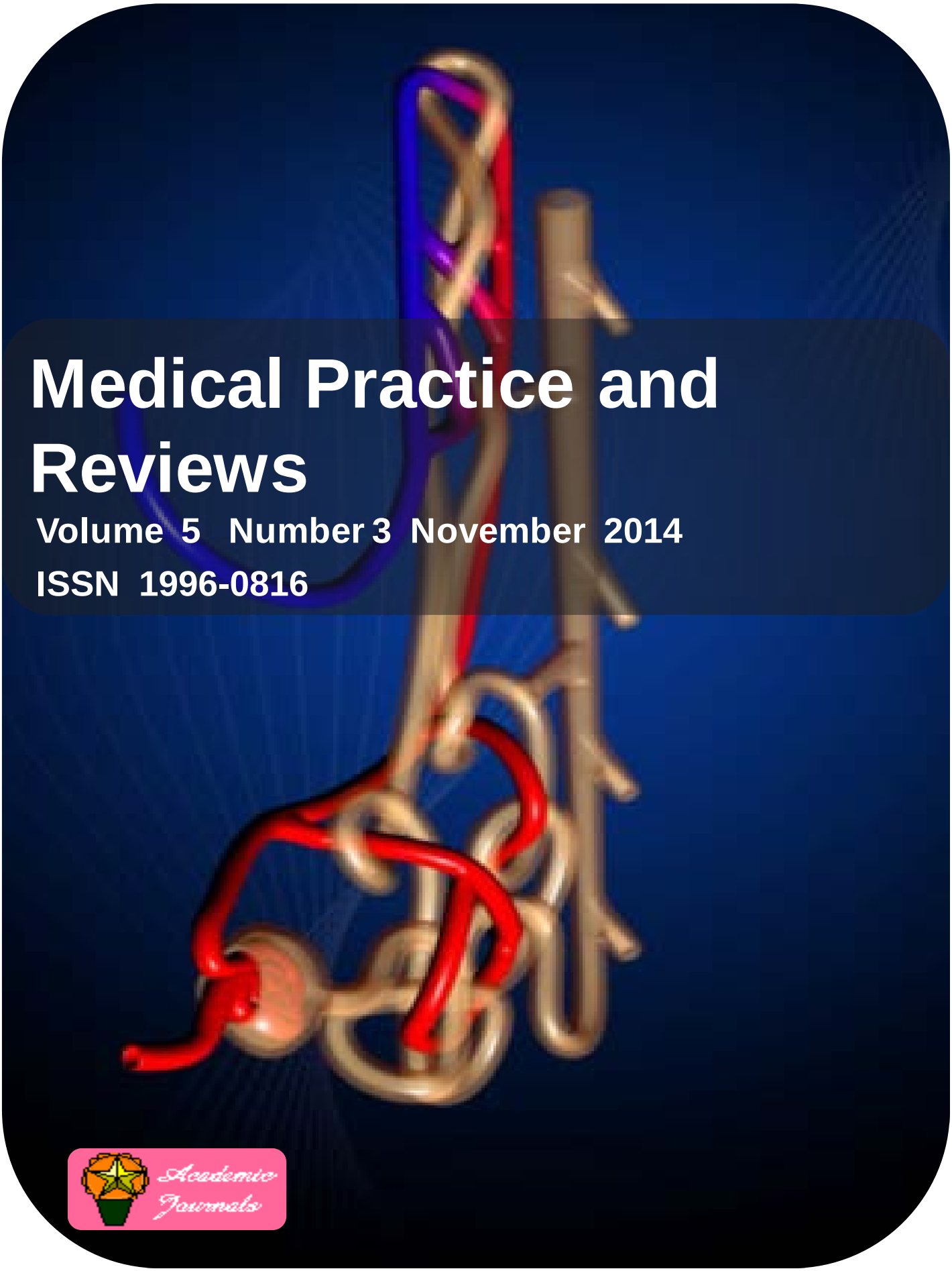

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Medical Practice and Review

Full Length Research Paper

Impact of computer technology on health: Computer Vision Syndrome (CVS)

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In today's society, the use of computer as a tool at workplaces, academic institutions, recreation facilities and homes has become very common. It is estimated that globally, about 45 to 70 million people spend hours staring into a video display terminal, popularly known as computer screen. Several studies, mainly in developed countries, have shown an association between computer use and visual health related symptoms (Computer Vision Syndrome, CVS) in both children and adults. In this report, a review of literature on CVS was undertaken to determine the prevalence of CVS and compare the prevalence between studies. The risk factors associated with the syndrome range from individual visual problems and poor ergonomics. The most common symptoms include headache, eye strain, double vision, dry eyes, eye fatigue and other symptoms of eye strain. The prevalence of the symptoms varied between studies. It is concluded that, as computer users are increasing rapidly, they are at risk of CVS. A better understanding of the pathophysiology underlying CVS is necessary to empower practitioners to accurately diagnose and treat patients with CVS; necessary precautions and care should be exercised to prevent serious impact of CVS on productivity and sustainable economic development of countries in Africa. In addition, special attention should be given to the young population including children and students in schools, colleges and universities.

