PRESBICIA, ASTHENOPIA, FATIGA OCUALR, COMPLICACIONES CON LOS JOVENES IGUALMENTE Y LAS PANTALLAS DIGITALES

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* In this day and age, computers and visual display terminals have become an integral part of our daily lives. Collectively referred to as digital devices (DD), smartphones, tablets, electronic book readers, and computers have significantly increased in recent years and resulted in several ocular and visual symptoms related to their use, conjointly now known as digital eye strain (DES) or computer vision syndrome (CVS) [1].

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* Asthenopia is a major complaint in subjects with CVS. The results of a 2008 questionnaire returned by over 400 computer operators in India revealed asthenopic symptoms in 46.3% of subjects.4 Similarly, a survey of 212 bank workers in Italy found asthenopic symptoms in 31.9% of the subjects, though it is worthwhile noting that this percentage was calculated after 87 subjects were excluded due to uncorrected hyperopia, undercorrected astigmatism, or overcorrected myopia, because the investigators wanted to investigate only subjects ‘without organic visual disturbances’.5
* It is unclear whether asthenopia during computer use is associated with age,4,7–9 although the prevalence does seem to be higher in females.10
* In a review of asthenopia, Sheedy et al.15 noted that symptoms commonly associated with this diagnostic term included eyestrain, eye fatigue, discomfort, burning, irritation, pain, ache, sore eyes, diplopia, photophobia, blur, itching, tearing, dryness and foreign-body sensation. While investigating the effect of several symptom-inducing conditions on asthenopia, the authors determined that two broad categories of symptoms existed.
* The first group, termed external symptoms, included burning, irritation, ocular dryness and tearing, and was related to dry eye. The second group, termed internal symptoms, included eyestrain, headache, eye ache, diplopia and blur, and is generally caused by refractive, accommodative or vergence anomalies.
* The correction of presbyopia can be problematic for patients who spend extended periods of time viewing digital screens. These difficulties may be most severe when viewing desktop monitors placed at fixed viewing distances and gaze angles. These screens are generally placed at or just slightly below primary gaze. Accordingly, the use of a standard bifocal spectacle lens, with the segment placed for a target positioned in downward gaze and providing clear vision for a viewing distance around 40 cm may be inappropriate
* Wearers of many progressive addition lenses experience similar difficulties. In providing an appropriate form of spectacle correction, practitioners must consider both the viewing distance and gaze angle (both horizontal and vertical). In terms of viewing distance, the United States Occupational Safety and Health Administration (OSHA) state that the preferred viewing distance for a desktop monitor is between 50 and 100 cm (representing an accommodative stimulus in a corrected individual of between 1 and 2 D). Additionally, they recommend that the centre of the computer monitor should normally be located 15–20 below the horizontal eye level and the entire visual area of the display screen should be located so the downward viewing angle is never >60 (http://63.234.227.130/SLTC/etools/computerworkstations/ components\_monitors.html).
* The use of non-spectacle methods of correcting presbyopia, such as contact lenses and intra-ocular lenses may also be problematic. For example, alternating or translating lens designs where the near portion of the lens moves in front of the pupil during downward gaze33 are unlikely to be successful when viewing a desktop computer screen positioned in primary gaze. A monovision correction, where one eye is corrected for distance vision while the fellow eye is corrected for near may be successful in early presbyopes (although the loss of stereopsis may provide difficulties). However, as the near addition power increases, the loss of clear intermediate vision may become an issue. ‘Simultaneous vision’ type lenses, whereby multiple powers are positioned before the pupil at the same time, are becoming increasingly common.
* These lenses require the wearer to suppress the blurred images.34 There appears to be little research at the present time as to whether the quality of intermediate vision provided by these lenses is sufficient to avoid CVS symptoms, given that small residual refractive errors (or the presence of significant amounts of retinal blur) may be challenging to the patient. Other new forms of presbyopic correction, such as multifocal and ‘accommodating’ intraocular lenses35 may raise the same issues as multifocal contact lenses, and further studies are required to determine whether they provide sufficiently clear vision for prolonged viewing of electronic screens at a variety of distances and gaze angles
* Laptop computers are typically placed at different distances and gaze angles to desktop models. The fact that the keyboard is attached to the monitor means there is less flexibility in adjusting the workstation while the keyboard remains in comfortable reach.36 The smaller screen size (and text height) may also impact upon the viewing distance depending on the observer’s visual resolution. Harris and Straker37 noted that laptop computers may be used in a variety of positions, ranging from sitting at a desk, sitting with the computer on one’s lap or even lying prone. Accordingly, a form of presbyopic spectacle correction prescribed for a desktop computer is often inappropriate for a laptop. A laptop computer is often viewed in downward gaze at a distance which may approximate the position at which a presbyopic individual would read hand-held printed materials. This may actually make providing a spectacle correction easier for these types of devices. A
* Vergence While few studies have examined the vergence response during the course of VDT work, several investigators have measured vergence parameters before and after periods of computer usage. For example, Watten et al.54 measured positive and negative relative vergence (or vergence ranges)55 at near both at the beginning and end of an 8-h workday. They observed significant decreases in both parameters, implying that computer use decreased one’s ability to converge and diverge appropriately. In contrast, Nyman et al.56 found no significant change in positive or negative relative vergence at near after 5 h of VDT work. They also reported no significant change in either distance and near heterophoria or the near point of convergence (NPC) following the work period. Similarly, Yeow and Taylor57 also observed no significant change in NPC after short term

