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Ergophthalmology around COVID-19

La ergoftalmología entorno a la COVID-19

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Abstract

Due to the confinement at home that is lived in various countries by the pandemic of the new coronavirus COVID-19 in Wuhan, China and its spread worldwide. Changes have been brought about in the daily life of the population, for example the way of carrying out academic and professional work. Work hours increased and with it the use of various visual devices to carry out activities. Therefore, the objective of this research was to evaluate the state of visual health and ergonomics by the population during the health contingency. An evaluation instrument generated in the "Microsoft Forms" software was applied to evaluate ergophthalmology and visual health. An absolute positive correlation was found in the symptoms of blurred vision and muscle pain in the male gender, while for the female gender an absolute correlation was reported in the glare symptom and a positive correlation in dry eye, red eye, burning, tearing and muscle pain. Therefore, it is of utmost importance to disseminate ergophthalmic measures to reduce the visual symptoms of the population.

Index terms: Visual health, ergonomics, COVID-19

Resumen

Debido al confinamiento en casa que se vive en diversos países por la pandemia del nuevo coronavirus COVID-19 en Wuhan, China y su propagación a nivel mundial. Se han provocado cambios en la vida cotidiana de la población, por ejemplo, la forma de realizar las labores académicas y profesionales. Aumentaron las horas de trabajo y con ello el uso de diversos dispositivos visuales para efectuar las actividades. Por lo que, el objetivo de esta investigación fue evaluar el estado de salud visual y ergonomía de la población durante la contingencia sanitaria. Se aplicó un instrumento de evaluación generado en el software “Microsoft Forms” para evaluar la ergoftalmología y salud visual. Encontrando una correlación positiva absoluta en los síntomas de visión borrosa y dolor muscular en el género masculino, mientras que por el género femenino se reportó una correlación absoluta en el síntoma de deslumbramiento y una positiva en el ojo seco, ojo rojo, ardor, lagrimeo y dolor muscular. Por lo que, es de suma importancia difundir las medidas ergoftálmicas para aminorar la sintomatología visual de la población.

Palabras clave: Salud visual, ergonomía, COVID-19

I. INTRODUCCIÓN

Faced with the outbreak of the new coronavirus COVID-19 in Wuhan, China, and its expansion to several countries around the world, the WHO (2020) at the beginning of December confirmed more than 66 million infected people and more than a million deaths [1]. Since the first positive cases appeared in China and later in different countries, preventive measures were disseminated to reduce infections in the population such as: use of masks, antibacterial gel, aerosols, continuous hand washing, keeping distance from people, monitoring of new cases and quarantines [2], [3], [4], [5].

The latter being a beneficial measure showing that it is an effective activity to reduce the infection rate, as long as it is applied in a compulsory and massive way, respecting preventive measures. Currently, the health contingency that is experienced has caused the confinement of millions of families in the world, which has modified habits of students and workers, for example changes in academic and work activities; which have been supported by various visual devices such as computers, electronic tablets, smartphones and high-resolution screens [6], [7]. Taking classes and sessions through video calling platforms such as zoom, skype and teams, in addition to using social networks and apps for continuous communication for longer. These new routines can cause damage to people's health, for example cardiovascular problems, obesity, mental, stress, muscular, visual, among others [8], [9]. [10], [11].

For this reason, the new lapses to satisfy work and academic needs have reduced the visual health of the population that spends a lot of time in front of the screen of visual devices. It is estimated that between 50 and 90% of users suffer from some of the following symptoms: headache, red eye, eye fatigue, irritation, dry eye, burning, glare, excessive tearing, blurred vision, difficulty in focusing on distant objects and muscle pain, which is already associated with computer vision syndrome [12], [13], [14], [15]. These repercussions on vision are caused mainly by prolonged use of at least 1 visual device in a period of at least 3 hours per day. Excessive use, whether due to long hours of work or many hours of entertainment, generates that little by little symptoms begin to be detected in the body and as the hours go by, the symptoms become more acute. Being dry eye one of the main symptoms and a trigger for others [16], [17], [18], [19], [20], [21].

