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Research Paper

EMF Radiation Level and Asthenopia Prevalence among Computer Users in Uyo Urban, South-South, Nigeria

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Abstract: A cross-sectional survey design was used to investigate the prevalence of asthenopic symptoms among 354 computer users with respect to the level of EMF radiation from computer monitor screens. The results of the study revealed a significant association between the risks and the radiation level as well as a significant increase in angle of gaze between those affected and unaffected users. It was found that frequent/severe headache (59.1%) was the most complained symptom followed by chronic eye irritation (41.5%). The findings in this work, if properly taken into consideration, will help to create social awareness and also help relevant authorities as well as individuals in the policy formulations regarding their ergonomics.

Keywords*: Angle of gaze; Asthenopic symptoms; Computer monitor; EMF tester; Radiation.*

Introduction

The 21st century, in which we are, has now become the age of modern technology to the extent that the influence of computers on human lives cannot be denied. Apart from being a time-saving tool, the computer can do work with accuracy when it is properly put to use. Also, its use can enhance productivity whether in offices or at home. As such, using a computer has been considered a necessity by business owners, students, job seekers, professionals, internet technology (IT) people, among others, thereby, making computer system to be a must-own appliance. Observably, application of computers in areas such as education, industry, entertainment, hospital/health, business, marketing, transportation, advertisement, communication, banking/financial establishments to mention but a few, from the government to private sector has now reached an impressive level of growth.

It is noteworthy that in Nigeria, efforts had always been made by the government and individuals to improve the level of computer literacy. One particular pointer to this fact, as tracked by the investiture of the National Committee on computer education, was the determination of the federal government of Nigeria to establish computer education into the country's secondary school structure. This is evident as published in Nigerian Tribune on April 11, 1988. The purpose of the aforementioned committee comprised planning for a dynamic policy on computer literacy in Nigeria as well as devising clear strategies to be used by the Federal and State governments in introducing computer education. According to the content of the said publication, one of the broad-spectrum objectives of the guiding principle was to allow school children to welcome and use the computer in a variety of facet of life and in upcoming employment.

Over the years, a great deal of work done to determine the number of computers in use has been yielding results. For instance, an assessment showed the availability of nearly six computers per thousand population with an installation of 18 million personal computers and the tendency for the number to increase all the time (Sharma et al., 2006). Also, the information provided by computer Industry Almanac Inc. in February 2012 showed that while the U.S had 19.4% followed by China with 12.2%, Italy had the least being 2.79% of personal computers in use with respect to the world total. Again, in the survey carried out by Camille (2016), it was found that 84%, 87% and 89% of households in the United States had a computer in 2013, 2015 and 2016 respectively. Since it is human beings that put computers to use, it is obvious that in most cases, certain tasks to be accomplished require spending a great deal of time working on computers. Though the use of computers is a welcome development as

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the positive aspect of such innovation makes life easier, it can as well turn to be a dangerous practice. This is because the primary focus of people is on the benefits, they intend to derive from using computers to work and as a result, many people do not actually care to consider the fact that it may also impair the quality of life through its certain negative effects over a long period of time.

There is no doubt that the computer is an electronic device. Thus, it emits electromagnetic field (coupling of the electric field and magnetic field) radiation by virtue of how it works. Notably, the monitor of any computer is a source of extremely low frequency (ELF) electromagnetic field (EMF) radiation when it is on. In Environmental Health Criteria Monograph No. 238, the World Health Organization (WHO) listed ELF as a possible carcinogen. This is in line with the 2012 renowned Bio-initiative report which reviewed over 1800 new scientific studies and included 29 independent science and medical experts from around the world. The report gave conclusive and substantial evidence that linked EMF exposure to breast cancer, Alzheimer's disease (AD), Lou Gehrig's disease, cardiovascular disease as well as symptoms including learning impairment, insomnia, miscarriage, infertility, brain fog, anxiety and depression (Bio-initiative report, 2012). As observed by Arun & Farheen (2014), adverse health effect is seen on the human body when it is exposed to both electric and magnetic field. In the study carried out by Ciejka et al. (2012)., it was revealed that ELF magnetic field applied for 39 minutes per day for 10days can affect free radical generation in the brain of experimental animals. Because of the possible association of ELF-EMFs with childhood malignancy like leukaemia and brain cancer, as well as neurological and psychological diseases in adults, they are said to play a vital role among the environmental risk factors that affect human health (Loomis et al.,1990; Hakansson et al., 2003; Davanipor *et al*., 2007). Also, during Epidemiological studies by Jop *et al*., (2012), it was found that there is a consistent association between ELF-EMF and leukaemia. In Sweden, Steadman & Hodgkinson, (1990), embarked on a research work in which a correlation was found between computer monitors and the health of those using them. This finding is critical to the fact that radiations from computer monitors can produce potentially hazardous biological effects (Anisimov, et al., 1997). Moreover, Li et al., (2013) in their work on the effects of electromagnetic radiation on health and immune function of operators who work under EMF radiation, used a control group and exposure group. They performed blood cell counting, biochemical test, physical examination, electrocardiograph as well as routine urine test and the data obtained were compared. Their findings led to the conclusion that those exposed to work under electromagnetic field were affected by the radiation.

