ORIGINAL ARTICLE

INVESTIGACIÓN en DISCAPACIDAD
Vol. 9, No. 2
May-August 2023
pp 65-74
doi: 10.35366/111120

Effect of musculoskeletal disorders due to the use of data display screens in young university students

Efecto de los trastornos musculoesqueléticos por el uso de pantallas de visualización en jóvenes universitarios

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Keywords:
musculoskeletal disorders, data display screens, lordosis, university students, COVID-19 pandemic.

Palabras clave:
trastornos musculoesqueléticos, pantallas de visualización, lordosis, estudiantes universitarios, pandemia de COVID-19.

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Received: March 31, 2023
Accepted: April 7, 2023

Abstract

Introduction: the WHO in March 2020 declared COVID-19 as a pandemic, with the pronouncement that social distancing will be applied, then the lifestyle had to change, including learning activities that had to migrate to online using data display screens (DDS). However, prolonged use can generate severe health effects such as musculoskeletal disorders. **Objective:** analyze and correlate the different musculoskeletal disorders with prolonged use of DDS, as well as identify the possible injuries or postural modifications in university students during the COVID-19 pandemic. **Material and methods:** a cohort study was conducted with 65 students according to the selection criteria applied. X-ray plates (AP and lateral cervical spine) were taken from each of the participants. The radiological markings were carried out to assess and identify the presence of biomechanical alterations; comparisons were also made according to the use of DDS. **Results:** among the different types of DDS that the participants used, the highest percentage was for the smartphone, which they used in their bedroom for 9 to 10 hours per day. According to the ratio between the cervical angle and depth measurement, 75.4% of participants presented hypolordosis, and 72.3% presented extension or posteriority of C1. **Conclusions:** we demonstrated the presence of biomechanical alterations in the cervical spine derived from the prolonged use of DDS in university students, mainly in those who use smartphones for 8 to 10 hours. There is a significant correlation between the radiological markings of the cervical angle and the depth measurement, and a decrease in cervical curvature (hypolordosis).

Resumen

Introducción: *la OMS declaró como pandemia al COVID-19 en marzo de 2020, con el pronunciamiento de que se aplicará el distanciamiento social, entonces el estilo de vida tuvo que cambiar, incluyendo actividades de aprendizaje que tuvieron que migrar a online usando pantallas de visualización de datos (DDS, por sus siglas en inglés); sin embargo, el uso prolongado de éstas puede generar graves efectos en la salud, como trastornos musculoesqueléticos.* ***Objetivo:*** *analizar y correlacionar los diferentes trastornos musculoesqueléticos con el uso prolongado de DDS, así como identificar las posibles lesiones o modificaciones posturales en estudiantes universitarios durante la pandemia de COVID-19.* ***Material y métodos:*** *se realizó un estudio de cohorte con 65 estudiantes según los criterios de selección aplicados. Se tomaron placas de rayos X (AP y columna cervical lateral) de cada uno de los participantes. Se realizaron los marcajes radiológicos para evaluar e identificar las alteraciones biomecánicas, también se hicieron comparaciones según el uso de DDS.* ***Resultados:*** *entre los diferentes tipos de DDS que utilizaron los participantes, el mayor porcentaje de uso lo tuvo*

How to cite: Hernández-Rodríguez J, Herrera-López ME, Montiel-Flores E, Romero-Morelos P, Bandala C, Gómez-López M et al. Effect of musculoskeletal disorders due to the use of data display screens in young university students. Invest Discapacidad. 2023; 9 (2): 65-74. https://dx.doi.org/10.35366/111120

el teléfono celular, que fue utilizado en el dormitorio de nueve a 10 horas por día, según la relación entre la medición del ángulo cervical y la profundidad; del total de participantes, 75.4% presentó hipolordosis y 72.3% extensión o posterioridad a nivel de cervicales. ***Conclusiones:*** *demostramos la presencia de alteraciones biomecánicas en la columna cervical derivadas del uso prolongado de DDS en estudiantes universitarios, principalmente en aquellos que usan teléfonos celulares de ocho a 10 horas, existe una correlación significativa entre las marcas radiológicas del ángulo cervical y la medición de profundidad, lo que representa una hipolordosis en los estudiantes.*