Some authors have reported a direct relationship between dry eye and exposure to blue light emitted by the screens of visual devices such as computers, electronic tablets and mobile phones [22], [23], [24], [25]. Dry eye in users of these electronic devices is a very common symptom and has been linked to reduced tear film break-up time. Either due to poor tear production or rapid evaporation of it, due to long hours of work in front of the visual screen [26], [27], [28], [29].

On the other hand, the blue light emitted by visual devices through their screens also affects the sleep cycle or circadian rhythm. Due to the over-excitation of the photoreceptors of the eye by the screens with high resolution, causing the secretion of melatonin to be inhibited and, likewise, sleep time is delayed. Another collateral damage with respect to the short time of sleep, is that the cellular re-epithelialization of the cornea is prevented since you do not sleep enough for this to occur normally [30], [31].

Therefore, in these times the importance of maintaining good ergonomics is accelerating, *i.e.* it is a discipline that is responsible for establishing an optimal workplace, where comfort, satisfaction and job security are sought; in order to maintain a good state of physical and psychological health as a beneficial factor to reduce eye and body symptoms when facing visual devices [32]. Since having a correct posture of the head, hands, arms and spine in front of the visual device can help the muscular and visual symptoms to appear less frequently [33-35]. The word ergoftlamology, which is a word composed of the words ergonomics and ophthalmology and refers to the study and investigation of eye discomfort caused in the workplace, by a physical or chemical agent [36].

As well as having adequate lighting in the work area, maintaining a correct distance between vision and the screen of the device in use, etc. [37], [38], [39].

Due to the changes made in the way of working in the face of the pandemic that is currently being experienced throughout the world, having school activities and workdays at home supported by the internet, multiple applications and various electronic devices. The objective of the research is to find the relationship

between ergonomic measures and visual symptoms of users of visual devices during the pandemic in population of Mexico City and its metropolitan area, in order to observe if the population presents changes in visual health given the new measures of academic and work during quarantine.

II. MATERIAL AND METHODS

In this research, a form was applied that was generated in the software "Microsoft Forms" and was disseminated through the following link:
https://forms.office.com/Pages/ResponsePage.aspx?id=DQSIkWdsW0yxEjajBLZtrQAAAAAAAAAAAAa__ZoH60VURVdTQ0lMNlVNVzdVRlQwUDJPVkw1VEE1Uy4u

It was also disclosed through a Word document with the aim of knowing the visual health status of visual device users before and during the COVID-19 pandemic. It was applied to the student and work population (mainly teachers) of Mexico City and the metropolitan area that met the evaluation criteria described in Table 1. Inclusion criteria included individuals of any gender, aged 15 years and older and who use one or more visual devices during the health contingency, and as exclusion criteria, people suffering from an uncontrolled chronic or autoimmune disease, due to since some symptoms are part of the pathology and could be confused by the one caused at the time of being in front of the visual devices [31].

The form is made up of 5 sections. Starting with the personal data information. The second section covers knowledge about optimal ergonomic measurements during working time with visual devices (amount of luminance in the work area, working distance, body position and working angles). The third section evaluates the ocular symptomatology presented while working in front of the device screens, considering 2 times (before and during the health contingency). Continuing the section on eye care and finally, closing with a thank you section. The questionnaire was conducted based on the LEST method, which is designed to evaluate ergonomic measures [40].

TABLE 1
EVALUATION CRITERIA

Inclusion criteria	**Exclusion criteria**
Any gander	People with autoimmune disease
Age 15 and over	People with uncontrolled chronic disease
User of 1 or more visual devices	

The questionnaire was based on the LEST method, which reports the established recommended ergonomic ranges [40]. We also used the likert scale to evaluate the qualitative and quantitative data on the questions regarding the state visual health of visual device users, the measurement scales are described in Table 2 [41].