However, it has been observed in recent times that not all computer users of same social health and economic status working in a particular establishment experience health challenges induced by EMF radiation from similar computer monitors to which they have been exposed for the same duration. This has raised a great deal of concern when considering the fact that there should, at least, be some specific and common adverse health effects all of them are supposed to suffer. Thus, this work is designed to address such concern by assessing the association between the level of EMF radiation from computer monitor screens and some specific asthenopic symptoms so as to identify the safe limit, if any, for starring at the monitor for a prolonged period of time. It is hoped that the findings from this work will create social awareness that will enable individuals, entrepreneurs, medical practitioners, governmental establishments and agencies among others, make informed decisions that will improve their ergonomics.

Design of the Study

An interview-based cross-sectional survey design was used in this study and the information collection was done by means of a structured questionnaire. The subjects were computer users who starred at the monitor for a minimum of 3 hours daily for a long period of time. Though emphasis was on the association between asthenopic symptoms and the level of EMF radiation from the monitor screen, cognizance was taken of the subject's gaze angle since such factor has a link with how a subject's distance from the screen center relates with the level of the radiation. Also, while considering only the complaints that last for about a week to be asthenopic symptoms caused by the radiation, the subjects who were receiving and form of medical intervention for theirs were excluded from the study.

Method

The questionnaires used were first serial-numbered and the subjects were then selected by simple random sampling technique for self-administration of the questionnaires. Care was taken to ensure that this selection carried about 85% of computer business outfits located within Uyo Urban in the Akwa

Ibom State of Nigeria where typing of the document with computers is the main service rendered to customers. Information was sought from the subjects regarding their year of computer use, asthenopic symptoms (during and after work), social demography as well as clinical and ophthalmic examination with the assurance of treating such with absolute confidentiality and anonymity. With the aid of a 3D EMF tester (Lutron, EMF-828), the level of EMF radiation from the screen centre to the seat position of each subject was measured and recorded in a confidential register against the subject's questionnaire serial number. Also, separate measurements of the radiation level were taken at various designated distances from the screen centre of the same computer. Thereafter, the 3D mean measured value was computed per distance. Again, for each subject, while on the seat, the angle of gaze to the monitor was determined as the inverse tangent of the ratio of d to L (Figure 1). Descriptive statistics were used to calculate the mean and standard deviation of both the ages and gaze angles of the subjects while frequencies were calculated of various symptoms.

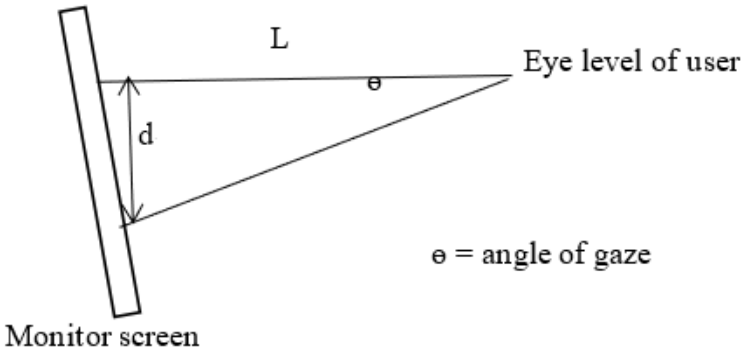

Figure 1. Schematic diagram showing angle of gaze

Results and Discussion

In this study, a total of 354 computer users comprising 32.2% males and females 67.8% females with mean age of 32.2 ± 10.1 years, who starred at the computer monitor for at least 3 hours daily, were used as subjects (Table 1). Most of the subjects being female is due to the fact that the cultural trends of our society in the study area enable more female than male computer operators to engage in the business of using a computer to type document for various categories of customers. It was found that all the 21 subjects who did not complain of any asthenopic symptom did not expose themselves to more than 1.4mG while starring at their computer monitor. On the contrary, the rest (94.1%) of the subjects were suffering from various asthenopic symptoms due to their exposure to at least 2.0mG of the EMF radiation from the monitor screen (Table 2). This reported number of complaints is close to the estimate of 90% reported in the study on computer vision syndrome (CVS) by Hayes et al., (2007). The most reported complaint in our study was a frequent/severe headache (59.01%) followed by chronic eye irritation (41.5%) whereas the least identified symptom was diplopia (1.1%). In their study on health disorders among computer professionals, Talwar et al., (2009), reported a headache in 46% of users. Irrespective of the computer model used, a significant association was observed in our study to existing at 0.05 level of significance between the risks (symptoms) and level of the radiation to which the subjects exposed themselves. Also, at equal distances from the monitor, subjects using different computer models were found to expose themselves to different levels of the radiation.