INTRODUCTION

According to the research of Huang et al.,[1] a novel coronavirus, known as COVID-19, was discovered in December 2019. Subsequent analyses and reports allowed it to be characterized and made known that the SARS-CoV-2 virus can develop various health complications, at the level of the central and peripheral nervous system and defined that there are multiple ways of contagion during the incubation period.[2] For this reason, governments and institutions worldwide had to take important decisions regarding the rapid dispersion and severity of the mortality caused by the virus throughout the planet. For this purpose, the Director General of the World Health Organization in March 2020 declared COVID-19 as a pandemic,[3] with the additional pronouncement that social distancing would have to be a measure that will be applied to stop its spread. Then the lifestyle had to be changed throughout the planet, including the physical closing of businesses, activities, sports, and schools that had to migrate to online learning methods, through the use of the internet and computer technology.[4,5] Among the electronic devices incorporated in teaching, the data display screens (DDS) stand out. According to the National Institute for Occupational Safety and Health of Spain,[6] the DDS refer to any alphanumeric or graphic screen, through which one can represent text, numbers, or graphics, regardless of the presentation method used. However, the use of the different types of DDS can generate severe health effects, among which are ergonomic risks, such as musculoskeletal disorders, visual problems, and mental fatigue, among others, and whose probability of experiencing them is directly related to the frequency and duration of the periods of use, the intensity and degree of attention required to carry out an activity.[7] The use of various screens has been an action that increased during the COVID-19 Pandemic, particularly among students around the world, generating persistent health risks, which has been the subject of attention for several investigations worldwide (Akulwar-Tajane et al.[8] and Paradina & Prasetyo[9]) and in Mexico as that of Realyvásquez-Vargas et al.[10] in which the impact of taking online classes and its relationship with musculoskeletal disorders is evaluated. However, these investigations have only been based on identifying the symptoms and causes that are established with the excessive use of screens, mentioning in a general way about the mechanical disorders that can occur, and are not in charge of emphasizing precisely the type of alterations, the area, and their location. For this reason, the objective of this investigation was to analyze and correlate the different musculoskeletal disorders with prolonged use of DDS, as well as identify the possible injuries or postural modifications in university students during the COVID-19 pandemic.

MATERIAL AND METHODS

Sampling and participants. A cohort study was conducted. We initially counted with 200 students that represent the universe of the study population, then was calculated a significative sample, through the following formula:

$$\text{Sample} = \frac{nZ^2\ \rho q}{i^2\ (n = 1) + Z^2\ \rho q}$$

After applying the formula for the significative sample, 65 students were included in the study: 35 females (53.8%) and 30 males (46.2%). For this, the following selection criteria applied: age (18-24 years old), asymptomatic, and used DDS for six or more hours per day. The exclusion criteria were not having pain in the cervical area, surgeries, and chronic degenerative diseases. All data were collected through a survey (attached for your review). Only those who met the requirements were included.

Ethical approval. Informed consent was obtained on the first page of the study's questionnaire, and it was written in Spanish, which is the official language in México, it explained the aims of the study. Privacy was guaranteed. Participants were able to withdraw from the questionnaire at any point. All collected data were used for scientific and research purposes. This investigation was carried out by the norms established in the Declaration of Helsinki regarding the investigation of human beings, and established in the General Health Law and its Regulations on Research; 100% of the students signed informed consent.

Intervention. X-ray plates (AP and lateral cervical spine) were taken from each of the study participants. The respective radiological markings proposed below were carried out on each radiographic plate to assess and identify the biomechanical alterations that could have occurred in our population of participants; comparisons were also made according to the use of DDS.

Radiological markings.