Key words: Computer vision syndrome (CVS), computer users, health impact.

INTRODUCTION

The discovery of the computer has to a greater extent revolutionised most professions and their work performance. Accountants, Architects, Bankers, Engineers, Flight Controllers, Graphic Artists, Journalists, Academicians, Secretaries, and Students cannot work without the help of computer. Recent studies have shown that technology is associated with several health-related challenges. The health-related complaints range from visual, musculo-skeletal and neural ailments which health care providers of today have to deal with.

Therefore, the need for research into computer-related health problems cannot be over emphasised, more so when one considers the upsurge in information technology and the daily increase in the number of computer users

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from all walks of life.

METHODOLOGY

A literature review is an intensive reading and analysis of the documents selected in the topic under study (Hart, 1998). Boswell and Cannon (2011) add that literature review lays out the foundation of a particular study and is intended to assess existing evidence regarding the topic of interest with the purpose of identifying what is known and unknown about a research subject. This paper aims to provide a review of the impact of computer technology on health among computer users focusing on the computer vision syndrome (CVS). The purpose is to raise awareness of researchers specifically in Africa on CVS as an emerging global epidemic which if not clearly understood and appropriate interventions designed may have negative impact on productivity and economic development.

In this review, a systematic literature review approach was used because, when compared with the traditional or narrative literature review, the systematic review provides a more rigorous and well-defined approach to reviewing the literature in a specific subject area (Cronin et al., 2008). Parahoo (2006) suggests that a systematic review should detail the time frame within which the literature was selected. In this report, we reviewed articles published between 1980 and 2014. This is the period during which the personal computer has become a common management tool and therefore, appropriate period to assess the health effects among computer users. Searches for the peer reviewed articles were conducted using PubMed, MEDLINE and Google Scholar Search Engines. Peer reviewed articles that specifically discussed CVS prevalence, risk factors, pathophysiology, symptoms and management were included. For each article, a more systematic and critical review of the content in terms of the source of the data and when the article was published was analysed. This report is therefore, a summary of the collected relevant information from the literature on the subject.

Computer-related health problems

Hales et al. (1994) reported that approximately 22% of computer users have musculo-skeletal problems, such as neck pain, back pain, shoulder problems and/or carpal tunnel syndrome (CTS). Such problems can be made worse by poor workstation design, bad posture and long periods of sitting. Sitting for long periods reduces circulation of blood to muscles, tendons and ligaments, and sometime leads to stiffness and pain. Playing electronic games for long periods, especially in children has also been linked to childhood obesity (Better health, 1999). In a similar study, Adedoyin et al. (2005) reported that low back pain and neck pain were the most common complaints with prevalence of 74 and 73%, respectively; 67% of their respondents complained of wrist pain, 65% finger pain, 63% shoulder pain and 61% complained of general body pain. The knee and foot pain were the least reported complaints with 26 and 25%, respectively.

Carpal tunnel syndrome, CTS

CTS is a stress-related injury caused by repetitive movement of joints in the wrist. CTS arise from compression of the median nerve where it passes through the carpal tunnel in the wrist (Palmer et al., 2007; Thomsen et al., 2008). It became common due to poorly placed computer components and extensive typing for prolonged periods of time. Anderson et al. (2003) reported that one in eight computer professionals suffer from CTS and cited the mouse as the main cause of the disorder and tingling/numbness in the right hand was associated with time spent using a mouse device but not time spent using a keyboard. Symptoms of tingling/numbness at night revealed a significant association only when the time spent using a mouse exceeded 30 h per week. They concluded that keyboard use is not an important occupational risk factor for developing CTS. In a one-year randomized controlled intervention trial which evaluated the effects of a wide forearm support surface and trackball on upper body pain severity and incident musculoskeletal disorders among 182 call center computer operators, Rempel et al. (2006) concluded that 63 participants were diagnosed with one or more incident musculoskeletal disorders. It was recommended that provision of a “large forearm support” combined with “ergonomic training” is an effective intervention to prevent upper body musculoskeletal disorders and reduce upper body pain associated with computer work. Hedge et al. (2002) in a longitudinal study that assessed the differential impact of standard and adjustable ergonomic keyboards on musculoskeletal symptoms among 71 computer users over a six-month period stated that there were significant improvements in neck, shoulder and arm comfort in users who used the “adjustable ergonomic keyboard”.

Ortiz-Hernandez et al. (2003) concluded that the use of personal computer increased the risk of developing musculoskeletal disorders. The increase is mediated by ergonomic factors such as mouse use, prolonged period of sitting, uncomfortable postures and psychosocial factors.