TABLE 2
ASSESSMENT SCALES

Variable	Sub variable	Method	Measurement scale
Visual device usage time	Hours	LEST method	0-2 h 2-4 h 4-6 h 6-8 h + 8 h
Ergonomic measurements	Illumination	Método method	200 lux 350 lux 400 lux 500 lux
	Working distance		20-30 cm 31-40 cm 41-50 cm

			51cm -more
	Viewing angle		5º 10º 20º 40º
	Arms and legs angle		30º 45º 90º
Visual symptomatology	Redness Tearing Burning Dry eyes Blurred vision Glare Headache Skeletal muscle pain	Likert Scale	Null (0)- mild (1)- moderate (2)- severe (3)

A. STATISTIC ANALYSIS

The principal components analysis was applied, where the average variabilities of each of the components were determined [42]. Correlation of variables using Fitopac (version 2.1).

III. RESULTS

The number of participants who answered the form in both genders was 102 people (62 men and 60 women). In Fig. 1, the relationship between gender and age of the participants can be observed, with the greatest number of male participants being found in the age range of 21 to 30 years. The number of women is homogeneous in all ranks. On the other hand, academic work is performed between the ages of 15 to 40 years, highlighting more specifically between 15-20 years. While professional work is performed by users 21 years of age and older, highlighting the age of 41 and over. Finally, the performance of both jobs (professional and academic) is most practiced, between the ages of 21 to 40 years.

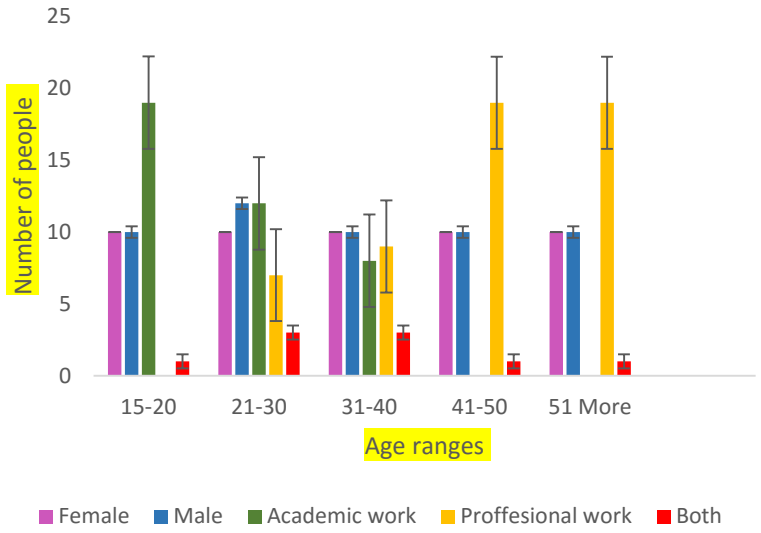

Fig. 1. Age groups of visual device users by gender and work activity

Table 2 shows the symptoms evaluated through the form, before and during the health contingency. It is shown in a comparative way between the male and female gender. Finding on the part of the male sex a greater increase in symptoms such as tearing, burning, dry eye, glare, headache and muscle pain during the health contingency that is currently experienced, going to a moderate state of 8, 2, 10, 5, 5 and 7% respectively. While for the female gender, the symptoms with the greatest change during quarantine are burning, glare and muscle pain at a severe level with 2, 5 and 5% respectively.