1. Cervical angle marking was performed in a cervical lateral projection, establishing four markings. First: two points were drawn in the central part of the tubercles of cervical 1 (C1) and joined with a line. Second: two points were drawn on the lower part of the vertebral body of C7 (inferior epiphyseal plate) and joined with a line. Third and fourth: two perpendicular lines were drawn at 90º, one on the C1 line, the other on the C7 line.
   Although the angle that is generated can range between 35º and 45º when this angle is abnormal it can be indicative of:
   Hypolordosis: if a decrease in the obtained angle is found in comparison with the reference values.
   Hyperlordosis: if there is an increase in the angle obtained compared to the reference values.
2. Depth measurement marking was made in a cervical lateral projection. A vertical line was drawn starting at the rear aspect of C2 and ending at the lower rear corner of C7. The distance between the line and the posterior edge of C4 was measured. Although it is known that the normal measurement should be 12 millimeters, the measurements can range from 7 to 17 millimeters, so if the measurement is different, it can be indicative of:
   Hypolordosis: if the measurement is less than 7 millimeters.
   Hyperlordosis: if the measurement is greater than 17 millimeters.
3. Ferguson's gravitational line marking: this marking was made in a cervical lateral projection, for which a vertical line was drawn that began at the apex of the C2 odontoid process. If this line felt anterior to the anterior third, it was indicative that the load or stress (weight of the head) is supported mainly by the anterior elements (vertebral body and intervertebral disc), so it may be indicative of an ante-projection of the head and increased stress on the C7 articular pillars. If it fell posterior to the anterior third, it indicated that the load or stress is borne more by the posterior elements of the vertebrae (articular pillars, etc.) and therefore could be indicative of facet stress.

Statistical analyses. The data obtained were captured in software in Excel and SPSS version 15, for their analysis with descriptive statistics (arithmetic mean, standard deviation, frequencies, and percentage), normality will be extended with the Kolmogorov-Smirnov test, and Pearson's correlation coefficient. Likewise, the value of $p < 0.05$ with a confidence interval of 95% was taken as statistical significance.

RESULTS

Starting from the information collected through the survey applied to each of the students who were part of the sample of this study, the percentages referring to the type of computer equipment they used to take their classes online, the place where they usually make use of the DDS, and the time they use them regularly daily, the analyzed data is presented making a distinction between the values obtained according to the gender of the participants, and also all the percentages achieved for each one are presented. Of the analysis carried out. The percentages of the type of computer equipment that the participants use to carry out their academic activities online are presented in *Table 1*, we observe that 52.3% of the total study participants usually use a mobile device (smartphone) for these activities, while 27.7% use the portable equipment (laptop) and finally

Table 1: Cross tabulation of the participants' gender and the computer equipment they use.

	Type of equipment, n (%)			
Gender	Computer	Laptop	Smartphone	Total
Female	10 (28.6)	9 (25.7)	16 (45.7)	35 (100.0)
Male	3 (10.0)	9 (30.0)	18 (60.0)	30 (100.0)
Total	13 (20.0)	18 (27.7)	34 (52.3)	65 (100.0)

Table 2: Cross tabulation of gender and place of use of data display screens (DDS) by the participants.

Gender	Place of use of DDS, n (%)				
	Living room	Bedroom	Dining room	Office	Total
Female	4 (11.4)	19 (54.3)	10 (28.6)	2 (5.7)	35 (100.0)
Male	3 (10.0)	17 (56.7)	5 (16.7)	5 (16.7)	30 (100.0)
Total	7 (10.8)	36 (55.4)	15 (23.1)	7 (10.8)	65 (100.0)

Table 3: Cross tabulation of gender and time of use of data display screens (DDS) by the participants.

Gender	Time of use of DDS, n (%)					
	6 hours	7 hours	8 hours	9 hours	10 hours	Total
Female	2 (5.7)	5 (14.3)	4 (11.4)	16 (45.7)	8 (22.9)	35 (100.0)
Male	4 (13.3)	3 (10.0)	4 (13.3)	9 (30.0)	10 (33.3)	30 (100.0)
Total	6 (9.2)	8 (12.3)	8 (12.3)	25 (38.5)	18 (27.7)	65 (100.0)

Table 4: Cross tabulation of type of data display screens (DDS) and the time of use by the participants.

Equipment	Time and type of equipment of use of DDS, n (%)					
	6 hours	7 hours	8 hours	9 hours	10 hours	Total
Computer	2 (15.4)	4 (30.8)	1 (7.7)	4 (30.8)	2 (15.4)	13 (100.0)
Laptop	1 (5.6)	2 (11.1)	4 (22.2)	7 (38.9)	4 (22.2)	18 (100.0)
Smartphone	3 (8.8)	2 (5.9)	3 (8.8)	14 (41.2)	12 (35.3)	34 (100.0)
Total	6 (9.2)	8 (12.3)	8 (12.3)	25 (38.5)	18 (27.7)	65 (100.0)

only 20% use the desktop equipment (computer), in addition, it was observed that in both genders there is a greater predominance for the use of a smartphone compared to other options.