Gerr et al. (2002) carried out a prospective study of computer users to determine the incidence and risk factors for neck or shoulder, hand or arm musculoskeletal symptoms (MSS) and disorders (MSD). The study was carried out on 632 individuals newly hired into jobs requiring more than 15 h/week of computer use and were followed for up to 3 years. The study concluded that hand or arm, neck or shoulder MSS and MSD were common among computer users and more than 50% of computer users reported MSS during the first year after starting a new job. However, Thomsen et al. (2008) concluded in their study that there is insufficient epidemiological evidence that computer work causes CTS.

Radiation emitted by computers

Radiations emitted by computers include visible light, ultraviolet, x-ray and radio frequency emissions. These emissions are very low and significantly below recommended safety levels. Though studies have not found any direct link between computer use and radiation-related visual symptoms, and there is no evidence that computer radiation contributes to the development of cataracts, some studies (Rycroft and Calnan, 1984; Nilsen, 1982) reported that most computers build up an electrostatic charge around the screen surface. It was further explained that these static charges can cause the attraction and accumulation of dust on the computer screen. The suggestion that these charges may be related to the development of skin rash or eye irritation in very sensitive people is inconclusive in previous studies (American Optometric Association, 1997).

Computer vision syndrome, CVS

Definition

The beginning of the 20th and 21st Centuries have been characterised by computer usage, and globally, personal computers have become the most common office tools. Almost all institutions, universities, colleges, government departments and homes are regularly using computers (MacKinnon, 2007; Anshel,

2005). Studies have however demonstrated that the use of computer for even three hours daily is likely to lead to a health risk of developing a clinical syndrome called CVS, low backache, tension headache and psychosocial stress (Bali et al., 2007; Chakrabarti, 2007; Sen and Richardson, 2007; Rathore et al., 2010). CVS has been defined as the combination of eye and visual problems attributed to the use of computer (Rosenfield, 2011).

Torrey (2003) and Graney (2011) have shown that computer users vision-related problems are the most frequently reported health-related problems occurring in over 70% of computer users. They have concluded that CVS is a vision disorder that has been described as the number one occupational hazard of the 21st century as the human eye finds today's computerised gadgets difficult to cope with. Anshel (2006) have defined CVS as the complex of eye and vision problems related to near work, which are experienced during or related to computer use. Similarly, Chakrabarti (2007) defined CVS as the excessive viewing of visual display terminal (VDT) screens without proper attention to practical visual hygiene. The American Optometric Association (AOA) has defined CVS as "a complex of eye and vision problems related to activities, which stress the near vision and which are experienced in relation or during the use of computer (AOA, 2013)"; and the Occupational Safety and Health Administration of the US Government (OSHA) has defined CVS as a "complex of eye and vision problems that are experienced during and related to computer use; it is a repetitive strain disorder that appears to be growing rapidly, with some studies estimating that 90% of the 70 million US workers using computers from more than three hours per day experience CVS in some form" (Nilsen, 2005). It has now been concluded that CVS is characterised by visual symptoms which result from interaction with a computer display or its environment. In most cases the symptoms occur because the visual demands of the task exceed the visual abilities of the individual to comfortably perform the task (Anshel, 2006).

Risk factors for CVS

Literature on the symptoms of CVS points to a close association between computer usage and symptoms. Many studies have shown that the prevalence of visual symptoms was higher among individuals who spend more than four hours working on video display terminals (Rossignol et al., 1987). Similar findings were reported in other studies and the authors concluded that the duration of the computer work was directly related to the eye symptoms, and that a longer duration of the computer work tended to result in long-lasting complaints that persist, even when the work had been completed (Shima et al., 1993; Kanitkar et al., 2005). In our previous study (Akinbinu and Mashalla, 2013), over 62% of the employees use computers for more than six hours daily and CVS symptoms were reported more among the employees who spent six to eight hours on the computer daily (48.9%) as compared to 23.7 and 0.72% among those who spend three to five hours and one to two hours, respectively. Our study results are supported by previous studies which indicated visual complaints were more common among subjects who used computers for more than six hours (Smita et al., 2013).

Studies that looked into the risk factors for CVS have demonstrated an association between CVS and use of spectacles. Smita et al. (2013) demonstrated that eye redness had a significant association with the use of spectacles. The symptoms of CVS have been reported to be more prevalent, with values ranging from 95 to 16.9% in contact lens wearers than between 57.5 and 9.9% among non-contact lens wearers (Tauste et al., 2014; Kojima et al., 2011). On the contrary, other studies have not shown such association (Bergqvist and Knave, 1994; Nakaishi and Yamada, 1999).

The distance of the VDT from the eyes has been shown to be an important risk factor for CVS because the closer the VDT to the eyes the more difficult the eyes have to work to accommodate with it. The physiological explanation for the challenge to accommodate is that close distance causes an excess accommodation which result in overworking the ciliary muscles of the eye which is manifested as eye fatigue and headache. Similarly, concentration on VDT tend to reduce the rate of blinking which exposes the eyes to free dry air that causes redness, dryness and eyestrain. Researchers have recommended a viewing distance between 30 and 70 cm as measure to reduce visual symptom (Bhandeni et al., 2008; Chiemeke et al., 2007; Taptagaporn et al., 1995).

