by the exposed subjects was measured by AC MILLIGAUSS METER MODEL UHS. Measurement findings showed that inside the office where several VDTs were utilized the range was higher close to the server (5,799 milligauss) and the office readings ranged from 2,462 to 3,611 milligauss.

Working hours minimum were 6 h and maximum were 12 h/day. Working year’s minimum was one year and maximum were 10 years.

There is an increasing incidence of radiation hazards nowadays, as mankind is continuously exposed to various sources of radiation. In Egypt, computer users were 22.5 million in 2011 as compared to 17.5 million in 2010, with increase of 28.31% and internet users increased from 17.5 million as compared to 14.2 million, an increase of 23% (Report from the Central Agency for Public Mobilization and Statistical Analysis, 2012).

As part of this evaluation, this study was planned to
investigate the probable effects of this kind of radiation (electromagnetic waves) on the ocular functions. In order to achieve this aim, the study was conducted on people working in the field of visual display terminals and they were chosen from different work places namely:

1) In the current study, age was a significant factor in blurred distant vision, worse night vision and body tiredness. Working years was a significant factor in tired eyes and burning watery eyes. Working hours was a significant factor in burning watery eyes, headaches and worse night vision.

2) In the current study, occurrence of dryness was 37.33% in cases meantime and the control also showed symptoms of dryness in 21.33% of the cases. A statistically high significant association was found between occurrence of dryness in cases and control.

3) The current study found a high prevalence of asthenopia (45.33%) in computer operators, with a statistically high significant association between occurrence of asthenopia and background variables (working hours) of using computers which comes in parallel lines with the report of Smith et al. (1981) and NIOSH (1981), as they stated that symptom severity has been associated with the length of time spent at the computer. A statistically significant association was found between occurrence of asthenopia and working years of using computers. Mocci et al. (2001) reported the prevalence of asthenopia as 31.9% in a study performed on 385 bank workers of Italy, while Sanchez-Roman et al. (1996) found this prevalence to be as high as 68.5% in their study in Spain.

4) Musculoskeletal strain in video display terminal workers which is not eliminated by the use of high quality work stations or conventional rest break schedules (Pascal et al., 2012). It is an ergonomic condition not directly related to the effect of VDT but to the work station and the working variables.

**CONCLUSION AND RECOMMENDATION**

Among the 150 subjects studied, exposed subjects to electromagnetic radiation emitted from VDT of LCD type were in a range of reading from 2.462 to 3.611 milligauss. 92% complained of tired eyes, 37.33% complained of dry sore eyes, 68% complained of blurred distant vision, and 45.33% complained of asthenopia.

Meantime control group complain was 18% of tired eyes, 21.33% of dry eyes, and 1.33% of asthenopia. The current understanding upholds meticulous work environment as a precaution and use of artificial tears as a wetting solution to suffice the symptoms (patients of CVS get only symptomatic relief). The problem of CVS is very new to medical science and is under investigation to explain the mechanism of the disease and to find a solution.

**REFERENCES**


