Desktop Computer Use: Physiological and Psychological Problems and Potential Solutions

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Abstract

The purpose of this paper is to explain the dangers of excessive desktop computer use along with the solutions to treat such problems. In today's digital society, digital natives are introduced to all kinds of technology at a young age, specifically, desktop computers. This is because desktop computers are present in almost every aspect of the average person's life; they are found in homes, schools, and the work place. Because the desktop computer is a multipurpose piece of technology, it can be used for activities such as emailing, playing games, social media, and Internet; therefore, most people develop positive opinions about desktop computers. *While there are positive aspects to desktop computer use, the desktop computer has been proven to cause physiological as well as psychological issues such as vision problems, musculoskeletal pain, and sleep disorders to the user when used excessively; therefore, it is important to know how to combat these issues to ensure safe desktop computer use.*

Physiological and Psychological Problems Associated with Desktop Computer Use and Potential Solutions

Desktop computers have become an ever present commodity in today's digital society. The average person spends about one and half hours a day, which adds up to ten and half hours a week, at a desktop computer (Rosenfield 2011). On a desktop computer, a person can email, search the Internet, play video games, pay bills, shop, and much more. The ability to do so many activities on one device has caused people to form a positive opinion about the desktop computer; however, this is because those people are also unaware of the potential harm desktop computers cause to the user. *While there are positive aspects to desktop computer use, the desktop computer has been proven to cause physiological as well as psychological issues such as vision problems, musculoskeletal pain, and sleep disorders to the user when used excessively; therefore, it is important to know how to combat these issues to ensure safe desktop computer use.*

Definitions

Before learning about the eye problems caused by desktop computer use, one must have foundational knowledge about the functioning of the eye along with a few basic eye issues. The American Optometric Association (AOA), a national association for vision research led by a board of trustees consisting of many optometric doctors from around the nation, explains the functioning of tears in the eye. Every time a person blinks, the surface of the eye, the cornea, is covered in tears, which are vital to eye functioning because they keep the eyes clean and provide clear vision (American Optometric Association, 2017). Optometrist Dr. Gary Heiting discusses how the eyes function as a person views a desktop computer screen. In order to view a desktop computer screen, a person has to both focus and correctly converge, or inwardly rotate,

the eyes onto the computer screen using the muscles in the eye (as cited in Meece, 2012). Computer Vision Syndrome (CVS) is the collection of eye problems that are caused by desktop computer use; dry eye and eyestrain are the most common CVS problems (Rosenfield, 2011). The AOA defines dry eye as “a condition in which a person doesn’t have enough quality tears to nourish the eye” (American Optometric Association, 2017, para. 1). Dry eye can be caused by incomplete blinking, which is when the eyelid fails to cover the whole cornea during a blink, and reduced blink rate, which is when the number of blinks within a certain time interval is decreased (American Optometric Association, 2017). According to Dr. Heiting, eyestrain is stimulated by the overuse of the eye muscles, which are constantly being used to view the desktop computer screen (as cited in Meece, 2012). Computers are extremely damaging to the eyes, and they are also harmful to the structure of the body.

Musculoskeletal pain caused by desktop computers will be discussed in this paper, so it is necessary to understand the medical definition of a musculoskeletal pain. Musculoskeletal pain is defined as either pain in the bones, muscles, ligaments, tendons, nerves, or a combination of these (The Cleveland Clinic Foundation, 2017). This pain can be caused by injury or overuse; in desktop computer users, musculoskeletal pain is caused by overuse (The Cleveland Clinic Foundation, 2017). The two most common areas of musculoskeletal pain among desktop computer users are the lower back and neck. In order to sit at a desktop computer, the user needs to maintain an upright position, which stresses the nerves and muscles in the lower back, leading to lower back pain. Also, when viewing the desktop computer screen/monitor, computer users tend to flex the neck 20 degrees, which overworks the muscles in the neck; hence, causing pain in the neck (Calik, Yagci, Gursoy, & Zencir, 2014). Along with causing musculoskeletal pain, desktop computers are responsible for causing sleep problems.