Other risk factors for CVS include the height and the inclination of the monitor. Studies have demonstrated an association between CVS symptoms and the risk factors where increased odds ratios (eye strain) for certain eye symptoms were observed when the computer operators kept the computer monitor at about the eye level instead of below the eye level (Bergqvist and Knave, 1994; Jaschinski et al., 1998). It has been recommended that in order to reduce the discomfort, the VDT should be at least 5 to 6 inches below the straight line of the user's vision. Such measures have been shown to reduce not only dry eye, but also the severity of the spasm and neck muscles (Rechichi and Scullica, 1990). On the other hand, Occupational Safety and Health Administration (OSHA) has recommended that the centre of the computer monitor should normally be located 15 to 20 cm below the horizontal eye level and that the entire visual area of the display screen should be located such that the downward viewing angle is greater than 60 degrees.

Glare and reflections on VDT have been reported to cause visual symptoms of CVS including eye strain. In order to minimise glare, it has been recommended to use antiglare cover over the screen and use of flat screens is also recommended. Conditions of high illumination and sensitivity to the glare due to computer use have been shown to increase the reading time and decrease attention to the task (Office Ergonomics Handbook, 2008).

Taking frequent breaks while using the computer has been shown to increase the efficiency because the breaks tend to relax the eye accommodative system thus decreasing eye fatigue and headache (Fenety and Walker, 2002; Levy et al., 2005; Smita et al., 2013).

Pathophysiology of CVS

The eye focusing mechanism in human seems not to be meant for electronically generated characters on the VDT, but rather responds well to images that have well defined edges with good background and contrast between the background and the letters. Therefore, visual work in a computer is demanding and includes frequent saccadic eye movements (ocular motility), accommodation (continuous focusing) and vergence (alignment demands), all of which involve continuous muscular activity (American Optometric Association, 1997). The characters on a computer screen are made of tiny dots called pixels. Pixels are the result of electronic beam striking the phosphor-coated rear surface of the screen. Each pixel is bright at its centre and with decreasing brightness towards the outer edges. Therefore, electronic characters have blurred edges as compared to letters on a printed page with sharply defined edges. This makes the human eye very difficult to maintain focus on pixel characters because in an attempt to focus on the plane of the computer the eye fails to sustain the focus, therefore relaxes on to focus behind the screen. This point is referred to as the Resting Point of Accommodation (RPA) or sometimes called the dark focus. The eyes are therefore, constantly relaxing to RPA and straining to refocus on to the screen thereby leading to eyestrain and fatigue (Abelson and Ousler 1999; Wimalasundera, 2006; Chakrabarti, 2007; Alexandre and Milano, 2006).

RESULTS AND DISCUSSION

The initial search provided 120 references. After applying inclusion/exclusion criteria, 104 references were included because they contain information in line with the aim of the review: to provide a review of the impact of computer technology on the health among computer users focusing on CVS. The purpose is to raise awareness of the researchers specifically in Africa on CVS as an emerging global epidemic which if not clearly understood and appropriate interventions designed may have negative impact on productivity and economic development.

Prevalence of CVS

Previous studies have estimated that the prevalence of CVS ranges between 64 and 90% among computer users (Hayes et al., 2007). It has been estimated that nearly 60 million people suffer from CVS globally and about one million new cases occur each year (Sen and Richardson, 2007). About 70% of computer workers worldwide report having vision problems and there is an alarming increases in the number of people affected (Blehm et al., 2005). Studies among students have shown that the prevalence of CVS among engineering students was 81.9% as compared to 78.6% among medical students (Logaraj et al., 2014). This study also demonstrated that a significantly higher proportion of engineering students (40%) used computers for between four and six hours as compared to 10% of the medical students. Other studies have also reported higher prevalence of CVS among students and other workers. In Malaysia, CVS prevalence reported among university staff was 68.1% (Rahman and Sanip, 2011). Keyboard users are equally affected; 59.5% prevalence of CVS was reported among keyboard users in Mauritius (Subratty and Korumtolee, 2005). Similarly, Iwakiri et al. (2004) reported 72.1% prevalence among office workers in Japan. In a study of the knowledge and practices in university students, Reddy et al. (2013) reported 89.9% of the 795 students had CVS symptoms and headache was the most common symptom found. Similar observations were a symptom of CVS was reported in 90% of the study population (Chu et al., 2011).

CVS has been reported to be more prevalent among male than female. Males have been reported to be at higher risk of developing symptoms of redness, burning sensation, blurred vision and dry eyes as compared to headache, neck and shoulder pain among females (Logaraj et al., 2014). On the contrary, Toama et al. (2012) reported that the proportion of females who developed CVS was more compared to the prevalence among males. Similar findings of relatively higher prevalence of CVS among females than males have been reported (Palm et al., 2007; Alexander and Currie, 2004).