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* The mass digitization of books is changing the way information is created, disseminated and displayed. Electronic book readers (e-readers) generally refer to two main display technologies: the electronic ink (E-ink) and the liquid crystal display (LCD). Both technologies have advantages and disadvantages, but the question whether one or the other triggers less visual fatigue is still open
* Reading behavior has been investigated by psychologists for several decades, some of them focusing on low-level processing of words such as visibility [1] or legibility [2] and others on comprehension levels [3], [4], [5]
* . Usually, the visibility processing (i.e. distinguishing a visual signal from the background) is not a matter of interest in reading since everyone assumes that visual factors are generally fitted in reading experiments. This assumption would be true if any linguistic material was presented on the same support. In the real world this cannot be true, and the use of computer displays for presenting linguistic material may involve a large variability. For example, it has been shown that the display polarity (negative/positive polarity) [7] or the refresh rate [8], [9] might affect vision during reading.
* E- readers generally refer to two main display technologies: the electronic ink (E-ink) and the liquid crystal display (LCD). The Eink (i.e. electronic ink or electronic paper) is designed to reproduce the appearance of ink on paper. With respect to LCD, the main advantages of E-ink display are better readability of their screens - especially in bright sunlight - and longer battery life. While E-ink readers do not allow colors and are limited for reading, LCD ereaders are usually tablets, which means they are not just a replacement for a book, rather multifunctional devices, which can be used for communication, organization or leisure activities [10]. LCD tablets have faster screens capable of higher refresh rates and are more suitable for interaction. Some last generation E-ink displays, like the Kindle Paperwhite, offer a reading experience in all lighting conditions, from bright sunlight to bedtime reading, guiding light towards the surface of the e-ink display from above
* According to Siegenthaler et al. [10], the discussion whether E-ink or LCD is better for reading is emotional, and scientific evidence is quite sparse. In fact, just few studies are focused on reading behavior and even less deal with visual fatigue. Moreover, the results of these studies are devicedependent, and the rapid technological advancement of these supports turns recent results out of date quite quickly. Concerning reading behavior, Shen et al. [11] found E-ink reader (Sony e-reader) to have higher search accuracy with respect to LCD (Kolin e-reader). Siegenthaler et al. [12], found no differences between the same E-ink device (Sony e-reader) and LCD (iPad 1st generation), as confirmed by both subjective (VFS
* s). Siegenthaler et al. [10] showed that iPad 1st generation, under special artificial light conditions, may even provide better legibility than Sony e-reader. Siegenthaler et al. [14], comparing five E-ink displays and a paper book, found that reading behavior on e-readers is very similar to the reading behavior on print (i.e. no differences in reading speed and regressive saccades), and that E