Desktop computers cause sleep problems because they affect the functioning of the pineal gland in the brain, so it is important to have an understanding of what this organ does, and the role it has in sleep. The pineal gland, a crescent shaped organ located in the interbrain, is "a neuroendocrine gland that secretes the neurohormone melatonin" (Acer, Turgut, Yalcui, & Duvernoy, 2011, p. 41). In simpler terms, it is an organ that produces and releases melatonin, which is a neurohormone that causes feelings of sleepiness (Acer et al, 2011). Human eyes contain photosensitive retinal ganglion cells (pRGC), which are specifically sensitive to light at 464 nanometers, in other words, blue light (Matthias et al., 2012). When the pRGC detect blue light, they send messages through the optic nerve, which connects the eyes to the brain, to the pineal gland to inhibit the production of melatonin (Matthias et al., 2012). Therefore, people tend to get tired at night because there is less blue light emitted from the sun, the pRGC detect this, and inform the pineal gland to produce melatonin. However, this normal rhythm, normally called the circadian rhythm, is affected when people are exposed to blue light other than the blue light emitted from the sun. Today, most desktop computers are equipped with a light emitting diode (LED) backlight, which emits a large amount of blue light (Matthias et al., 2012), so people who view computers before bed often find it difficult falling asleep, displaying symptoms of insomnia, which is the inability to fall asleep.

After reviewing definitions of the physical functions and issues associated with the areas affected by desktop computer use, one can now explore the studies that prove overuse of desktop computers cause problems within each area, and learn the safety procedures recommended to combat these problems.

Vision Problems and Solutions

Mark Rosenfield, Ph.D. in vision sciences and author of several peer reviewed journals in the field, reviews studies in which CVS symptoms, specifically dry eye, are associated with desktop computer use. Two of the reviewed studies observed the blink rate of subjects while viewing a desktop computer screen (Rosenfield, 2011). One study observed 104 office workers while reading a book or relaxing, and then again while viewing the desktop computer screen. The mean blink rate per minute for the subjects reading or relaxing was 22 blinks per minute as opposed to seven blinks per minute while viewing the desktop computer screen. Another study, which followed the same procedure, of 26 subjects reported similar results. Before viewing the desktop computer screen, the subjects mean blink rate was 18.4 blinks per minute, and the mean blink rate while viewing the desktop computer was only 3.6 blinks per minute. Therefore, in both studies, the mean blink rate for the subject was reduced when he or she viewed a desktop computer screen. As a result, people who view desktop computers are highly likely to have dry eye because there is a lack of tears covering the eye every minute. Rosenfield (2011) also reviews a study in which the number of incomplete blinks performed by the subjects during a reading task on the desktop computer, and then on hard copy material, were compared; it was concluded that there was a higher number of incomplete blinks in the subjects who read the material on the desktop computer as opposed to the hard copy material. Hence, when a person views a desktop computer screen, he or she is likely to have a reduced blink rate or perform incomplete blinks. Both of these contribute to dry eye, which is a symptom of CVS (Rosenfield, 2011).

There are several ways to combat these eye problems caused by desktop computer use. Dr. James Sheedy, the “director of the Vision Performance Institute at Pacific University in Oregon” (Meece para. 8, 2012), recommends the 20-20-20 rule, which requires the desktop

computer user to take a break every 20 minutes, and observe something 20 feet away for 20 seconds. This gives the muscles in the eye a break from focusing and converging on the screen. In an Australian study of over 1000 computer workers, the 20-20-20 rule seemed to work. Out of the 1000 workers, 63.4 percent of them displayed CVS symptoms; however, the percentage dropped to only 25.2 percent when the workers were given periodic breaks (Rosenfield, 2011). Another solution is to purchase desktop computer glasses, which magnify the screen; hence, decreasing the amount to which the eye muscles need to focus and converge. As a result, this reduces the amount of eyestrain (Meece, 2012). According to the American Optometric Association (2017), eye drops, which add tears to the eye, aid in the prevention of dry eye during desktop computer use. Desktop computers have been proven to be harming people's eyes; however, they do more physiological harm to the body than just the eyes.