In the early years of computer existence, the computer user was almost restricted to adults. However, today the computer has become a common household tool and millions of children use computers at schools and homes for education and recreation purposes (Kozeis, 2009).

Few studies on the prevalence of CVS among children have reported that children, like adults can experience similar symptoms related to computer use by adults. Extensive viewing and focusing on computer screen can cause eye discomfort, fatigue, blurred vision, headaches, dry eyes and eye strain (Barar et al., 2007; Bali et al., 2007; Izquierdo et al., 2004; Jacobs and Baker, 2002). Even with the growing literature, CVS still remains an underestimated and poorly understood condition at the workplace (Izquierdo et al., 2004; Yan et al., 2008; Izquierdo, 2010). A comparison of the prevalence of common CVS symptoms is shown in Table 1.

Table 1 shows variation in the prevalence of CVS between studies and populations, and headache is reported by most authors. The finding suggests that CVS still remains poorly understood and more research is needed to develop research instruments that will be used to capture the needed information for comprehensive determination of the extent of CVS symptoms among computer users including those poorly reported which may equally affect individual work performance.

Symptoms of CVS

Most studies have indicated that CVS is a syndrome marked by symptoms such as eyestrain, burning sensation, blurred vision, gritty sensation, headache and neck pain. Some computer users may experience continued reduced visual abilities such as blurred distant vision even after work (Chiemeke et al., 2007). The symptoms may be aggravated by poor lighting, glare, improper work station set up and uncorrected refractive errors (Torrey, 2003; Ihemedu and Omolase, 2010).

In Africa, not many studies on CVS have been carried out in spite that computer use has attained a significant patronage especially with the upsurge of information and communication technology. Consequently, many organisations can barely manage their businesses without the computer. Poor publicity and utilisation of preventive measures however, have hampered the effectiveness of computers due to the overwhelming symptoms experienced by some users (Ihemedu and Omolase, 2010). Awareness of visual problems from computer use has also been minimally stressed in most industrially developing countries like Nigeria (Chiemeke et al., 2007). Some researchers (Divjak and Bischof 2009; Mvungi et al., 2009) have explained that CVS can be avoided by suitable preventive actions but majority of the sufferers are ignorant of this.

Table 1. Comparison of the frequency (%) of the common CVS symptoms reported in the literature by different authors in the recent years.

Symptom	Our study	Shrestha et al. (2011)	Edema and Akwukwuma (2010)	Megwas and Aguboshim (2009)	Sen and Richardson (2007)	Bali et al. (2007)	Singh et al. (2007)	Shantakumari et al. (2014)	Reddy et al. (2013)	Chiemeke et al. (2007)		
										Mild	Moderate	Severe
Headache	30.9	13.3	-	41.7	61	82.1	-	53.3	19.7	53.4	24.3	3.9
Blur vision	10.1	-	59.4	-	-	-	-	-	-	37.9	37.9	7.8
Eyestrain	30.9	-	-	31.5	-	97.8	-	-	16.4	53.4	22.3	20.4
Redness	4.3	-	-	-	46	-	-	-	-	36.9	25.2	3.9
Double vision	12.9	-	-	-	>46.0	-	-	-	-	43.7	28.2	1
Watery eyes	10.8	-	-	-	-	-	-	-	-	-	-	-
Tired eyes	-	12.5	62.5	-	-	-	25	48	-	35.9	11.7	1
Burning	-	-	-	-	-	-	31	54.8	-	-	-	-

Headache

Several previous studies have shown that headache is one of the symptoms presented by many computer users. Bali et al. (2007) reported 82.1% of the study population complained of headache as compared to 43.3 and 45% among medical and engineering students, respectively (Logaraj et al., 2014). Equally high prevalence of headache (61%) was reported by Sen and Richardson (2007) and 41.7% by Megwas and Aguboshim (2009). Lower prevalence of headache (29.9%) was reported by Talwar et al. (2009), 17% by Kesavachandra et al. (2006) among employees at an information technology workplace and even much lower frequency (13.3%) by Shrestha et al. (2011). A quantitative, descriptive cross-sectional study design was used to determine the level of knowledge and the extent of CVS among computer users at the Securities and Exchange Commission (SEC) in Abuja, Nigeria. A structured questionnaire was administered to 100 computer users (male and female) aged between 18 and 40 years. It was reported that most respondents (45%) spend between six and eight hours on the computer and only 6% used the computer for less than one hour. About 40% of the respondents were aware of CVS and 74% of them experienced at least one of the symptoms of CVS. Headache was one of the most common symptoms reported by 30.9% of the studied population (Akinbinu and Mashalla, 2013).