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* Computers are evolving through various types, screen sizes, and graphics to accommodate the needs of users [14], where computer monitors have the greatest effect on users. In Thailand, it was found that the most commonly used screen size was 18.5 inches, followed by 21.5 inches, and 23 inches [15]; a survey of computer use at Walailak University found that the most common computer screen size was 18.5 inches, followed by 23 inches
* Additionally, previous studies demonstrated that decreasing the distance between the eyes and the computer screen contributed to visual fatigue, with a significant decrease in the frequency of flashing light [5]. Computers are developed in various sizes and screen styles [13, 15]. However, studies comparing the effects of different computer screen sizes on eye fatigue are scarce.
* The achieved results found that increased screen size enhances the viewing distance and decreases the screen height [14]. This study also suggested that increasing the distance between the eyes and the computer screen resulted in a significant reduction in dry eyes, blurred vision, and headaches [13]
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* Across all age groups in developed nations, engagement with digital devices has increased substantially in recent years, particularly in the field of mobile media.5 A multination European study including England, reported that by 3years of age, 68% of children regularly use a computer and 54% undertake online activities.6 In 2016, it was estimated that UK adults typically spend 4hours 45min per day using digital media,7 with a similar pattern in the USA, where approximately two-thirds of adults aged 30–49 years spend five or more hours on digital devices.
* In older age groups, use of technology is growing rapidly (figure 1) between 2011 and 2017, the proportion of the population classed as ‘recent internet users’ (within the last 3 months) more than doubled in the 75 years and over age group, and increased from 52.0% to 77.5% in those aged 65–74 years.9 Recent US data indicate that 37% of adults aged 60 years and over spend five or more hours per day using digital devices, and this age group prefers using laptops and desktops for browsing the internet, whereas younger adults are more likely to use smartphones for this purpose.8 Use of social media and multitasking is particularly prominent among younger adults with 87% of individuals aged 20–29years reporting use of two or more digital devices simultaneously.8
* According to the American Optometric Association,10 the most common symptoms associated with DES are eyestrain, headaches, blurred vision, dry eyes and pain in the neck and shoulders. Asthenopia is the formal term for eye strain, for which two distinct mechanisms and sets of symptoms were described by Sheedy et al.
* External symptoms of burning, irritation and tearing and dryness were noted to be closely related to dry eye, while internal symptoms of strain, ache and headache behind the eyes were linked to accommodative and/orbinocular vision stress.
* Similarly, Portello et al12 also identified a clear split of computer-related symptoms into two categories: those associated with accommodation (namely, blurred vision at near, blurred distance vision after computer use and difficulty refocusing from one distance to another) and those that seemed linked to dry eye (irritated/burning eyes, dry eyes, eyestrain, headache, tired eyes, sensitivity to bright lights and eye discomfort).
* The 2016 Digital Eye Strain report,8 which included survey responses from over 10 000 US adults, identified an overall self-reported symptom prevalence of 65%, with females more commonly affected than males (69% vs 60% prevalence). DES was reported more frequently by individuals who used two or more devices simultaneously, compared with those using just one device at a time, with prevalences of 75% and 53%, respectively.
* efractive error and presbyopia Correction of refractive error (notably astigmatism) and presbyopia is accepted as an important intervention in DES sufferers. Double-masked, randomised studies have established that even 0.50–1.00 D of uncorrected simulated astigmatism impacts negatively on subjective visual comfort,64 65while 1.00–2.00 D of induced or natural astigmatic error may increase task errors by up to 370% and reduce productivity of computer workers substantially.4 Uncorrected astigmatism may be a particular issue among presbyopic patients using off-the-shelf reading spectacles and contact lens wearers with undercorrected or uncorrected cylindrical errors. The variety of working distances involved in using different digital devices can prove problematic for individuals requiring a near vision add. Small fonts are common on smartphones due to reduced screen size, and a mean working distance of 32.2cm was established in adults undertaking a web-based smartphone task,66 which may reduce during prolonged viewing.67 Minimum viewing distances of 500–635mm68 69 have been recommended for computer monitors, while working distances of around 500mm, 70 or slightly less with increased age,71 are typical for e-readers. Consequently, a single near add may not provide adequate vision across the range of demand levels, meaning that multiple prescriptions or an occupational correction (eg, combining intermediate and near prescriptions) are required. Computer glasses, with progressive lenses designed to optimise vision in the intermediate and near regions, may reduce symptoms in presbyopic computer users to a greater extent than ergonomic intervention,72while a 2004 study indicated that over a 12-month period, some designs of computer lenses provided greater overall satisfaction and improved subjective evaluation of area of clear vision than single vision spectacles.73 UK employees using display screen equipment (DSE) habitually as a significant part of their work are entitled to a sight test funded by their employer, along with spectacles specifically for screen use.74 According to College of Optometrists guidance on examining DSE/ computer users,75 practitioners should carry out a full eye examination to determine the cause of any visual problems associated with screen use, ask the patient to describe their workstation and environment and provide appropriate advice including ergonomic information. Despite near-universal use of digital devices, little is known regarding the interpretation of this guidance or how UK optometrists examine and advise patients regarding digital device usage, whether for professional or social purposes. To optimise patient care, increased education of optometrists and opticians regarding DES could be advantageous, given the high prevalence of the condition and continuing research developments in this active field, which may not be covered in detail in undergraduate training programmes.
* Accommodation and vergence anomalies Accommodative anomalies including poor facility and high lag may reduce visual comfort during nearwork, including computer use. Clinically, accommodative facility may be assessed with plus and minus sphere flipper lenses while the patient fixates a near target, counting the number of cycles ‘cleared’ in 1min (cpm).76 With the conventional ±2.00 D flippers at 40cm, 11 cpm has been described as the cut-off between symptomatic and asymptomatic adults,76 although more recent research suggests that facility testing should take into account the amplitude of accommodation of individual patients and be scaled accordingly.77 Lag of accommodation is usually assessed by dynamic retinoscopy, with the distance-corrected patient fixating a near target.78 Ophthalmic practitioners should examine visual function at the distances at which screens are used by individual patients58 to ensure clear vision at appropriate task distances. The American Optometric Association promotes the 20-20-20 rule (a 20s break every 20min to view a distant object at 20 feet) to alleviate DES.10 Frequent short breaks can relax accommodative and vergence responses, attenuating asthenopic symptoms without impairing productivity.79 80 Vergence dysfunctions include various motor disorders, for example, convergence insufficiency, decompensated heterophoria and poor vergence facility. Individuals with binocular vision problems experience greater visual symptoms with prolonged use of the eyes.81 82 Vergence characteristics have been studied with respect to computer operation, producing mixed results. Watten and colleagues reported significant reductions in vergence ranges (assessed by increasing base in and base out prism power, until blur experienced) at the end of the working day,83 although other authors have shown no differences in vergence functions between individuals involved in computer work and those not using a computer.84–86 Rosenfield et al54 reported no change in vergence facility (ability to make rapid changes in vergence response, using alternate presentation of base out and base in prism) following a 25min computer task. Later work indicated no variation in associated phoria during computer work, although notably, the least symptomatic individuals had a mean associated phoria of 1.55Δ base in, that is, a slightly reduced vergence response.47 Around 20% of individuals were found to prefer an induced small exo-associated phoria compared with an ortho condition, BMJ Open Ophthalmology: first published as 10.1136/bmjophth-2018-000146 on 16 April 2018. Downloaded from https://bmjophth.bmj.com on 25 November 2024 by guest. Protected by copyright. Sheppard AL, Wolffsohn JS. BMJ Open Ophth 2018;3:e000146. doi:10.1136/bmjophth-2018-000146 7 Open Access suggesting that CVS may be ameliorated by stimulating an exo-associated phoria in some individuals.58