TABLE 3
VISUAL SYMPTOMS BEFORE AND DURING THE HEALTH CONTINGENCY

Gender	Age range	Visual symptomatology															
		Before the Pandemic								**During the Pandemic**							
		Redness	Tearing	Burning	Dry eyes	Blurred vision	Glare	Headache	Skeletal muscle pain	Rednees	Tearing	Burning	Dry eyes	Blurred vision	Glare	Headache	Skeletal muscle pain
MALE	15 a 20	0.3	0	0.4	0.3	0.3	0.5	0.4	0	0.9	0.2	1	0.7	0.7	0.6	1.1	0.4
	21 a 30	0.25	0.16	0.5	0.58	0.08	0.25	0.16	0.33	1.25	0.33	0.75	1.16	0.25	0.66	0.75	0.83
	31 a 40	0.3	0.1	0.6	0.5	0.4	0	0.3	0.7	1.2	0.5	1	1.2	0.9	1	1.3	1.4
	41 a 50	0.6	0.4	0.6	0.9	0.5	0.3	0.5	0.6	0.8	0.7	1.2	1.4	0.8	0.4	0.7	1.1
	51 More	0.2	0.1	0.2	0.3	0.8	0.1	0.4	0.8	0.6	0.6	0.8	0.9	1.2	0.6	0.9	1.5
FEMALE	15 a 20	0.5	0.5	0.8	0.4	0.7	0.5	0.4	0.4	0.6	0.8	1.4	1.3	1.2	1.1	0.6	1.3
	21 a 30	0.4	0.4	0.3	0.6	0.4	0.5	0.4	0.2	1.2	1.2	1.6	1.3	1.3	1.8	1.5	1.6
	31 a 40	0.6	0.3	0.4	0.5	0.7	0.5	0.6	0.8	1.1	0.4	1.1	1.2	1	1.7	1	1.6
	41 a 50	0.6	0.3	0.5	0.8	0.7	0.2	0.4	0.6	1.5	0.7	1.1	1.3	1.5	0.7	1.4	1.5
	51 More	0.4	0.3	0.2	0.7	0.2	0.2	0.2	0.6	0.8	0.9	1.2	1.7	0.8	0.6	1.3	1.6

In Fig. 2, it can be observed that most of the users of visual devices are unaware of the optical measures to carry out their activities in their work area.

It is observed that 10% only know the position of the light when they are working, only 1% know that 500 lux is the amount of light that the work area must maintain. On the other hand, only 10% know the angle at which the arms and legs should be (90º). The ergonomic measure that the least population has knowledge of the working distance in front of the device screen (50 cm), since 40% know that it is between 50 cm.

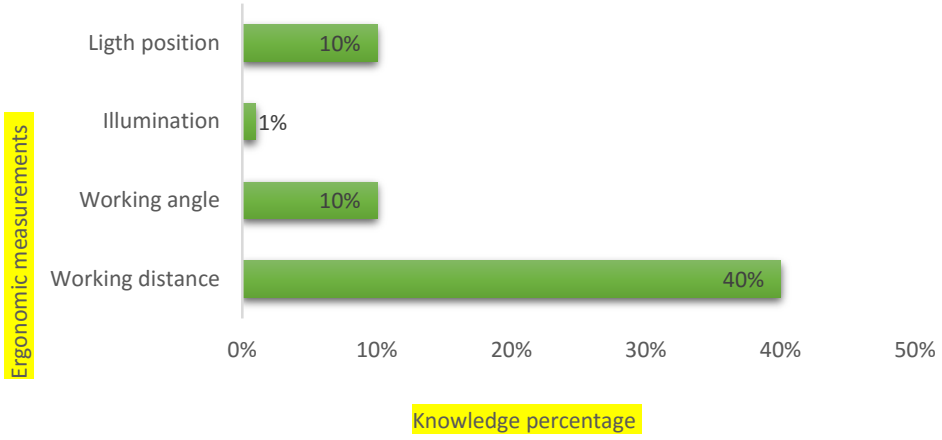

Fig. 2. Knowledge of ergonomic measurements

Fig. 3, shows the results on the use of visual devices in the female gender, before (left image) and during (right image) the COVID-19 pandemic. It is observed that the computer and the mobile phone maintain constant use before and during the pandemic. But the tablet increased use during the pandemic. On the other hand, the use of the image projector presented a decline in use, since they are more occupied in the classrooms generally.