Blurred vision

The Online Medical Dictionary defines blurred vision as indistinct, fuzzy visual images or a lack of sharpness of vision resulting in the inability to see fine detail. Blurred vision may result from abnormalities present at birth such as near-sightedness or far-sightedness that require corrective lenses (glasses) or it may signal the presence of eye disease. An association between computer use and blurred vision of about 10.1% was reported among the employees of the Securities and Exchange Commission in Abuja, Nigeria was also reported (Akinbinu and Mashalla, 2013). Other previous reports have also indicated the association of blurred vision with computer usage (Anshel, 2005; Rajeev et al., 2006; Husnum et al., 2010; Chiemeke et al., 2007). In terms of the extent of the complaint, our finding agree favourably with previous results which reported 13.2% (Talwar et al., 2009), 16.4% among medical students (Logaraj et al., 2014); while Chiemeke et al. (2007) reported 7.8% in the severe category as compared to 37.9% in the mild category. Much higher prevalence of blurred vision (59.4%) was reported by Edema and Akwukwuma (2010) and 31.6% among engineering students (Logaraj et al., 2014). Blurred vision was reported by 10.2% of university students (Reddy et al., 2013). Rosenfield (2011) reported that there is a significant difference in the median score with respect to blurred vision when comparing computer use and hardcopy printout. The difference in the extent of the complaint is likely to be attributed to several factors including the characteristics of the study population, sample size, data collection tool and individual data collectors.

Eyestrain

There is confusion among study population when reporting on eye strain because in some cases eyestrain is reported as burning sensation. Eyestrain or asthenopia is an ophthalmological

condition that presents with nonspecific symptoms such as fatigue, pain in or around the eyes that are caused by reading or looking at a computer screen for too long (Gowrisankaran et al., 2012). The American Heritage Dictionary defines eyestrain as pain and fatigue of the eyes, often accompanied by headache, resulting from prolonged use of the eyes, uncorrected defects of vision, or an imbalance of the eye muscles (The American Heritage Dictionary of the English Language, 2009). The association of eye strain with computer use has been reported and the prevalence is variable. While Logaraj et al. (2014) reported that nearly 32.3 and 42.8% of the medical and engineering students, respectively complained of burning sensation, a lower prevalence of 20.9% was reported by Talwar et al. (2009).

Akinbinu and Mashalla (2013) reported 30.9% frequency of eyestrain as compared to 53.4 and 20.4% in the mild and severe categories reported by Chiemeke et al. (2007). Our finding was similar to 31% prevalence reported by Singh et al. (2007). Moderately high prevalence (54.6%) was reported among call centre workers in Brazil by Sa et al. (2012) 53.3% among university students in the United Arab Emirates (Shantakumari et al., 2014). Very high prevalence of 91.0 and 97.8% were reported by Smith et al. (1981) and Bali et al. (2007), respectively. The prevalence of eyestrain in university students in Malaysia was low accounting for only 16.4% (Reddy et al., 2013).

Redness

Eye redness has been reported as a symptom of CVS. The prevalence of eye redness has however been variable ranging from 13.9 and 23.3% among medical and engineering students, respectively (Logaraj et al., 2014). Higher prevalence of 40.2 and 40.7% symptoms of eye redness was reported in India by Shrivastava and Bobhate (2012) and Talwar et al. (2009), respectively. As previously stated not much has been reported in Africa. Some studies in Africa have reported the association between computer use and eye redness in the region. Chiemeke et al. (2007) reported low prevalence of eye redness in the severe category (3.9%) and as high as 36.9% in the mild category. A low prevalence (4.3%) of eye redness was also reported in the population studied (Akinbinu and Mashalla, 2013), and there could be several factors attributed to the variance in the frequency of eye redness ranging from methodological to environmental variations in the workplaces.

Double vision

Clinically, double vision (diplopia) indicates weakness of one or more extra ocular muscles and several causes including neurological lesions of the 3rd, 4 or 6th cranial nerves, disorders of neuromuscular junction, diseases of, or injury to the ocular muscles and orbital lesions. Diplopia could occur monocularly or binocularly. Binocular diplopia could be caused by a life-threatening lesion like intracranial tumour. Others are aneurysms, nerve palsies, myasthenia gravis or trauma. Monocular diplopia is when double vision continues when the unaffected eye is covered. In monocular diplopia (less common), the extra image may be seen as a “ghost image” (the two images are only slightly separated). Causes of monocular diplopia include dry eye, refractive errors, warped cornea, cataract, unstable tear film and media opacities (Karmel, 2009; Kozarsky, 2013; Nordqvist, 2014).

Double vision has been reported as one of the symptoms of CVS and the prevalence range from low to high. It has been reported that double vision was present in 12.9% of our study population (Akinbinu and Mashalla, 2013). Our finding however, was lower than 43.7 and 28.2% in the mild and moderate categories, respectively (Chiemeke et al., 2007). Similar high prevalence of diplopia (46%) was reported by Sen and Richardson (2007). In the absence of neurological lesions or diseases affecting the eye muscles, diplopia in CVS is more likely to be attributed with extraocular muscles fatigue resulting from glaring on computer monitor for extended period of time.