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* Several universities are still implementing online teaching platforms in order to limit COVID-19 spread in campus environments; as a result, students spend extended hours daily using electronic devices. However, although China is in the recovery process and some universities are slowly reintroducing physical teaching, most international students are still using online education, mainly because they share classes with their peers who left China at the beginning of the pandemic

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* It has been shown that 30% of workers use computers all the time during their working days based on the findings of the European Working Conditions Survey (EWCS, 2010) [4], and 25% of computers between onefourth and three-fourths of the time spent during the working hours [3]. Moreover, computer use is not restricted to adults, as a recent study involving over 2000 American children between the age of eight and 18 years found that, in an average day, children spend about 7.5 hours using entertainment media, 4.5 hours watching TV, 1.5 hours on a computer and over an hour playing video games [5].
* Students of any age have gradually transitioned to computer-based learning believing that it is a more attractive option compared to conventional classroom teaching, not to mention that most schools and universities nowadays have smart boards and require online submission of homework/assignments. This paradigm shift has penetrated among youth [6]. The prevalence of deteriorating effects of prolonged DD use among university students translates to CVS/DES symptoms, especially when the visual demands of a given task exceeds the visual abilities of a student to comfortably perform the task at hand [7].

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* Studies5,8,9 have revealed that the symptoms of CVS are more prevalent amongst spectacle and contact lens wearers.