Musculoskeletal Pain and Solutions

In 2002, a recorded 20 billion dollars were spent on worker's compensation from musculoskeletal disorders in the United States alone (Rosenfield, 2011). Several studies have proven that desktop computer users are likely to develop musculoskeletal pains, specifically in the lower back and neck. The Cornell Musculoskeletal Discomfort Scale (CMDS) measures the location on the body (i.e.,11 different locations), frequency within the past seven days, severity, and the effect musculoskeletal pain has on the performance of a task, which changes depending on what version of the CMDS is used. A version of this scale was utilized in a study of 871 Pamukkale University students in Turkey; the objective of the study was to determine the effect desktop computer use had on musculoskeletal pain among the students (Calik et al., 2014). The task in this version of the CMDS was the ability to study. To assess desktop computer use, a questionnaire, which contained questions about how many years the subject had used a desktop

computer and the number of hours spent on a computer daily, was given to the students also. The mean number of hours spent on a desktop computer for the 871 students was reported to be 3.1 hours daily, and 21.5 hours weekly (Calik et al., 2014). The most affected areas were the neck, which affected 47.3 of the students, and lower back, which affected 43.7 percent of the students (Calik et al., 2014). Neck and lower back pain were also reported to have the largest impact on the students' ability to study; out of the 871 students, 21.6 percent of students reported that neck pain affected their ability to study, and 18.3 percent reported lower back pain. After running statistical tests on the data, the statisticians determined that an increase in computer use daily is correlated with lower back pain, and an increase in total computer usage is correlated with neck pain (Calik et al., 2014). Thus, if a person uses a computer for a few weeks, then he or she is going to feel pain in the lower back region; however, if the person continues to use the computer, then he or she will also develop neck discomfort along with the pre-existing lower back pain. A similar study was performed on 395 government office workers in Manisa, Turkey. A different version of the CMDS and the same questionnaire about computer use, used in the study of the Pamukkale University students, were used in this study; the task in the version of the CMDS was the ability to do government work (Ardahan & Simesk, 2016). The average time the subjects worked at their desktop computers was found to be seven hours; Out of the 395 workers, 67.8 percent of the subjects experienced neck pain, and 59.49 percent experienced lower back pain (Ardahan & Simesk, 2016). These percentages are higher than those in the study of the students; however, the average hours spent at a desktop computer was seven hours in this study while it was only 3.1 for the study with the students (Ardahan & Simesk, 2016). Thus, it is a logical argument to say the increase in percentage of musculoskeletal pain is related to the longer amount of time spent on a desktop computer. The percentage of people that reported neck and

lower back pain affected their ability to do work were 33.6 and 30.6 percent respectively, which is similar to the previous study (Ardahan & Simesk, 2016). This study also concluded that the more years of experience a person had using a desktop computer, the more likely he or she experienced neck pain.

One more study analyzed musculoskeletal pain among 1024 Nigerian subjects from six federal universities (Adedoyin, Idowu, Adagunodo, Owoyomi, & Idowu, 2005). A questionnaire, which asked about computer use as well as the area and severity of the musculoskeletal pain, was given to the subjects. The mean time spent at a desktop computer daily was found to be six hours for the subjects, and the areas of the body in which the most musculoskeletal pain was experienced occurred in the neck, which affected 73 percent of the subjects, and lower back, which affected 74 percent of the subjects (Adedoyin et al., 2005). Therefore, in each of these studies, neck and lower back pain were the most prevalent among desktop computer users.