Those affected were found to stare at their computer monitor at a mean gaze angle of $15.0^0 \pm 1.4^0$ significantly greater than the unaffected subjects ($10.4^0 \pm 1.1^0$). This similar observation on gaze angle was documented by Izquierdo et al., (2004) in their report on CVS study. Table 3 shows the mean EMF radiation intensity (E) in mG and distance (X) in meters from the screen, its shows a direct relationship between mean EMF radiation intensity (E) and distance (X) from the screen. The increase in gaze angle could be attributed to the closeness of the subject's face to the monitor, which implies exposure to a high level of the radiation. This is supported by the inverse square law nature the radiation level has with the distance between the subject's position and the centre of the computer monitor screen used (Figure 2). The figure illustrates the fact that as the square of the radiation distance increases from the screen, the level of radiation from the screen reduces at a decaying mode and vice versa.

Table 1. Distribution of subjects based on gender and mean angle of gaze

Gender			Mean angle of gaze	
Male	**Female**	**Total**	**Users with symptoms**	**Users without symptoms**
114	240	354	$15.0^0 \pm 1.4^0$	$10.4^0 \pm 1.1^0$

Table 2. Association of asthenopic symptoms with the EMF radiation level

EMF radiation level	No. of subjects	The frequency of asthenopic symptoms				
		Blurred vision	Chronic eye irritation	Diplopia	Frequent and severe headache	Glare
0.5mG – 1.4mG	21	0.0%	0.0%	0.0%	0.0%	0.0%
2.0mG – 3.9mG	59	0.8%	7.6%	0.0%	10.2%	5.1%
4.0mG – 5.9mG	106	2.8%	13.0%	0.3%	19.8%	9.9%
≥ 6.0mG	168	9.6%	20.9%	0.8%	29.1%	17.5%

Table 3. Mean EMF radiation level (E) and distance (X) from the screen

X (m)	E (mG)
0.20	7.824 ± 0.243
0.25	5.584 ± 0.658
0.30	4.767 ± 0.411
0.35	3.867 ± 0.234
0.40	3.200 ± 0.243
0.45	2.348 ± 0.285
0.50	1.453 ± 0.764

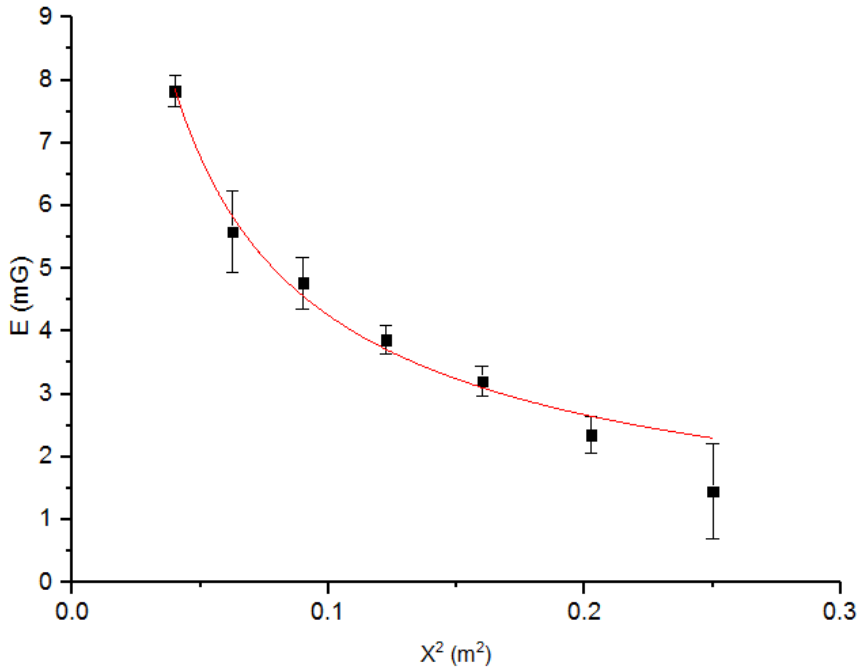

Figure 2. Relationship between mean EMF radiation level and the square of the distance from the screen centre

Conclusion

It was revealed in this study that any asthenopic symptom in computer users basically depends on the level of EMF radiation to which they expose themselves when starring at their computer monitor for at least 3 hours daily over a long period of time. The risks were found to start manifesting between 2.0mG and 3.9mG. Among the identified symptoms in those affected, the frequent/severe headache was the most complained risk followed by chronic eye irritation while the least was diplopia.

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