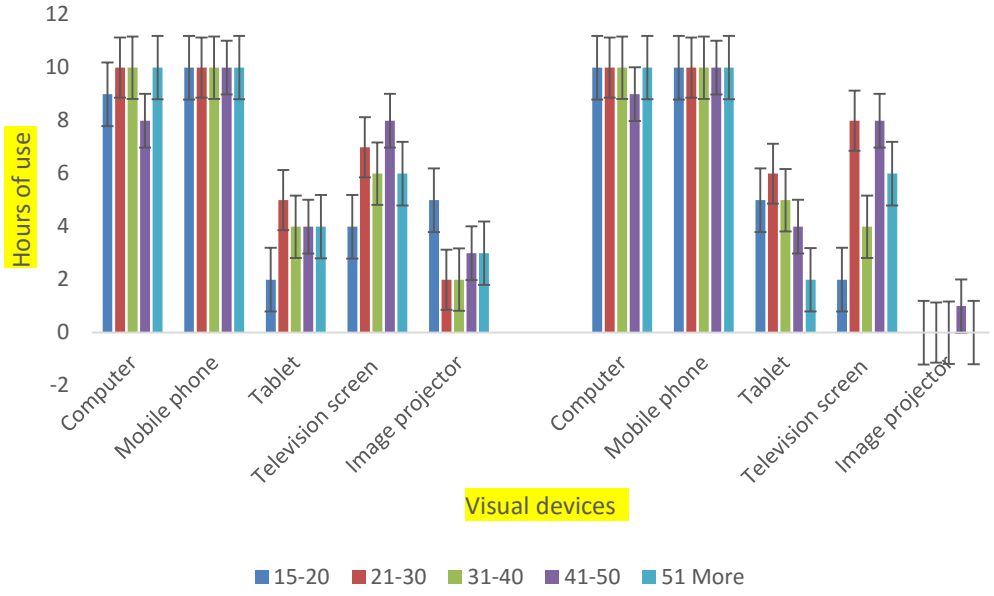

Fig. 3. Use of visual devices by age range before and during the COVID-19 pandemic, female gender

Fig. 4 shows the main component analysis of each of the elements and the correlation between the variables: Red eye, excessive tearing, burning, dry eye, blurred vision, glare, headache and muscle pain. The analysis was carried out by female and male gender and according to the age range of 15-20, 21-30, 31-40, 41-50 and 51-plus.

Regarding the evaluation of the male gender, it is observed that the symptoms with the greatest change before and during quarantine are: red eye from 3 to 15% in the age range of 21-30, headache from 3 to 11% in the range of 31-40 years. Likewise, an absolute positive correlation was found in the symptom of muscle pain and blurred vision (The angle formed between them is less than 15 °, so the cos Φ> 0.96-1, where Φ is the angle formed between the two vectors of the correlated variables, located in quadrant IV). Also, a moderate positive correlation was observed in the dry eye symptom (located in quadrant I). In addition to a positive correlation in tearing and burning (located in quadrant III and IV).

On the other hand, in the data of the female gender, the symptoms with the greatest change before and during the quarantine was observed, headache of 3 to 10% in the age range of 21-30 years. On the other hand, an absolute positive correlation was found in the glare symptom. (The angle formed between them is less than 15 °, so the cos Φ> 0.96-1, where Φ is the angle formed between the two vectors of the correlated variables, located in quadrant IV). A positive correlation was also found between the symptoms of dry eye, burning, muscle pain, tearing, and red eye (located in all quadrants). Being the most reported symptoms by the female population.