There are a few safety procedures people can follow to minimize the severity of neck and lower back musculoskeletal pain. In the study of the government office workers, the results revealed that those who took breaks every three hours experienced a significantly less amount in the severity of musculoskeletal pain in all regions of the body (Adedoyin et al., 2005). Likewise, Calik et al. (2014) found that frequent breaks reduced neck and lower back pain, and proper monitor alignment, which prevented the desktop user from flexing the neck at 20 degrees, reduced neck pain. Not only is physiological harm being done to humans by desktop computers, but psychological issues such as sleep problems are also being caused by desktop computers.

Sleep Problems/Insomnia and Solutions

In Matthias et al. (2012), a study in which the production of melatonin during desktop computer use was performed. The subjects attended two five hour sessions that were one week apart from each other. During the sessions, the subject returned four hours before his or her usual bedtime, and sat in a cubicle where the only source of light was emitted by the desktop computer. In one session the subjects viewed a LED backlit desktop computer, and in the other they viewed a cold cathode florescent lamp (CCFL) backlit desktop computer, which emits much less blue light than the LED backlight. Throughout each session, the subject's salvia was recorded every half hour to record melatonin levels, and every hour the GO/NO GO task was performed (Matthias et al., 2012). The GO/NO GO task measures the reaction time; to perform to the task, the subject must press a button when the letter 'M' was displayed, and press nothing when the letter 'W' was displayed. After analyzing the melatonin levels in the saliva for the subjects, the authors of the study concluded "the evening increase in endogenous melatonin levels was suppressed and rose later under exposure to the LED screen compared to the non-LED screen" (Matthias et al., 2012, p. 4). In simpler terms, this means the natural evening production of melatonin was delayed during the session in which the subjects viewed the LED backlit desktop computer. Subjects reaction time decreased by 8.5 percent when viewing the LED back-lit desktop computer, and increased by 2.5 percent when viewing the CCFL back-lit one (Matthias et al., 2012). Therefore, when subjects viewed the LED back-lit computer, they had faster reaction times, indicating they were more awake (Matthias et al., 2012). A study conducted on 2155 students aged 11 to 18 from Thessaly, Greece, supported the argument that desktop computers were affecting the ability to fall sleep. The study required all the subjects to fill out two surveys; one accessed the type of desktop computer user the subject was, and the other identified the insomnia symptoms of the subject (Siomos, Braimiotis, Floros, Dafoulis, &

Angelopoulos, 2010). After analyzing the data, the authors found that the "frequency of computer use was statistically correlated with insomnia complaints" (Siomos et al., 2010, p. 3); thus, the more a person used a desktop computer, the more insomnia symptoms he or she displayed. Additionally, the authors reported that "even minimal computer users fared significantly worse as to the number of suffers of insomnia when compared to non-users" (Siomos et al., 2010, p. 5), so even if a person used a desktop computer minimally, then he or she will still have far more insomnia symptoms than a nonuser. Hence, the sleep problems caused by desktop computers are nearly impossible to avoid, unless the user is smart about when he or she uses the computer.

There are a few ways to avoid the sleep problems caused by desktop computers; one way is to avoid using the desktop computer close to bed time. A delay in production of melatonin while using a desktop computer is inevitable because of the blue light emission; however, the user can control whether this delay happens in the middle of the day, when melatonin is naturally not being produced, or happens near bed time, when melatonin is naturally being produced. Therefore, the right time to use a desktop computer is during the day because melatonin production is already being prohibited. Another thing a person can do is purchase a computer that does not have an LED backlight, so he or she is not exposed to as much blue light.

Conclusion

Desktop computers have been proven to cause eye, musculoskeletal, and sleep problems; however, desktop computers are not going away anytime soon, so it is important to understand and apply recommended methods to cope with these problems. All schools and businesses that require people to work on desktop computers should encourage them to do the following: take optional breaks about every hour and a half to rest the musculoskeletal system as well as the

eyes, and not require work to be done on a computer within an hour of 10 o'clock, which is a usual bedtime, to avoid delayed melatonin production or trouble falling asleep. By following these recommendations, people should be able to successfully combat the eye, musculoskeletal, and sleep problems experienced during desktop computer use.

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