Regarding the place where the participants usually make use of the DDS to develop their academic activities, *Table 2* shows that, among the possible areas of stay, both in the female and male participants, the highest percentage that was registered indicates that the place of preference is inside the bedroom (bed) with values of 54.3% and 56.7%, respectively. While the lowest percentage of use of the DDS in the case of the female sex is in an office at 5.7%, and in the case of the male sex it was recorded that it is in the room with a value of 10%, evaluating the total number of the percentages it was identified that the living room (armchair) and the office are the least preferred places to develop the academic activities of the participants, with 10.8% for both cases.

The analysis of the time of use of the electronic devices is presented in *Table 3*, in which it was found that 66.2% of the participants invest 9 to 10 hours per day for the use of DDS, likewise, it was recorded that only 9.2% of study subjects spend 6 hours a day using DDS, when evaluating the percentage of time using DDS in each of the genders, it was found that 45.7% of female participants spend 9 hours a day compared to a DDS, while the highest percentage of male participants (33.3%) tend to invest up to 10 hours a day in front of a DDS. On the other hand, as shown in *Table 4*, we confirm that the use of smartphones has a greater predominance with a value of 52.3% corresponding to a total of 34 participants, followed by using portable equipment with 27.7% proportional to 18 participants, finally, the use of desktop equipment (computer) represents 20% because only 13 participants report using it.

The data corresponding to the inferential statistics made to all the radiological markings of the lumbar spine and the cervical spine are presented in *Table 5*, it was observed that in all of them, there was a normal distribution according to the Kolmogorov-Smirnov statistical test.

In *Table 6* we can see that, after performing the test to calculate Pearson's correlation coefficient, it was determined that the cervical angle had a high positive slope concerning the depth measurement, the same type of correlation was observed between the angle cervical and the angle of the Atlas. Regarding the relationship between the depth measurement and the angle of the Atlas, it was determined that there is a moderate positive slope. In the case of the lower back, it was observed that the lumbar lordosis angle correlated with a positive slope with Ferguson's line. It is worth mentioning that in all the previous markings a $p < 0.05$ was obtained. It is important to mention that in the analysis between the cervical angle and the angle of the lumbar lordosis, no correlation was observed.

The analysis of the percentages of the measurements made and the determination of the degree of lordosis according to the value of the evaluated angle is presented in *Table 7*. We observed that there is a greater predominance of cervical hypolordosis in the female participants because presented a value of 80% in the cervical angle and depth measurement of 77.1%, in the same way, this effect was presented in the male participants, because the measurement of the cervical angle, a value corresponding to 70% was registered.

Table 5: Descriptive statistics of the measurements performed.

Radiological markings	N	Measurement (mm)	Kolmogorov-Smirnov
Cervical angle	65	32.1 ± 11.3	0.77
Depth measurement	65	5.3 ± 4.8	0.16
Angle of the Atlas	65	15.0 ± 7.7	0.29
Gravity line of C2	65	6.9 ± 13.1	0.94
Lumbar lordosis angle	65	43.1 ± 9.2	0.92
Ferguson's line	65	0.35 ± 15.6	0.78

Data are presented as the mean ± standard deviation.

Table 6: Pearson's correlation coefficient between the markings performed.

Radiological markings		Correlation coefficient	p
Cervical angle	Depth measurement	0.75	0.05
Cervical angle	Angle of the Atlas	0.53	0.05
Depth measurement	Angle of the Atlas	0.45	0.05
Lumbar lordosis angle	Ferguson's line	0.49	0.05

Table 7: Cross tabulation of the gender and the angle of measurement performed.

