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Computer vision syndrome: an obscure visual problem in modern daily life

Síndrome da visão do computador: um problema visual obscuro no cotidiano moderno

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KEYWORDS:

Computer vision syndrome; Digital eye fatigue; Visual fatigue; Blue light; Phototoxicity.

ABSTRACT

Technological advances in computing field and the facilitation of Internet access in the globalized world have revolutionized the way people work and communicate. However, these advances do not bring only benefits. These changes are affecting the social interaction and the mental and physical health of some individuals. As an example, the Computer Vision Syndrome gradually changed from a health problem in the workplace to a public health problem, with consequences on the individual's quality. This article reviews recent studies about the Computer Vision Syndrome and its characteristics, social impact and prevention.

PALAVRAS-CHAVE:

Síndrome da visão do computador; Fadiga ocular digital; fadiga visual; Luz azul; Fototoxicidade.

RESUMO

Os avanços tecnológicos no campo da computação e a facilitação do acesso à Internet no mundo globalizado revolucionaram a forma como as pessoas trabalham e se comunicam. No entanto, esses avanços não trazem apenas benefícios. Essas mudanças estão afetando a interação social e a saúde mental e física de alguns indivíduos. A título de exemplo, a síndrome da visão do computador passou gradualmente de um problema de saúde no local de trabalho para um problema de saúde pública, com consequências na qualidade de vida do indivíduo. Este artigo revisa estudos recentes sobre a Síndrome da Visão do Computador e suas características, impacto social e prevenção.

INTRODUCTION

Currently, technological advances in the area of computing and the facilitation of Internet access in the globalized world, allow workers to be more productive when it comes to online information[1]. However, they tend to spend more time looking at electronic devices with visual displays, such as computers, laptops, smartphones, tablets, and even smartwatches, contributing to the emergence of Computer Vision Syndrome (CVS)[2]. In addition, children, young people and the elderly are also affected when they spend many hours a day using electronic devices for entertainment, studying and interacting in social networks[3]. In this perspective, more than 80% of a person's learning is mediated by the eyes, demonstrating the importance of visual health[4]. Beyond that, the human being has never spent so much time in front of digital devices, thus several visual problems are oc-

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curring due to this practice; therefore, the Computer Vision Syndrome (CVS) has been recognized as a health problem for more than 20 years. The terms digital eyestrain and visual fatigue can also be used in this situation[5]. This condition is characterized by severe eye discomfort linked to the use of digital devices, including blurring, photophobia, dry eye, headache, and eye fatigue[6]. Thus, this article intends to contribute to the knowledge of academics and health professionals, in addition, to complementing existing publications on the subject. The authors aim to expose the Computer Vision Syndrome as well as explain the risk factors and ways of prevention.

METHODS

We utilized the Medline (PubMed) database for all articles published between 2013 and 2019 to perform a review of the literature, with the addition of 21 other articles that we considered relevant. Descriptors included were “Digital Eye Strain”; “Computer Vision Syndrome”; “Blue Light” AND “Phototoxity; and “Refractive error” AND “Computer”.

During October 2018 to June 2019, four researchers independently analyzed the filtered data, according to a customized protocol. The inclusion criteria included achieve the approval of more than 50% of the researchers and articles related to Computer Vision Syndrome. Duplicates, articles considered not relevant to the subject matter and articles that did not discuss Computer Vision Syndrome or its relevant associations were among the exclusion criteria.

RESULTS

Primary search pointed a total of 678 articles when combining the descriptors. After addition of 21 relevant articles and duplicates removal, 461 articles remained. After screening and eligibility filtering, 41 articles were included in this review. A PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram was included to illustrate each phase of this review (Figure 1).

The evaluated outcomes were finally included into the following categories in Discussion: “Computer Vision Syndrome”, “Visual fatigue”, “Blue light”, “Dry eye”, “Refractive errors” and “Prevention” (Table 1).