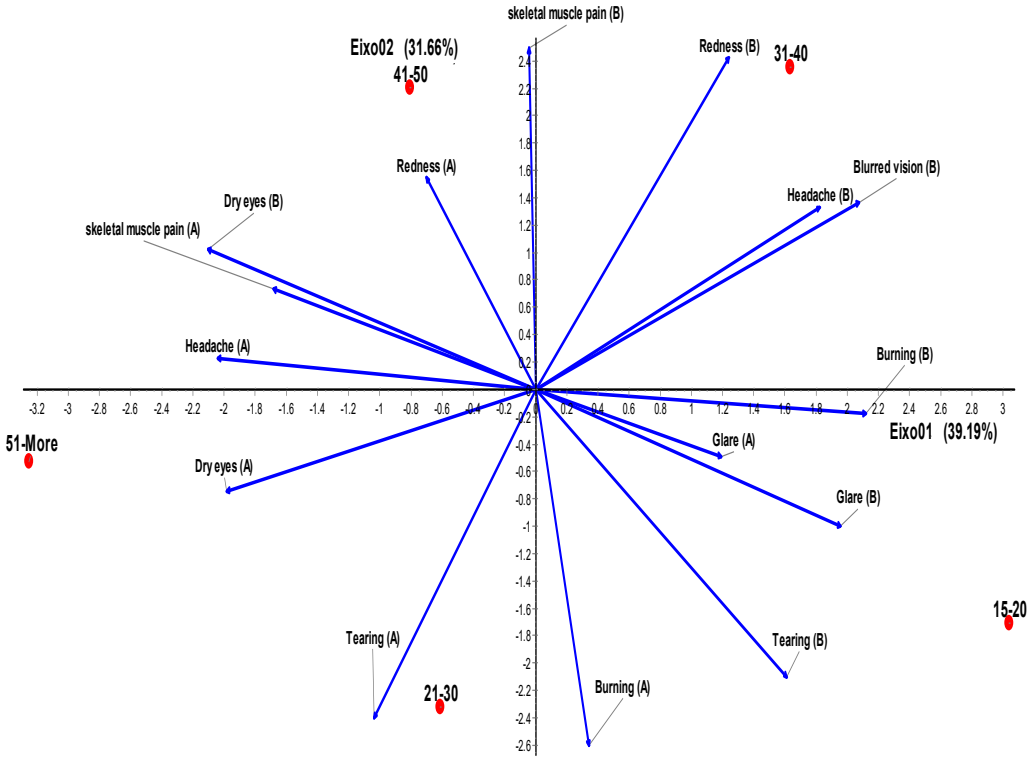

Fig. 4a. Analysis of principal components and correlation of variables before and during the health contingency: Female gender.