Gender	Normal	Hypolordosis	Hyperlordosis	Total
		Cervical angle, n (%)		
Female	4 (11.4)	28 (80.0)	3 (8.6)	35 (100.0)
Male	5 (16.7)	21 (70.0)	4 (13.3)	30 (100.0)
Total	9 (13.8)	44 (75.4)	7 (10.8)	65 (100.0)
		Depth measurement, n (%)		
Female	8 (22.9)	27 (77.1)	0 (0)	35 (100.0)
Male	11 (36.7)	17 (56.7)	2 (6.7)	30 (100.0)
Total	19 (29.2)	44 (67.7)	2 (3.1)	65 (100.0)
		Angle of the Atlas (C1), n (%)		
	Normal	**Extension**	**Flexion**	
Female	3 (8.6)	26 (74.3)	6 (17.1)	35 (100.0)
Male	2 (6.7)	21 (70.0)	7 (23.3)	30 (100.0)
Total	5 (7.7)	47 (72.3)	13 (20.0)	65 (100.0)

Table 8: Cross tabulation of time of use of data display screens (DDS) and the angle of measurement performed.

Time (hours)	Normal	Hypolordosis	Hyperlordosis	Total
		Cervical angle, n (%)		
6	1 (16.7)	4 (66.7)	1 (16.7)	6 (100.0)
7	3 (37.5)	4 (50.0)	1 (12.5)	8 (100.0)
8	0 (0)	6 (75.0)	2 (25.0)	8 (100.0)
9	3 (12.0)	21 (84.0)	1 (4.0)	25 (100.0)
10	2 (11.1)	14 (77.8)	2 (11.1)	18 (100.0)
Total	9 (13.8)	49 (75.4)	7 (10.8)	65 (100.0)
		Depth measurement, n (%)		
6	2 (33.3)	3 (50.0)	1 (16.7)	6 (100.0)
7	3 (37.5)	4 (50.0)	1 (12.5)	8 (100.0)
8	2 (25.0)	6 (75.0)	0 (0)	8 (100.0)
9	4 (16.0)	21 (84.0)	0 (0)	25 (100.0)
10	8 (44.4)	10 (55.6)	0 (0)	18 (100.0)
Total	19 (29.2)	44 (67.7)	2 (3.1)	65 (100.0)
		Angle of the Atlas (C1), n (%)		
	Normal	Extension	Flexion	
6	0 (0)	4 (66.7)	2 (33.3)	6 (100.0)
7	1 (12.5)	3 (37.5)	4 (50.0)	8 (100.0)
8	0 (0)	7 (87.5)	1 (12.5)	8 (100.0)
9	3 (12.0)	20 (80.0)	2 (8.0)	25 (100.0)
10	1 (5.6)	13 (72.2)	4 (22.2)	18 (100.0)
Total	5 (7.7)	47 (72.3)	13 (20.0)	65 (100.0)

and depth measurement of 56.7%, while in the analysis of the Atlas angle, we observed that derived from the prolonged use of DDS there is a greater predisposition to present an extension or posteriority of the Atlas (C1) in the female participants compared to the male participants, presenting a difference greater than 4% between the results, however, if the total value of the angle of extension is evaluated between all After considering the participants, it can be confirmed that this effect is predominant for both sexes evaluated by reaching a result of 72.3%, which is greater than the results of the normal and flexion angle, corresponding to 7.7% and 20%, respectively.

The ratio between the time of use of the DDS with the degree of the cervical angle presented by the participants of the present investigation is shown in *Table 8*, it was observed that 75.4% of the total participants presented hypolordosis, and among the different times of use of the DDS, it is possible to distinguish that the highest percentages occur among those who make daily use for 8 hours (75%), 9 hours (84%) and 10 hours (77.8%). On the other hand, only 10.8% of the total study participants presented hyperlordosis, with the highest percentage occurring in 8 hours of daily use (25%). The percentage of subjects with the presence of a normal cervical angle was 13.8%. Regarding the depth measurement data, it was observed that of the total number of participants who presented hypolordosis (44), the largest number of them focused between 9 and 10 hours of daily use of DDS with a total of 31 participants representing 70.4%, only two participants presented hyperlordosis, which represents 3.1% of the total, and 19 participants maintained a normal measurement (29.2%) throughout the different times evaluated *(Table 8)*. Regarding the Atlas angle, it was identified that 47 participants present extension or posteriority of C1 40 of them reported prolonged use of DDS (between 8 and 10 hours per day), corresponding to 85.1% of the total with alterations.