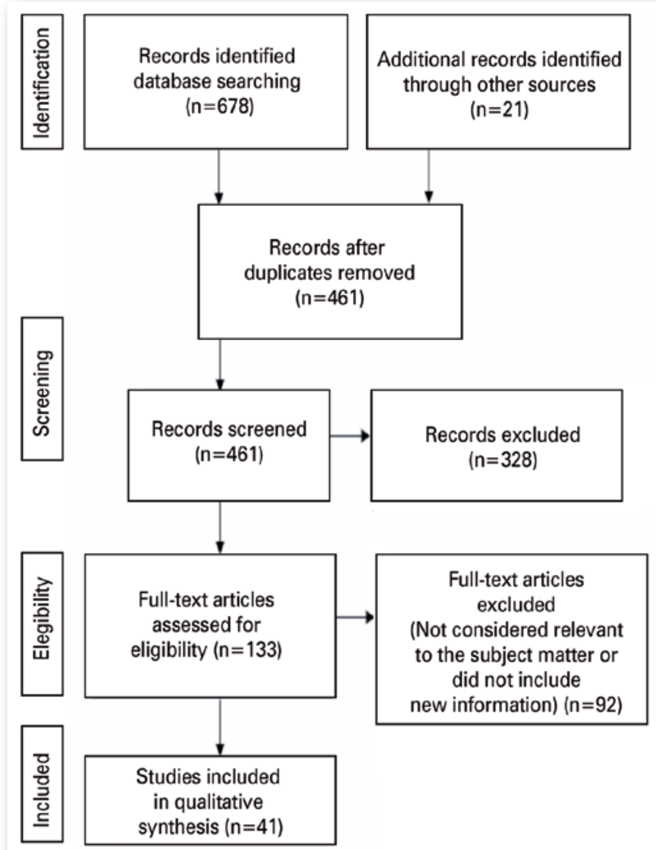

Figure 1. PRISMA Flow Diagram.

Table 1. Topics approached during this review and articles discussing each subject matter.

Main topic approached	Articles
General aspects of the Computer Vision Syndrome	2015 Salva[4]; 2016 Ranasinghe[9]; 2016 Tauste[11]; 2017 Randolph[1]; 2017 Bogdănici[8]; 2018 Lurati[3]; 2018 Munshi[3] 2018 Ahmed[7]; 2018 Dessie[10]; 2019 Seguí-Crespo[2]; 2019 Coles-Brennan[5]
Visual fatigue related to the Computer Vision Syndrome	2017 Park[14]; 2017 Maducoc[16]; 2017 Long[17]; 2017 Yoshimura[18]; 2018 Sheppard[12]; 2018 Antona[15]; 2019 Lin[13];
Risks associated to the blue lights exposition	2015 Jaadane[19]; 2016 Marshall[20]; 2016 Tosini[21]; 2016 Lee[25]; 2017 Leung[22]; 2019 Twenge[23]; 2019 Niwano[24];
Aspects related to dry eye and Computer Vision Syndrome	2013 Portello[29]; 2016 Parihar[28]; 2018 Fahmy[26]; 2018 Craig[27]
Relationship between Computer Vision Syndrome and refractive errors	2014 Choi[32]; 2014 Jones-Jordan[34]; 2015 Williams[31]; 2015 Jin[35]; 2015 He[36]; 2017 Torii[30]; 2018 Lim[33];
Important points about Computer Vision Syndrome prevention	2011 Tribley[41]; 2012 Sa[39]; 2014 Cardona[38]; 2015 Van der Lely[40]; 2018 Kolbe[37]

DISCUSSION

Computer vision syndrome

The main occupational risk of the 21st century and its symptoms affect almost 70% of all computer users, with the main symptoms: digital eyestrain, dry and irritated eyes, eye tiredness/fatigue, blurred vision, red eyes, burning eyes, excessive tearing, double vision, headache, sensitivity to light/brightness, slowness in changing focus and changes in color perception[7] (Table 2). Symptoms can be aggravated in situations with poor ambient lighting (favoring only the brightness of the screen of a digital device), excessive brightness of the display screen, reflection on the screen, inadequate viewing due to distances and poor posture, or a combination of these factors[8]. CVS affects around 60 million people around the world, resulting in a reduction in the quality of life of those who suffer from this condition[9].

In this perspective, CVS can generate several symptoms in which they are not directly related to the eyes, such as stress, irritability, increased nervousness, fatigue, and drowsiness. The texts and figures on the screens of digital devices are created by variations of small points of light known as pixels, which are brighter in the center and decrease in intensity towards the edges, making it difficult for the human eye to focus[10]. Also, users of contact lenses who use the computer for more than 6 hours a day are more likely to develop CVS than those who do not wear contact lenses and use the computer for the same period, with a prevalence of 65% vs. 50% (OR=4.85; 95% CI) 1.25-18.80; p=0.02)[11].

Visual fatigue

Visual discomfort induced by digital mobile devices (Computers, smartphones, notebooks, smartwatches etc.) is a symptom that can be associated with Computer Vision Syndrome (CVS)[12]. Glare-free displays can relieve symptoms of discomfort eye piece and improve visual performance[13]. However, when using these devices indefinitely, visual fatigue can be induced even if the devices are equipped with automatic brightness balance technology during display[14].

Thus, even in conditions of similar environments and with healthy individuals, prolonged reading on a smartphone is more harmful than the printed reading concerning visual fatigue and worsens even more when this practice is performed in an environment with little or no lighting[15]. Individuals who substitute printed reading for reading on e-readers for an extended period are 4.9 times more likely to report severe visual fatigue (95% CI [1.4 - 16.9]), even those who do not have clinical characteristics that can predispose this condition[16].