Dry eyes

A dry eye is a symptom constituting CVS. The dry eye in CVS however is different from the dry eye syndrome commonly seen in elderly persons. It has been established that blinking rate may be reduced by 60% in a person sitting at a computer monitor for an extended period. Consequently, a reduction in the blinking rate contributes to a reduced tear production which temporarily causes stress to the cornea, and resulting in dry eyes (Anshel, 2007). Although our data collection tool did not elucidate information on dry eyes, other studies have shown that dry eyes during computer use is a major problem. Dry eyes is more commonly reported among women, elderly and those who wear contact lenses, and less common in the younger age-group and non-contact lenses wearers (Schaumberg et al., 2003; Glasson et al., 2003; Nichols et al., 2005). Similar high prevalence of dry eyes was reported (21.5%) among male and 10.1% among female Japanese office workers using VDT (Uchino et al., 2008). On the contrary, Logaraj et al. (2014) showed nearly 18.6 and 30.0% of female and male respondents, respectively reported dry eyes following computer use. In their study, nearly 53.9% of the engineering students were viewing computer for more than four hours per day compared to 14.9% among medical

students who were viewing computer for more than four hours per day.

Studies on the association between wearing spectacles and occurrence of CVS symptoms have shown that individuals who wear spectacles experience the symptoms more significantly than those who do not (Reddy et al., 2013). Students wearing contact lenses were 40.8% likely to develop dry eyes as compared to 22.3% of the non-contact lenses wearers (Logaraj et al., 2014). These findings create a challenge to Optometrists because of the increased trend of individuals requesting contact lenses in the modern world.

Watery eyes

In contrast to dry eyes seen in CVS, other computer users have reported watery eyes among their complaints. In a study among university students, Reddy et al. (2013) reported that 4.3% of the study population had complained of watery eyes. Study by Akinbinu and Mashalla (2013) reported 10.8% of the population experienced watery eye which is comparable to Chiemeke et al. (2007) who reported 11.7% (moderate) complaints of watery eye.

One of the possible explanations for watery eye during computer use can be associated with dry eyes in which reflex tears are produced. Ocular surface dryness stimulates the reflex arc of the 5 and 7th cranial nerves producing excess tears (Price and Richard, 2009). Reflex tears are different in composition from the normal (basic tears) needed to lubricate the ocular surface. Reflex tears are aqueous and are deficient of the mucin and oil needed for proper tear film mechanics (Haine, 1998); they do not help control dryness, so the eye may react further and produce more reflex tears (Nordqvist, 2014).

Worth noting are other ocular disorders that can cause watery eyes, chronic blepharitis, trichiasis, corneal abrasion, viral/allergic conjunctivitis, ectropion, canalicular obstruction, exposure keratopathy (Price and Richard 2009) and more importantly eyestrain due to uncorrected refractive error (Scott & Tidy 2013).

Economic cost of CVS

Healthy vision is critical for employees to maintain high productivity and efficiency at their workplaces. To employers, eye injuries and occupational-related vision problems are likely to lead to economic costs and affect organisational effectiveness and efficiency. In a recent cost-analysis study in the USA, the estimated expenditure on eye disease health amounts to US $16 billion annually (Rein et al., 2006). Such an amount exceeds the US $7.2 billion expenditure on breast cancer (Brown et al., 2001) and US $9.4 billion on HIV (Hellinger and Fleishman, 2000). Mounting evidence shows that CVS can significantly harm workplace productivity, as it places an unusual strain on human physical well-being thereby reducing the quality of life (Torrey, 2003). Previous studies (Izquierdo et al., 2004; Chiemeke et al., 2007; Divjak and Bischof, 2009) have demonstrated a direct correlation between proper vision correction and the time required for a computer worker to complete a task; and that productivity is reduced even more among computer users who were unaware that they had vision problems. CVS is therefore a significant public health problem as it affects computer users from various vocations; Architects, Accountants, Flight controllers, Scientists, Engineers, Lecturers, Secretaries to mention a few (Torrey, 2003).

Management of CVS

CVS is a diagnosis of exclusion, hence acceptable diagnostic procedures should be established and the tendency to label any vague collection of symptoms as CVS should be discouraged (Bali et al., 2007; Chakrabarti, 2007). Since the symptoms of CVS can occur in people who do not use computers, the diagnosis of CVS should be made in conjunction with the symptoms the computer-using patient reports (Anshel, 2006). Therefore, the patient history should be taken, including age, chief complaint and onset of symptoms (Izquierdo, 2010). A questionnaire should be administered to collect information about the history of computer use, work habits, window proximity, ceiling and desk illumination, type and position of the computer (Anshel, 2007). Previous eyeglasses and eye drops should be evaluated. Review of systems may include history of disease conditions like xerostomia, thyroid disease, menopause, arthritis, carpal tunnel syndrome, Parkinson's disease; and systemic medication use (anticholinergics, antihistamines, antidepressants and diuretics) that may exacerbate dry eye symptoms (Izquierdo, 2010).