DISCUSSION

Currently, the use of the various types of DDS has acquired great relevance, to the degree of being essential in various activities, especially those that are linked to information and communication technologies, however, the prolonged use of these instruments has been reported to have a series of harmful health effects, among them, they can cause musculoskeletal disorders due to prolonged and inappropriate use of these instruments,[11] other effects on physical health, involve visual fatigue, changes in sleep quality, and physiological stress, coupled with the fact that excess screen time (refers to the amount of time spent in various activities performed online using digital devices), can cause a negative impact on mental health, as it has been associated with isolation, low emotional stability, and greater risk for depression or anxiety.[12] In the present study, the information referring to the type of computer equipment, the place of preference for the use of DDS, and also the time of daily use by the participants, were collected and analyzed, in this regard, it was identified with great clarity that most of them, including both genders, use a smartphone in a higher percentage in their bedroom for around 9 to 10 hours per day. Our data coincides with the study by Amro et al.,[13] who evaluated musculoskeletal disorders and their association with social media use among university students during the quarantine time of COVID-19, where they observed an increase in the time use of various DDS equipment, particularly, in the case of smartphones report that the time practically doubled to more than 7 hours per day, as pointed out by most of the participants of this research, however, the investigation of them, only mentions data and percentages referring to musculoskeletal disorders such as headache, neck pain, and back pain in participants who externalize them, without performing any radiological marking or analysis in those who still do not present any symptoms of pain or similar as was done in this study, other works that have evaluated the effect of the use of DDS for the transition to learning online, Elhossiney et al.,[14] who report and characterize various osteomuscular discomforts that occur throughout different parts of the body in students, and that have repercussions on physical condition and mood, however, in their investigations, they do not include asymptomatic students, so their conclusions are mainly focused on proposing treatments and considerations that remedy these affectations, while they offer few preventive strategies for those who still do not have any indication of musculoskeletal disorders, which by imaging and radiology techniques can be identified at an early stage, as we demonstrated in this study.

The research reports by Burton[15] are a good precedent where he mentions and supports that verification of alignment has traditionally been in the form of standard criteria using radiographs since physicians are always looking for measurement tools that are conservative and non-invasive, so radiological markings are part of a tool that is particularly useful to measure biomechanical alterations in an inexpensive, practical, and highly reproducible and reliable way.

The work of Filho et al.,[16] points out the optimal measurements for the Angle of the Atlas, as well as the appropriate location of C1 among humans, and its differences between sexes; and they specifically emphasize the importance of spinal stability to reduce the risk of problems and injuries.

Regarding the angle of the Atlas, in the present work it was identified that 47 participants present extension or posteriority of C1 in 40 of them (representing 85.1% with this alteration), they spend a prolonged time of use of DDS (between 8 and 10 hours per day), so this may be the origin of a certain alteration. Manoharan et al.,[17] made a retrospective study of the relationship of cervical sagittal vertical alignment after sagittal balance correction in adult spinal deformity, using markings linked to C2 and C7, as is the case of the gravity line of C2, these markings allowed them to evaluate the correction of the spinal deformity, while in our case it was taken as an indicator of facet stress, due to the breadth of application, analysis, and interpretation that this marking has, as well as the others that are reported in the present work. The lumbar lordosis angle has been evaluated in previous studies, such as that of Been & Kalichman,[18] who mention that this marking has been a key postural component of interest to physicians and researchers for many years and sought to determine normal values. of lordosis according to certain characteristics, which were taken into consideration for the analysis of our results, therefore, they seek to determine normal values of lordosis according to certain characteristics, which were taken into consideration for the analysis of our results, Okpala,[19] even made a comparison of four radiographic angular measures of lumbar lordosis, highlighting that radiography is the gold standard in research and that the measure of the lumbar lordosis technique is one of the most reliable because it allows to simplify and standardize, to propose a diagnosis, treatment, and follow-up of patients, so its use in this study reinforces the conclusions that we later issued. The establishment and maintenance of lumbar lordosis (physiological curvature) can be evaluated through radiographic analysis techniques, such as the Ferguson's line, also called lumbosacral angle or «sacral angle» as mentioned by Naqvi et al.,[20] who also indicate that the values of this measurement allow to identify abnormalities like hypolordosis and hyperlordosis, so it is important to know the normal values of this angle, to diagnose pathological conditions, in this regard Okpala,[21] carried out a retrospective study of lumbosacral angle, for measuring lordotic angles among the Nigerian population, establishing the values of normal lordosis, hypolordosis, and hyperlordosis, although the initial objective of this research is to assess the effect of musculoskeletal disorders due to the use of DDS in university students, also it allows to be a precedent for future studies that seek to identify the degree of lordosis among the student and local population of our country, because the method used in this work is widely used internationally.