Besides, the viewing distance (distance between the head and the hand holding the smartphone) during a 60 min period of reading a text on a smartphone tends to decrease. In this case, the symptoms of eye fatigue are more reported after this practice, even in individuals with normal visual acuity and without accommodative or binocular visual disturbances[17]. Consequently, when using a smartphone before sleeping in the supine position, the viewing distance tends to decrease normally as a matter of comfort. This correlates with worsening sleep status and sleep efficiency, as the blue light from digital device monitors directly influences the reduction of melatonin secretion, which is one of the causes for a lower quality of sleep[18].

Table 2. Frequency of symptoms caused by Computer Vision Syndrome.

Symptoms	Frequency
Dry eye	31 and 32%
Visual fatigue	55 and 81%
Tendon disorders	15%
Tendon disorders (hand/wrist área)	12%

Blue light

In this perspective, the damage to the retina induced by light depends on the intensity of the radiation, the wavelength of the radiation, and the exposure time[19]. The blue light range is between 400-490 nm, which can cause damage to the photoreceptors, where the highest risk of damage to the retina is associated with wavelengths with a peak of 441 nm. Contributing to the appearance of pathologies such as cataracts and macular degeneration (depending on the period and exposure), this being the third largest cause of blindness worldwide[20].

Man evolved under sunlight, demonstrating that blue light provides changes in the physiology of the circadian cycle[21]. In this way, daytime exposure to blue light regulates the internal circadian biological clock, stimulating the brain to stay awake during the day, inhibiting the secretion of melatonin[22]. Thus, the use of electronic devices, over a long period, tends to decrease hours of sleep, and can affect any age[23].

Blue light can harm cells on the eye surface, depending on the intensity and time of exposure[24]. Excessive exposure to blue light with short wavelengths can induce oxidative damage and apoptosis to the cornea[25]. In one experiment, phototoxicity caused by prolonged exposure to blue light was mitigated in an experiment by 10.6% to 23.6% by blue filter lenses. However, the use of blue light filters also decreased scotopic sensitivity by 2.4% to 9.6% and melatonin suppression by 5.8% to 15.0%, more than 70% of the participants in this experiment did not had optical changes detected[22].

Dry eye

Dry eye syndrome is a common disorder, comprising around 25% of the causes of patient visits to the ophthalmology office, affecting women more than men, especially after menopause[26]. Thus, dry eye syndrome has a multifactorial nature and is characterized as a disease whose central pathophysiological concept is the loss of homeostasis of the tear film[27].

Its main symptoms are eye discomforts, such as burning, watering, foreign body sensation, and eye fatigue, being reported as some of the symptoms of Computer Vision Syndrome (CVS)[28]. In addition, CVS is reported to produce significant symptoms in approximately 40% of office workers, and around 15% and 30% of the general population (depending on the diagnostic criteria adopted) have dry eye symptoms[29].

Refractive Errors

Myopia is the most common refractive error caused by stretching the axial length of the eyeball[30]. Multiple factors are involved in the development of myopia. Both genetics and the environment play an important role in the development and progression of myopia[31]. It is known that the lower participation in outdoor activities is a significant environmental risk factor for myopia, as well as the low serum dose of 25-hydroxyvitamin D[32,33].

Regarding the genetic contribution, heritability is estimated at 0.77 to 0.94 in twins[34]. However, while a substantial proportion of myopia cases can be explained by inheritance, environmental etiology is extremely important. There is a consensus that genes can determine susceptibility to environmental factors, to the point that adding 40 minutes outdoors, when comparing the usual activity in children aged six years, it can result in a reduction in the incidence rate in myopia in the following three years[35,36].

Prevention

Adequate lighting in the work or study environment can improve visual comfort and performance. It is recommended that the reduction of the monitor's brightness and contrast and, if possible, the light from the window (solar lighting) should be on the side, helping to illuminate the environment. The use of progressive computer-specific lenses reduces the perception of CVS symptoms[37,38].

It is interesting to rest the eyes during prolonged use of the computer and impose a time limit in front of a computer, when possible[39]. Moreover, blue light blocking glasses have a significant effect in decreasing the suppression effect of melatonin caused by the illumination of LED screens[40]. After 2 hours of continuous use of the computer, users should rest their eyes for 15 minutes. In addition, it is necessary to keep the screen of the digital device always clean and focused. Regular eye exams are essential to maintain visual health and prevent CVS[41].

Computer vision syndrome is already considered a public health problem, despite being new and still poorly understood. Currently, it is not feasible to go back technologically and exclude electronic screens from modern daily life. Therefore, avoiding the risk factors mentioned throughout the article and periodically having eye consultations can be a good alternative for the prevention of this syndrome. Further studies are needed to better address this issue.

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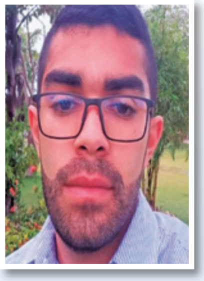

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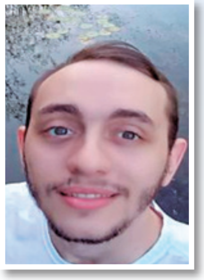

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