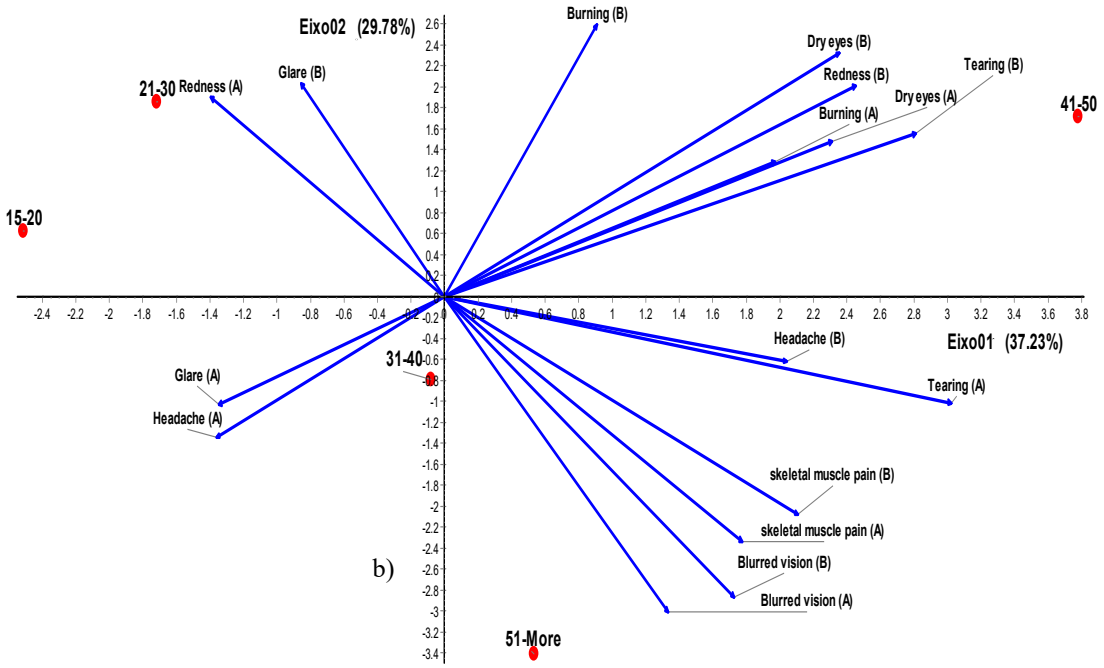

Fig. 4b. Analysis of principal components and correlation of variables before and during the health contingency: Male gender.

IV. Discussion

According to the results found in this research, it is reflected that confinement at home due to the COVID-19 pandemic has influenced the time of use of visual devices to perform professional and academic work. Finding a relationship between ignorance of recommended ergonomic measures at the time of academic or work tasks and the increase in working hours per day, supported by various visual devices such as mobile phones, computers, screens and tablets. Highlighting the absolute positive correlations of burning symptoms, blurred vision and muscle pain in the male gender. While the female gender reflected a moderate positive correlation between the symptoms of red eye, dry eye and muscle pain. Men being the gender with the greatest damage to visual health.

These deductions can be supported by the results of Carroll (2020), who, together with his work team, reported changes in habits among the Canadian population during quarantine. They applied an online form to various families to evaluate their daily life, which reported changes in unhealthy diet, increased stress and the propitious of a more sedentary life due to the excessive use of screens [43].

On the other hand, Von Gaudecker (2020) who together with his collaborators applied a form to the Dutch population, with the intention of identifying the modification of working hours from home according to the preventive measures imposed by the country. They observed that working hours decreased for those with a low academic degree compared to those with a higher education degree [44]. Regarding the part of ocular symptoms, the results are similar to those reported by Boadi-Kusi (2020) and collaborators, who applied a questionnaire to evaluate the work area and carried out a visual health study on employees of the administrative area of the University of the Cape Coast, where they found the presence of computer vision syndrome in just over half of the users of this visual device, since the majority used the computer for 6 hours or more [45].

Likewise, other works reflect that a large part of the ocular symptoms such as irritation, headache, dryness, photophobia, eye pain, red eye, excessive blinking and difficulty in focusing on objects is associated with the use of visual devices and erroneous ergonomic measures. As demonstrated by Atalhi (2020), Kharel and Khatri (2018) and their group of researchers respectively, who evaluated these characteristics in university students, also reporting an increase in visual symptoms among users of electronic devices [46], [47]. Highlighting the presence of the most common symptoms of computer vision syndrome such as headache and dry eye, which worsens as hours go by working in front of the computer screen [48], [49], [50].

As mentioned previously, some of these symptoms presented an absolute positive correlation in the male gender, during the work at home that is currently carried out. In other words, men presented greater damage to visual health compared to women. This could be because women are more careful with their health in general, as demonstrated by Unden and Elofsson (2006), when assessing different factors to self-assess the health of men and women. Reporting that both genders care about their health, but with the difference that the female gender gives priorities to aspects such as sleep and visits to the doctor. While the male gender leans towards physical and cultural activities [51].