According to the results of the present investigation, it was possible to determine that there is a statistical significance of $p < 0.05$ in the Pearson correlation coefficient made between the radiological markings evaluated, so it is possible to mention that biomechanical alterations were found among all the participants of the sample studied, this reminds us of what was mentioned in the analysis carried out by Cieza et al.,[22] and by the WHO,[23] which indicates that approximately 1.71 billion people have musculoskeletal conditions worldwide, among which low back pain is the most frequent, with a prevalence of 568 million people, in which they cause disorders that they limit mobility and dexterity, greatly reducing the quality of life, since musculoskeletal disorders can cause a wide variety of conditions and musculoskeletal pain diseases that involve an injury or disorder of the muscles, bones, tendons, ligaments, joints, cartilage and spinal discs, so these disorders can cause pain and loss of function, and be one of the causes of disabling conditions linked to the workplace. Research by Gore,[24] mentions that neck pain has increased frequently in today's society, since in his research he carried out a follow-up study for 10 years in 200 asymptomatic subjects, and reports that there was an incidence of 15% in those who developed neck pain, is important to note that the sample of the present study were university students between the ages of 18 and 24 years of age, who were asymptomatic, however, biomechanical alterations were visualized in the diagnosis of cabinet studies, therefore, as reported in studies such as the one by Stovner et al.,[25] that headache disorders are among the most prevalent and disabling conditions worldwide, which is why they will be one of the conditions that most request attention in the population worldwide.

In the present investigation, all the diagnoses of the radiological markings led us to the decrease or loss of cervical lordosis, which according to the diagnoses established by the International Statistical Classification of Diseases and Related Health Problems (ICD-11), is classified as within the diseases of the musculoskeletal system and it is called cervical hypolordosis, and according to the depth measurement and cervical angle markings, there was between 80-85% presence of cervical hypolordosis among the participants.

It should be noted that different studies have already made correlations between biomechanical alterations and the symptoms of the cervical area, within which we can mention Katsuura et al.,[26] in whose article they refer to the correlation between neck pain symptoms and loss of lordosis, Bagnall et al.,[27] comments that the cervical lordosis is formed *in utero* and with a wide range of studies they report the need for normal cervical lordosis. The current Index Medicus literature indicates that neck pain, headaches, surgical cases, rehabilitation treatments, whiplash, and degeneration incidences point to the relevance of cervical curvature as an important outcome in care, however, it had not been possible to describe the type and what was one of the specific factors that cause this type of injury in the cervical spine. To date, there are very few publications in the area of biomechanics of the human body, so it should be noted that the present investigation reports the daily time that university students dedicated to the use of DDS and the space they occupy for their academic activities, where the use of the smartphone predominates with 75%, it can be a good background for future work where the relation between academic activities and daily consultation of social networks from DDS is evaluated, therefore, it will be of the utmost importance that these types of activities be taken into consideration, making use of the DDS in the new academic models that will be implemented in educational institutions, because as Chen & He[28] mention, the biomechanical changes located in the cervical spine are derived from the different positions and time of neck flexion, causing variations in the height of the trunk, and the health of the spine and the well-being of each individual will depend on these factors together.

CONCLUSIONS

Biomechanical alterations in the cervical spine derived from the prolonged use of DDS in university students during the COVID-19 pandemic were found.

It was identified that the use of the DDS to carry out academic activities can range from 8 to 10 hours per day, and using smartphones in an inappropriate posture predominates.

There is a significant correlation between the radiological markings of the cervical angle and the depth measurement.

Derived from the prolonged use of the DDS and a bad posture in the place where they are used, a decrease in cervical curvature (hypolordosis) has originated in young university students.

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Declaration of competing interest: the authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.