There are variations in the recommendations on reducing the symptoms of CVS with the majority of practitioners recommending improving work environment including reducing glare by adjusting light at the workstation, stay a good distance from the computer, at least 20 to 28 inches after staring for 20 min, look away and focus on an object that is 20 feet away for 20 s (American Optometric Association, 2013). Similarly, frequent breaks and looking at a distant object away from the computer terminal at least twice an hour was sufficient to prevent CVS symptoms (Cheu, 1998). However, most patients put under such measures receive temporary symptomatic relief (Gangamma et al., 2010).

Various studies have recommended different approaches to treat CVS. For people viewing images on a typical computer screen at a distance of 20 inches, Watt (2003), Huber-Spizy and Janeba (1997) and Rathore et al. (2010) recommended that such people would require

special spectacles to reduce discomfort. Subsequent modifications of occupational progressive lenses were designed for viewing mid-distance and near distance objects (VDT) and computer accessories (key board, mouse), respectively (Butzon and Eagles, 1997). Feigin (2003) reported beneficial effects of spectral filters for refraction dynamics among computer users. His study showed that coating lenses with antireflective substances helped in reducing glare and workers on VDT who were using spectral filters were more comfortable at work than those not wearing such glasses.

The use of pharmacological agents in treating CVS is still inconclusive. In a study among Indian Opthalmologists, Bali et al. (2007) reported 97.8% of the practitioners agreed that the main mode of treatment of CVS is artificial tears. Elastoviscous eye drops were reported to be more effective in reducing discomfort than regular normal saline solution (Freudenthaler et al., 2003). In another study, herbal eye drops (Itone eye drop) demonstrated more beneficial effects on reducing the CVS symptoms than artificial tear substitutes (Biswas et al., 2003). Other pharmacological agents used to treat CVS range from analgesics (topical Non-Steroidal Anti-Inflammatory Drugs) to steroids (topical steroids, topical cycoplegics) (Bali et al., 2007). The variety of the prescribed pharmacological agents suggests that they all aim at alleviating ocular-surface related symptoms and the complexity of treating CVS. It can be concluded that, apart from using ocular surface lubricants, computer glasses and counselling for improved workplaces, there is still no available remedial measures for the prevention and cure of CVS in the modern medicine (Wikipedia, 2011). Recent developments in the search of cure for CVS have recommended alternative systems of medicine including Ayuverda, known for years in India for improving homeostasis and ocular strength (Gangamma et al., 2010; Dhiman et al., 2012). Further studies are still needed to determine the efficacy of the alternative modalities in the treatment of CVS.

Conclusion

With advances in technology and dependency on information technology, computer has become a common tool in schools, colleges, universities and workplaces. It is more so now because in 2000, it was reported that more than 75% of daily activities of all jobs involve the use of the computer (Ihemedu and Omolase, 2010). Literature indicates that prolonged viewing of VDT is associated with visual and musculoskeletal symptoms. The visual symptoms constitute a syndrome manifested by symptoms of headache, eyestrain, tired eyes, blurred vision, irritation and burning sensation in the eyes, eye redness, and double vision. While the syndrome has been well described among computer users especially in the developed world, increasing dependence on computer in the developing world suggests that CVS is a growing public health problem which is not very clearly understood.

CVS has been reported to affect all walks of life and children are equally affected. While most ministries of education in developing are advocating modernisation of libraries, building and furnishing computer laboratories and enhancing ICT application in teaching and learning there is not much literature on the impact of the computer on children's vision in the developing countries, more specifically in Africa. Similarly, the growing number of computer usage as a strategy for enhancing efficiency and effectiveness at workplaces is likely to have health effects of employees, the extent of which has not been fully researched.

CVS significantly impairs workplace productivity and reduces the quality of life by placing unusual strain on the human physical well-being. Not much research is available on the treatment of CVS. Therefore, strategic interventions are required to minimize the impact of the modern epidemic on the productivity, efficiency and quality of life of the computer users. Further studies are recommended to be carried among adults at the workplaces, among children in schools and students at colleges and universities for the purpose of informing development of implementable and effective measures to reduce the health impact of computer technology health.

RECOMMENDATIONS

Given the overwhelming symptoms experienced by computer users, adequate education about CVS and its prevention amongst people at risk is highly recommended. In addition, special attention should be given to the young population including children and students in schools, colleges and universities. Training institutions should develop baseline databases and learning materials, that is, mainstream CVS in their curricula. Eye care practitioners on the other hand should endeavour to probe patients who attend clinics during consultations about the history of computer use and spend time to discuss with the patients about CVS. In order to minimise the risk factors for CVS, national policies should be developed and applied to regularly assess risks at work stations and develop ergonomic guidelines.

Conflict of Interest

The authors have nothing to declare as conflict of interest related to the paper.

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