Due to all of the above and in the face of new forms of professional and academic work, new measures have been taken to continue producing in the workplace and continue learning in the educational area. For example, the population has been re-educating itself to a new way of carrying out activities in these areas remotely, supported by new tools and virtual applications that facilitate group communication with school or work colleagues, bosses and teachers [52], [53]. Thus, this research work, comparing the results found by other authors, proposes taking recommended ergophthalmic measures together to modify and educate a new way of working at home, helping to reduce the visual and muscular symptoms that occur after working long hours. Such measures are to have lighting of 500 lux in the activity area, maintain a working distance between the view and the screen of the device in use, of 50 cm [54], [55]. In addition to maintaining a body position of legs and arms at an angle of 90 ° -110 ° and an angle of gaze towards the screen 20 ° (see Fig. 5) [56], [57].

Finally, it is recommended to include in the daily diet, foods rich in vitamins A, C, D and E, Lutein and Zeaxanthin. Since these nutrients help protect visual health against pathologies such as: cataract, dry eye syndrome and macular degeneration. Most of these nutrients act as antioxidants, that is, they protect cells from free radicals and the damage they generate. Some foods that contain these nutrients are: carrots, broccoli, cabbage, spinach, melon, mango, milk, beef, chicken, salmon, potatoes, tomatoes, kiwi and red-green peppers [58].

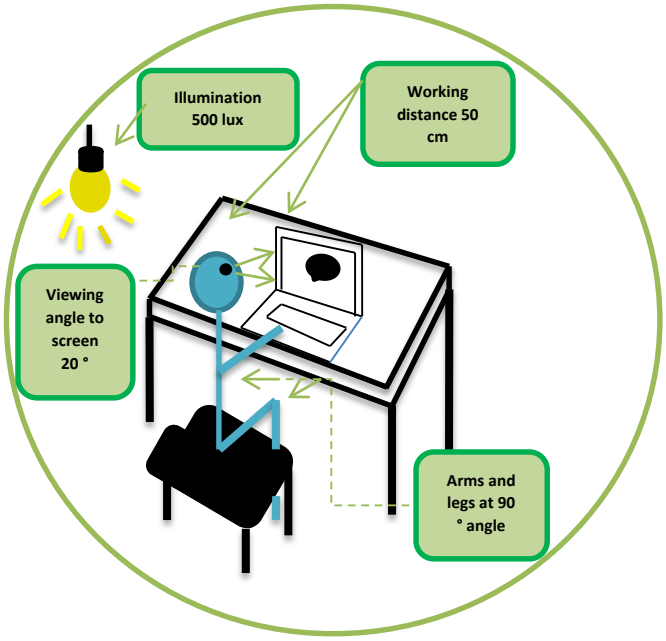

Fig. 5. Recommended ergophthalmological measures.

V. Conclusions

The research work through field research showed no knowledge of ergonomic measures by the population and allowed to know the continuous suffering of ocular symptoms in long hours during professional and academic work from home during the health contingency by the COVID-19. Likewise, it reflects an absolute positive correlation between the symptoms of burning, vision and muscle pain in the male gender. For the female gender, a moderate positive correlation between dry eye, red eye and muscle pain.

On the other hand, through the photoacoustic spectroscopy test it was observed that all the screens of the visual devices meet their objective of protection against blue light, although there are some that protect in a greater range than others, which may depend on the material with which they are manufactured since the black hue of the screen can interfere with the absorption and transmission of blue light.

Therefore, it is of utmost importance to implement recommended ergophthalmic measures during work at home in front of visual devices during quarantine. Likewise, in the office and schools when normality is returned after the current pandemic. In addition to acquiring lenses with filters, anti-reflective or blue ray to protect the eyes against the blue light emitted by electronic devices and to consume foods rich in vitamin A in the daily diet.

GLOSSARY

Ergophthalmology: New interdisciplinary area of study and investigation of eye discomfort caused in the workplace, by a physical or chemical agent.
Tearing: Much tear production
Lux: International System lighting intensity unit

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